

Advances in Multidisciplinary Research and Development

(Volume - 8)

Chief Editor

Dr. Dhondiram Tukaram Sakhare

Assistant Professor & Research Guide, UG, PG & Research Centre,
Department of Chemistry, Shivaji Arts, Comm. & Science College Kannad
Dist. Aurangabad, Maharashtra, India

**Scripown Publications
New Delhi**

Copyright © 2023 Scripown Publications

*All rights reserved. No part of this publication may be reproduced, distributed, or transmitted in any form or by any means, including photocopying, recording, or other electronic or mechanical methods, without the prior written permission of the publisher, except in the case of brief quotations embodied in critical reviews and certain other noncommercial uses permitted by the copyright law.
To take permissions, contact: info@scripown.com*

Chief Editor: Dr. Dhondiram Tukaram Sakhare

Edition: 1st

Publication Year: 2023

Pages: 156

ISBN: 978-93-94375-45-1

Price: ₹950/-

Scripown Publications

*2nd Floor, 304 and 305, Pocket - 4,
Sector - 22, Rohini, North West Delhi,
Delhi, 110086, India*

Contents

S. No.	Chapters	Page No.
1.	A New Reagent System for the Determination of Kelthane in Water and Vegetable Samples <i>RS Dhundhel, A.Chandra</i>	1-10
2.	Microcontroller Based Night Detecting and Automatic Light System <i>Dr. V. Vanitha, Dr. C.S. Sundar Ganesh</i>	11-19
3.	True Clovers - Genus Trifolium <i>Dr. Ram Naresh, Dr. Ragini Dubey, Yatendra Singh, Dr. Shiwanand Panday</i>	20-34
4.	Role of Media and Its Impact on Consumer Motivation and Behaviour <i>Meenu, Kavita Dua</i>	35-48
5.	Biochemistry and Their Chemistry with Dentistry <i>Anamika Mishra, Chahat, Dr.Sahil, Dr. Pankaj Dhiman, and Dr. Mansimaranjit Kaur Uppal</i>	49-59
6.	The Buying Patterns of Today's Consumers and Consumer Behavior <i>Aysha Be, Dr. Kavita Dua</i>	60-72
7.	Microbial Expansins: Structure, Biological Functions and Applications <i>Dr. P. Jayamma, Dr. J. Sai Prasad, Smt. R. Aruna</i>	73-88
8.	Ayushman Bharat: India towards Achieving Universal Health Coverage <i>Swati Chaudhary, Bhumika, Dr. Sahil Thakar, Dr. Swati Sharma</i>	89-98
9.	Updates in Scrub Typhus <i>Somnath Maitra</i>	99-125
10.	Recent Progress in Pharmaceutical Sciences <i>Amartya De</i>	126-134

11. Impact of COVID 19 on Higher Education through Online Education Platform 135-141
Rawal Singh Aulakh, Sakshi Sahni,
12. The Medicinal and Pharmacological Study of Some Plants Used In Dibites Cure 142-156
Mr. Sandipan Babasaheb Jige

Chapter - 1

A New Reagent System for the Determination of Kelthane in Water and Vegetable Samples

RS Dhundhel

Shri Shankracharya Institute of Professional Management

A.Chandra

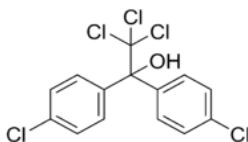
Technology, Raipur, Chattisgarh, India

Abstract:

A spectrophotometric method has been developed, based on the modification of Fujiwara reaction for the determination of Kelthane in sub ppm level. Kelthane on its alkaline hydrolysis gives chloroform, which can be reacted with pyridine to product pink colour. In the present method the pink colour obtained in the above reaction is discharged with a few drops of acetic acid followed by the addition of p-aminoazobenzene reagent which gives an orange coloured dye. The absorption maxima of orange colour dye formed is measured at 440nm. Beer's law is obeyed in the range of 5.0-50.0 µg/10 ml. of Kelthane. The molar absorptivity and Sandell's sensitivity were found to be $5.22 \times 10^4 \text{ L mol}^{-1}\text{cm}^{-1}$ and 0.01 µg cm^{-2} respectively. This method is free from interference of other Organochlorines pesticides and can be successfully applied for the determination of Kelthane in water and vegetables.

Keywords: Spectrophotometry, Kelthane, p - aminoazobenzene, environmental samples.

Introduction



Kelthane or Dicofol is a well-known acaricide of Organochlorines group of pesticide. Kelthane is chemically known as 4,4'-dichloro- α -trichloromethyl-benzhydrol or 1'1-bis (chlorophenyl) 2'2'2-trichloroethanol, which is a mixture of two isomers^[1-2].

Kelthane appears to be effective against wide range of mite species. It is effective tetrachid, mites, cydamen, broad mites, erophyid mites, European red, red spider, apple rust, tomato rust etc. It is also highly effective against many false spider mites ^[2-5]. Because of the similarity of chemical structure of Kelthane to that of DDT, there has been concern about Kelthane begin a possible source of DDT contamination in the environment ^[4]. It has a moderate acute oral toxicity. The oral LD ^[50] in rat is 809 mg/kg and 1810 mg/kg body weight for rabbit ^[2]. It has been proved that Kelthane is a severe irritant. The national cancer Institute suggests the possibility of Kelthane as oncogenic; the toxic effects of Kelthane show a general weakness, come and death in animal. It is a contact herbicide with a high toxicity. The tolerance limit of Kelthane in fruits and vegetables is 1 mg/kg ^[6-9].

Field study shows Kelthane in soil at least 4 years after application. The residue of Kelthane may accumulate in fish as well as rotational crops. The very long persistence of residue of this material on and in citrus makes the use of Kelthane on slow growing crops where long lasting residue are desirable ^[9-12].

Several instrumental techniques have been determined for the detection of Kelthane such as Gas chromatography-electron capture ^[13], Gas chromatography ^[14], single drop micro extraction ^[15], Photocatalytical degradation ^[16], Thermo analytical method ^[17], Microwave steam distillation ^[18], Degradation method ^[19], Solid phase extraction ^[20], Matrix Solid phase extraction ^[21], Multiresidue analysis ^[22] and spectrophotometer for its determination ^[23].

In the present work a simple and more sensitive method is developed for the determination of Kelthane. Kelthane is hydrolyzed with sodium hydroxide solution and chloroform thus obtained gives a pink coloured dye with pyridine in alkaline medium. In the present modification the pink colour of the dye is discharged with few drops of glacial acetic acid then reagent is added which gives an orange coloured dye having absorbance maxima at 440 nm and has Beer's law range of 5.0-50.0 µg/ml (0.5-5ppm). The method is successfully applied for the determination of Kelthane in water, milk and different vegetable and found to be free from the interference of other copollutants and pesticides.

Experimental

Apparatus:

A systronic UV-VIS spectrophotometer model 104 with 1cm. matched quartz cell is used for all spectral measurements.

Chemicals:

All reagents used are Anala R grade and double distilled water is used throughout the study.

Standard Solution of Kelthane:

A stock solution of 1 mg mL^{-1} solution of Kelthane is prepared in ethanol. Working standard solutions is prepared by appropriate dilution of the stock.

Sodium Hydroxide:

A 5.0 mol l^{-1} aqueous solution is used.

P-amino acetophenone reagent (E. Merck, Germany)

0.25% (w/v) solution of PAAB in 25 % of ethanol was prepared.

Hydrochloric Acid:

10M aqueous solution.

Pyridine, acetic acid, n-hexane, ether solvent. All reagents used of Anala R Grade.

Procedure

An aliquot containing 5.0 to 50 μg of Kelthane was taken in a 25 ml graduated test tube. Solution of test tube was evaporated off up to 0.5ml on a water bath. To this 1 ml of pyridine followed by 2 ml of 5 M sodium hydroxide were added and the test tube was kept in a boiling water bath for 2-5 minutes. The pink coloured dye obtained was cooled in ice cold water and then decolorized with few drops of glacial acid. Then 1ml of p-aminoazobenzen reagent was added and the solution was kept for 10 minutes for full colour development. The volume of test tube was made up to 10 ml with distilled water and absorbance of the orange coloured dye was measured at 440 nm against a reagent blank, which was colourless.

Result and Discussion

Spectral Charecteristics:

All spectral studies were made at 440 nm with 10 ml of final volume containing various amount of Kelthane. All spectral measurements were carried out against demineralised water as the reagent blank showed negligible absorbance at 440 nm wave length. (Fig. 1)

Beer's Law:

Beer's law was obeyed in the range of 5.0-50 μg of Kelthane in 10 ml of final volume (0.5-5.0 ppm). (Fig. 2)

Molar Absorptivity:

The molar absorptivity was found to be $5.22 \times 10^4 \text{ L mol}^{-1} \text{ cm}^{-1}$.

Sandell's Sensitivity:

Sandell's sensitivity was found to be $0.01 \mu\text{g cm}^{-2}$.

Chemical Reaction:

The reaction takes place in four steps. In the first step Kelthane is hydrolyzed by sodium hydroxide to chloroform I. and 4, 4'-dichlorobenzophnone. In the second step, chloroform reacts with pyridine in alkaline medium to form Schiff's base of glutaconic aldehyde II. In the third step by adding glacial acetic acid, the pink coloured of Schiff base of glutaconic aldehyde III, which forms an orange coloured dye IV with p-aminoazobenzene reagent in the fourth step.(Scheme 1)

Optimization Condition:

For the hydrolysis of Kelthane to chloroform and the reaction of chloroform with pyridine to form the pink coloured dye; effect of concentration of pyridine and sodium hydroxide has been checked.

Effect of NaOH Concentration:

It was found that the maximum hydrolysis was observed with 1ml of pyridine and 2 ml of 5 mol L^{-1} sodium hydroxide were sufficient for full colour development. Higher amount of these reagent do not show any adverse effect.

Effect of Pyridine:

1 ml of pyridine was sufficient for complete colour development. Excess amount of reagent do not show any adverse effect.

Effect of Time and Temperature:

Effect of heating time on the development of pink coloured dye was checked. It was found that 2-5 minutes in a water bath at temperature range of 50°C were sufficient for the complete colour development. Further heating and increasing temperature of the solution decreases the absorbance. (Fig 5 & 6)

For the decolourisation of pink coloured dye drops of glacial acetic acid

were sufficient. Excess of glacial acetic acid decreases the absorbance of final colour solution.

Reproducibility of the Method:

The reproducibility of the method was checked by the replicate analysis of solution containing 5µg/10 ml of Kelthane for a period of 7 days. The standard deviation and relative standard deviation were found respectively in table I.

Effect of Foreign Species:

Effect of various pollutants and pesticides on the determination of Kelthane was checked. To a sample containing 1µg of Kelthane known amount of foreign species and pesticides were added. The Kelthane was analyzed as described above. The method was found to be free from interference of other pesticides and pollutants normally present in table II.

Application

Determination of Kelthane in water sample: 100ml of Kelthane free water sample was taken and fortified with known amount of Kelthane and kept for 3-4 hours, Kelthane was then extracted in hexane. Hexane was evaporated off and Kelthane was determined by the proposed as well the reported method. The recoveries are shown in table III ^[23].

Determination of Kelthane in Vegetables: Vegetables like tomato, apple and bean were weighted (50g), crushed and spiked with known amount of Kelthane. After 2-3 hours Kelthane was extracted in hexane. Hexane was evaporated off and Kelthane was determined by present as well as reported method. The recoveries are shown in table ^[23].

Conclusion:

This method has been compared with other method reported for the determination of Kelthane and it is found that this method is more sensitive and simple than the earlier reported method by simple modification of discharging the colour obtained by fujiwzra reaction with acetic acid and later regeneration of the colour with p-aminoazobenzene reagent. It can be successfully applied for the determination of Kelthane in water and vegetables.

Acknowledgement:

Authors are thankful to the Head School of Studies in Chemistry Pt. Ravishankar Shukla University Raipur (C.G.) for providing laboratory facilities.

Table 1: Reproducibility of the method Concentration of = 5 µg/10ml

No. of days	Absorbance 440nm
1	0.380
2	0.390
3	0.380
4	0.400
5	0.380
6	0.385
7	0.390
8	Mean = 0.386
9	Standard deviation = 0.00758
10	Relative standard deviation= 0.758

Table 2: Effect of foreign species Concentration of Kelthane = 5µg/10ml

Foreign species	Tolerance limit in ppm	Foreign species	Tolerance limit in ppm
Propoxur	450	Sn ²⁺	500
Carbaryl	500	Hg ²⁺	450
Paraquat	250	Cd ²⁺	1000
BHC	250	PO ₄ ³⁻	300

*The amount of foreign species causing an error of $\pm 2\%$

Table 3: Recovery of Kelthane in Water and Vegetables

Sample	Kelthane Added (µg) (b)	Kelthane obtained in Present method*(c)	(c/b)	% Recovery (c/b)x100
Water**	10	9.48	0.948	94.8
	20	18.69	0.934	93.4
Tomato***	10	9.56	0.956	95.6
	20	19.58	0.979	97.9
Grapes***	10	9.69	0.969	96.9
	20	19.06	0.953	95.3
Soil***	10	8.66	0.866	86.6
	20	18.51	0.925	92.5
Beans***	10	9.23	0.923	92.3
	20	19.32	0.966	96.6

**Mean of three replicate analyses

**Amount of sample 100ml

***Amount of sample 50 gm

Scheme 1- Chemical Reaction:

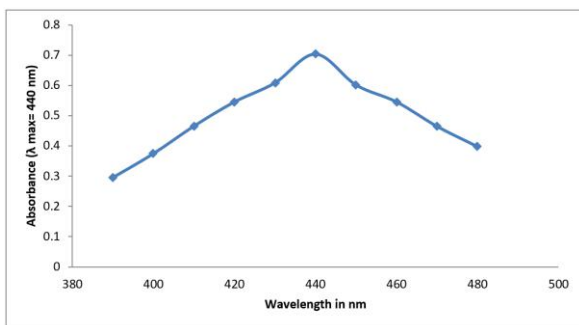
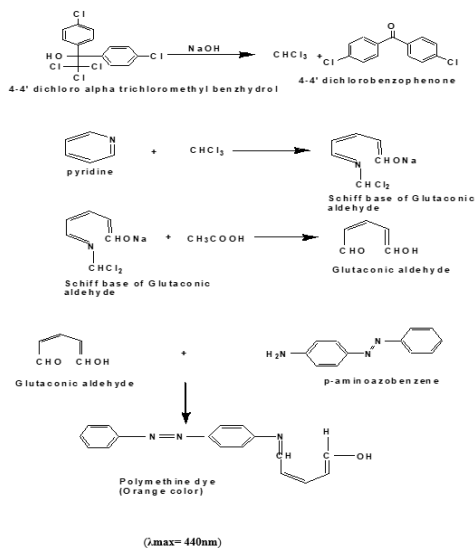


Fig 1: Absorption Curve of the dye concentration of Kelthane = 5 μ g/ 10ml.

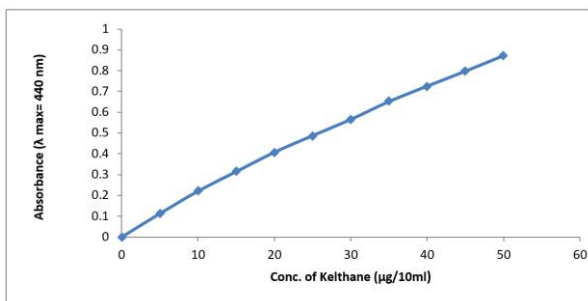


Fig 2: Calibration Curve for the determination of Kelthane concentration of Kelthane = 5µg/ 10ml.

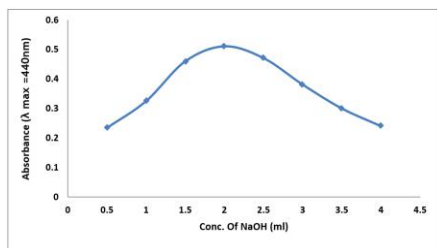


Fig 3: Effect of NaOH on colour development concentration of Kelthane = 5μg/ 10 ml.

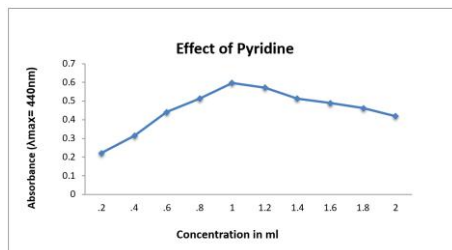


Fig 4: Effect of Pyridine on colour development concentration of Kelthane = 5μg/ 10m

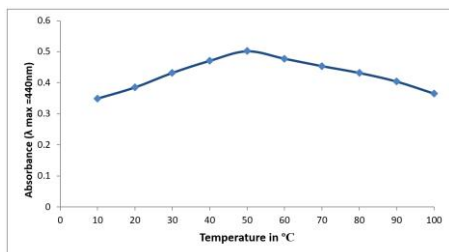


Fig 5: Effect of Temperature on colour development Concentration of Kelthane = 5μg/ 10ml.

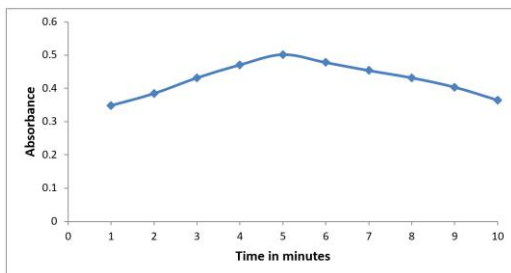


Fig 6 : Effect of Time on colour development concentration of Kelthane = 5μg/ 10ml.

References:

1. Gunther, F.A. and jeppson, L.R., "Modern insecticide and world food production", 1960, *Chapman and Hall.London*, 129.
2. Grudiyev G.S., "The Chemical production of plant", 1983, *Mir publisher, Moscow*, 159.
3. Reddy J.B. "Plant protection in India", 1968, *Applied publisher India* 72.
4. Krynistskey A.J., Stafford C.J. and Wiemeyer S.N., 1983, *J.Assoc.Off.Anal.Chem*, 3, 359.
5. Black R.F., Kurtz, G.P. and baum, H., 1971, *J.Assoc.Off.Anal.Chem.*, 54, 1237.
6. Elbadary E.A., Kansouch A.S, 1975, *Bull.Entomol.Soc.Egypt Eco.Ser.*, 9, 341, vide C.A., 1980, 93(17), 162642h.
7. F.A Patty, "Industrial Hygine and Toxicology", Intrtscience-wiley.New York (1963), 1350.
8. Gunther Z. 1964, *Academic Press, New York*, 2, 263.
9. Gunther F.A., and Günter J.D., 1973, *Springer Verlag,New York*, 56, 125.
10. *U.S. Environ. Protection Agency*, Noyes Data Corporation, USA 1988.
11. Singh R.P., .Agnihotri N.P, 1884, *Entmol.Res.* 8(1), 14, vide C.A., 1985, 102(13), 108178.
12. Zohdy G.J., Moden F.M, 1984, *Acarol* 6th, 2, 669, vide C.A., 102 (13), (1985), 108178.
13. Ormad M.P Melero, J.Sarasaq Alonso, A.Puig Infante, NM.C. /matinez Navascues, N.Cebrian Gujardo, M.S. Mutuberria Cortabitarte and J.L.Ovelleiro Narvion 1992 *Journal of chromatography A*, 607, 311-318.
14. Katerina M. and Steven J.L., 2004, *Journal of chromatography a*, 1040, 259-272.
15. Maosheng Z., Jiarong H., Changlin W., Binbin Yu, Xiaioqing Y. and Xi C., 2008, *Talanta*, 74, 599-604.
16. Binbin Yu, Jinbin Z., Lifen G., Maosheng Z., Limei Z. and Xi C., 2007 *Talanta*, 72, 1667-1674.
17. Jacek Lubkowski, Tadeusz Janiak, Jurand Czerminski and Jerzy Biejowski, 1989, *Thermochimici Acta*, 155, 7-28.
18. Jie Ji, Chunhu Deng, Huigin Zhang, Yunyun Wu and Xiangmin Zhang, 2007, *Talanta*, 71, 1068-1074.

19. Thiel A. , Guth , S., Böhm S., Eisenbrand G., 2011, *Toxicology*, 282, Issue 3, 88-93.
20. Torres C.M., Pico Y., Redondo M.J. and Manes J, 1996, *Journal of chromatography A*, 719, 95-105.
21. J.George Soleas,Joe Yan,Kirby Hom and David M.Goldberg, 2000, *Journal of chromatography A*,882, 205-212.
22. Shivhare.p. and gupta, V.K., 1992, *Fresssenius Journal of Anal.Chem.* 343, 612.
23. Robert EM, English PB, Grether JK, Windham GC, Somberg L, Wolff C, 2007, *Environ Health Perspect* 115 (10): 1482-9.

Chapter - 2

Microcontroller Based Night Detecting and Automatic Light System

Dr. V. Vanitha

Professor, Department of Electrical and Electronics Engineering, Karpagam College of Engineering, Coimbatore, Tamil Nadu, India

Dr. C.S. Sundar Ganesh

Assistant Professor, Department of Electrical and Electronics Engineering, Karpagam College of Engineering, Coimbatore, Tamil Nadu, India

Abstract:

Currently in some areas of the town, some of the street lights are manually operated on and off by a human. In such case there is a need of a person that continuously switch on during the night and switch off during the morning. During rainy days people are afraid to touch the switch of street light because of sometimes it gives electric shock because of rain water and wet climate. So hence we are introducing the automated street light that will automatically glow on the light night timing and off during the morning time.

Keywords: Light Dependent Resistor, Lamp, Microcontroller, Power supply, Automatic light

1. Introduction:

The Street lights are the major requirements in today's life for safety purposes and avoiding accidents during night. Providing street lighting is one of the most important and expensive responsibilities of a city. Lighting can account for 10-38% of the total energy bill in typical cities worldwide. Street lighting is a particularly critical concern for public authorities in developing countries because of its strategic importance for Now, we need arise to make the system automated so that human intervention and manual work avoided and create the transparency in system. In our project we propose the concept about to economic and social stability. The fixtures of street lights indirectly have assisted the public and government in reduction of crime rate and accidents in the area. It also encourages social inclusion by

providing an environment in which people feel they can walk in hours of darkness. Despite that in today's busy lifestyle no one bothers to switch it OFF/ON when not required. Inefficient lighting wastes significant financial resources each year, and poor lighting creates unsafe conditions.

Energy efficient technologies and design can cut street lighting costs dramatically. The main consideration in the present field technologies is Automation, Power consumption and cost effectiveness. Automation is intended to reduce man power with the help of intelligent systems. Power saving is the main consideration forever as the sources of the power are getting diminished due to various reasons. Designing a cost-efficient system is very important as the requirement is more. In order to overcome this problem, automatic street light control methods are introduced.

The main objective of our project is to provide a better solution to minimize the electrical wastage in operating street lights, in this era of automation humans are restless and are not in a position to regulate the manual operations in any field, a rapid advancement in embedded systems has paved path for the design and development of microcontroller based automatic control systems. Our project presents an automatic street light controller using light dependent resistor (LDR).

By using this system manual works are removed. The street lights are automatically switched ON when the sunlight goes below the visible region of our eyes. It automatically switches OFF the street lights under illumination by sunlight. It is a simple and powerful concept, to switch ON/OFF the street light system automatically. It automatically switches ON the streetlight when the sunlight goes below the visible region of our eyes and switches OFF the streetlight when ample amount of sunlight is available. The component used for light sensing is a Light Dependent Resistor. By using the LDR we can operate the streetlight automatically, when ample amount of light is available the streetlight will be in the OFF state and when it is dark the light will be in ON state, it means LDR resistance is inversely proportional to light falling on it. When the light falls on the LDR it sends the commands to the control circuit that it should be in the OFF state and the streetlight turns OFF.

Existing methods like registering the complaint, switching on/off the light manually is time consuming & requires man power. The new method automatic ON/OFF and fault detection without human intervention is easier when compared to the existing system. We proposed an automatic light control system which eliminates the disadvantages of the existing systems by

taking date and time from the GPS, as it also gives information about the position of the system. Based on the results the microcontroller calculates and automatically detects geographical area and retrieve relevant data for sunrise and sunset in the area, respectively ensures very precise ON/OFF mode of the lighting System. It increases bulb life in result of the dimming effect.

2. Automation:

The automation defines as the technique of making an apparatus, a process, or a system operate automatically. Automation is the technology by which a process or procedure is performed with minimal human assistance. Automation or automatic control is the use of various control systems for operating equipment such as machinery, processes in factories, boilers and heat- treating ovens, switching on telephone networks, steering and stabilization of ships, aircraft and other applications and vehicles with minimal or reduced human intervention.

It defines automation as "the creation and application of technology to monitor and control the production and delivery of products and services. Using our definition, the automation profession includes “everyone involved in the creation and application of technology to monitor and control the production and delivery of products and services”; and the automation professional is “any individual involved in the creation and application of technology to monitor and control the production and delivery of products and services.”

The Advantages of Automation are as Follows:

- Increased throughput or productivity.
- Improved quality or increased predictability of quality.
- Improved robustness (consistency), of processes or product.
- Reduced direct human labor costs and expenses.
- Installation in operations reduces cycle time.
- Can complete tasks where a high degree of accuracy is required.
- Replaces human operators in tasks that involve hard physical or monotonous work (e.g., using one forklift with a single driver instead of a team of multiple workers to lift a heavy object).
- Reduces some occupational injuries (e.g., fewer strained backs from lifting heavy objects).
- Replaces humans in tasks done in dangerous environments (i.e., fire, space, volcanoes, nuclear facilities, underwater, etc.).

- Performs tasks that are beyond human capabilities of size, weight, speed, endurance, etc.

3. Components Used

3.1 Relay



Fig: 3.1 Picture of relay



Fig: 3.2 Symbol of relay

A relay is an electrically operated switch. It consists of a set of input terminals for a single or multiple control signals, and a set of operating contact terminals. The switch may have any number of contacts in multiple contact forms, such as make contacts, break contacts, or combinations thereof.

Relays are used where it is necessary to control a circuit by an independent low-power signal, or where several circuits must be controlled by one signal. Relays were first used in long-distance telegraph circuits as signal repeaters: they refresh the signal coming in from one circuit by transmitting it on another circuit. Relays were used extensively in telephone exchanges and early computers to perform logical operations.

The 6v relay is an electromechanical switching device which controls the AC devices through the DC power. Features of Relay 6V: Max Current: 5A AC/DC (max). Max Voltage: 250V AC/30V DC. Nominal Voltage: 6V. Coil resistance: 270 ohm. Coil Current: 44.4mA.

3.2 Transistor

A transistor is a semiconductor device used to amplify or switch electrical signals and power. The transistor is one of the basic building blocks of modern electronics. It is composed of semiconductor material, usually with at least three terminals for connection to an electronic circuit. A voltage or current applied to one pair of the transistor's terminals controls the current through another pair of terminals. Because the controlled (output)

power can be higher than the controlling (input) power, a transistor can amplify a signal. Some transistors are packaged individually, but many more are found embedded in integrated circuits.

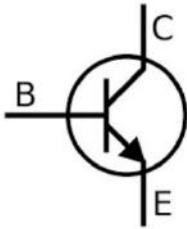


Fig 3.3: Symbol of Transistor



Fig 3.4: Picture of Transistor

3.3 Light Dependent Resistor

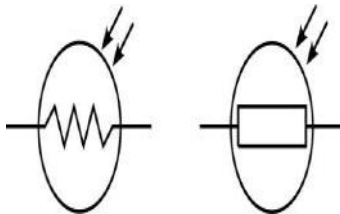


Fig 3.5: Symbol of LDR



Fig 3.6: Picture of LDR

A photoresistor (also known as a Photocell, or light-dependent resistor, LDR, or photo-conductive cell) is a passive component that decreases resistance with respect to receiving luminosity (light) on the component's sensitive surface. The resistance of a photoresistor decreases with increase in incident light intensity; in other words, it exhibits photoconductivity. A photoresistor can be applied in light-sensitive detector circuits and light-activated and dark-activated switching circuits acting as a resistance semiconductor. In the dark, a photo resistor can have a resistance as high as several mega ohms ($M\Omega$), while in the light, a photo resistor can have a resistance as low as a few hundred ohms. If incident light on a photo resistor exceeds a certain frequency, photons absorbed by the semiconductor give bound electrons enough energy to jump into the conduction band. The resulting free electrons (and their whole partners) conduct electricity, thereby lowering resistance. The resistance range and sensitivity of a photo resistor can substantially differ among dissimilar devices. Moreover, unique photo resistors may react substantially differently to photons within certain wavelength bands.

The resistor is a passive electrical component that creates resistance in

the flow of electric current. In almost all electrical networks and electronic circuits they can be found. The resistance is measured in ohms (Ω). An ohm is the resistance that occurs when a current of one ampere (A) passes through a resistor with a one volt drop across its terminals. The current is proportional to the voltage across the terminals. This ratio is represented by Ohm's law: $R=V/I$.

4. Flowchart

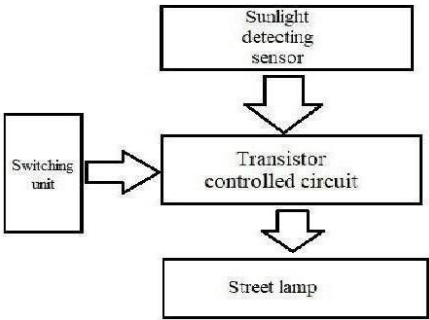


Fig 5.1: Flowchart

A flowchart is a diagram of a system in which the working flow or functions are represented by blocks connected by lines that show the relationships of the blocks. They are heavily used in engineering in hardware design, electronic design, software design, and process flow diagrams.

In this project the flow starts from sensing the intensity of light by LDR. After that the flow is directed to the control circuit consisting of BC547 transistor. The control circuit controls the switching operation of the system through a relay.

5. Circuit Diagram

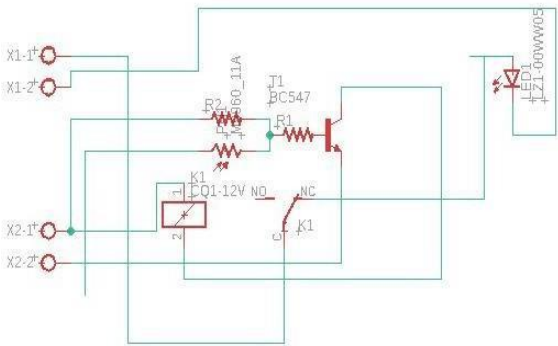


Fig 5.1: Circuit Diagram

A circuit diagram (wiring diagram, electrical diagram, elementary diagram, electronic schematic) is a graphical representation of an electrical circuit a drawing meant to depict the physical arrangement of the wires and the components they connect is called artwork or layout, physical design, or wiring diagram.

6. Working

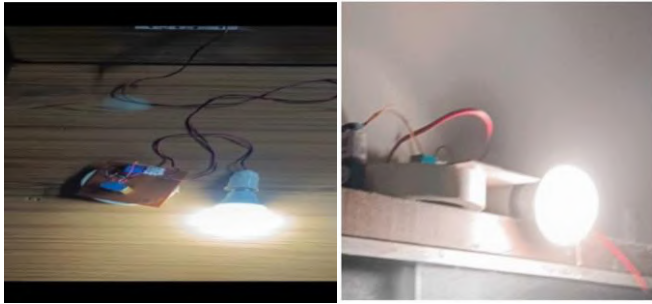


Fig 5.3: Working

When less intensity of light is recognized by LDR the light will glow and when high intensity of light is recognized by LDR the light will not glow. The resistance across the LDR varies with the light intensity falls on it. When the light intensity is high, the resistance across the LDR is low so the Base of the transistor BC547 is connected to ground through LDR.

During the daytime when there is a light, the LDR has very low resistance and all voltage coming through R1 dropped with the ground. This makes the voltage at the base of the transistor very low and it will not switch ON the transistor. Because the transistor is OFF, the current will not flow through the transistor. As a result, the relay will not be switched ON and the bulb remains OFF.

At night when there is no light, the LDR has high resistance and very less power dropped with the ground. This makes the voltage at the base of the transistor high to turn the transistor ON. Because the transistor is turned ON, current flows through the transistor. It flows from the positive battery terminal, through R2, the relay, and the transistor down to the negative battery terminal. As a result, the relay turns ON and hence the bulb turns ON.

Current Path: +5v → 10k Resistor → LDR → GND

As no positive pulse at Base of the BC547 so the transistor turns off. So current can flow through the relay coil and the AC lamp connected with the

Relay turns on. If the light intensity becomes low then the resistance becomes very high across LDR. So the current through the 10k resistor cannot flow through the LDR. Then the current through 10k resistor fed positive pulse to Transistor Base. Then the NPN transistor turns on.

Current Path: +5v → 10k Resistor → Base BC547

So current can flow through the relay coil and the AC lamp connected with the Relay turns on.

Thus we can use a LDR to make this automatic street light.

7. Conclusion and Future Scope

We design and implement an automatic system where in the street lights that are not required through the night can be dimmed. Additionally, the ambiance of light is checked and lights are turned on when it is dark and turned off during the day.

Our government is striving hard to provide electricity to customers. Thus, this paper once implemented on a large scale can bring in significant reductions in the power consumption caused by street lights. Here we are saving lot of power without any wastage, by these advanced technologies.

The above project we can develop Solar Street light system with automatic Street light controller. The system can be powered from a battery, which can be charged during day time by harvesting the solar energy through a solar cell. The solar energy harvested from sunlight can be stored, inverted from DC voltage to AC voltage using sun tie converter. The AC voltage can be stepped up and given to the electric grid. The AC voltage from the electric grid can be stepped down, rectified and used for powering the circuit. Meanwhile, the street light can also be powered by the A.C. voltage, which is controlled by a relay switch connected to the switching part of the circuit. The above-mentioned strategy will enable us to harvest solar energy in an effective way for the operation of the circuit and for powering the street light also.

References

1. D. A. Devi and A. Kumar, "Design and Implementation of CPLD based Solar Power Saving System for Street Lights and Automatic Traffic Controller", International Journal of Scientific and Research Publications, vol. 2, no. 11, 2012
2. J. Mohelnikova, "Electric Energy Savings and Light Guides, Energy & Environment", 3rd IASME/WSEAS International Conference on, Cambridge, UK, February 2008, pp.470-474.

3. Mustafa Saad, Abdalhalim Farij, Ahamed Salah "Automatic Street Light Control using Microcontroller," International Journal of Engineering Research and Applications, vol. 3, no. 2, pp. 92-96, 2013.
4. Sharath Patil G.S, Rudresh S. M, Kallendrachari.K. Vani. H.V, "Design and Implementation of Automatic Street Light Control Using Sensors and Solar Panel," International Journal of Engineering Research and Applications, vol. 5, no.6, pp. 97-100, 2015.
5. Abdul Latif Saleem, Raj Sagar. R, Sachin Datta N. S, Usha MS., "Street Light Monitoring and Control System," International Journal of Engineering and Control System, vol. 1, no. 2, pp. 68- 71, 2015.
6. M. A. Wazed, N. Nafis, M. T. Islam and A. S. M. Sayem, "Design and Fabrication of Automatic Street Light Control System", Engineering e-Transaction, Vol. 5, No. 1, pp 27-34,2010
7. A. Lavric, V. Popa, I. Finnis, C. Males, and A.-M. Gaitan, "An original lighting monitoring and control system using Wireless Sensor Networks," Use of Modern Information and Communication Technologies, pp. 167-173, 2012.
8. R. Priyasree, R. Kauser, E. Vinitha and N. Gangatharan, "Automatic Street Light Intensity Control and Road Safety Module Using Embedded System", International Conference on Computing and Control Engineering, April 2012
9. K. S. Sudhakar, A. A. Anil, K. C. Ashok and S. S. Bhaskar, "Automatic Street Light Control System", International Journal of Emerging Technology and Advanced Engineering, vol. 3, pp. 188-189,2013.
10. K.Y. Rajput, G. Khatav, M. Pujari, P. Yadav, "Intelligent Street Lighting System Using GSM", International Journal of Engineering Science Invention, vol.2, no. 3,pp. 60- 69,2013.
11. Mr. Eswaravel, E, Mr. Lokeshwaran, V, Mr. Prabu, D, Mr. SyedGhouse N, Mr. Sundar Ganesh, C S "Microcontroller Based Home Automation Systems" , International Journal of Advanced Research in Electrical, Electronics and Instrumentation Engineering ,,vol 4, no. 4, 2015.
12. R. Mohamaddoust, A. T. Haghighat, M. J. M. Sharif and N. Capanni, "A Novel Design of an Automatic Lighting Control System for a Wireless Sensor Network with Increased Sensor Lifetime and Reduced Sensor Numbers", Sensors, vol. 11, pp. 8933-8952

Chapter - 3

True Clovers - Genus *Trifolium*

Dr. Ram Naresh

ICAR-Agricultural Technology Application Research Institute, Zone-III,
Kanpur, Uttar Pradesh, India

Dr. Ragini Dubey

Teaching Associate, C.S.A. University of Agriculture & Technology,
Kanpur, Uttar Pradesh India

Yatendra Singh

Monad University, Hapur, Uttar Pradesh, India

Dr. Shiwanand Panday

Teaching Associate, C.S.A. University of Agriculture & Technology, Kanpur, Uttar
Pradesh, India

General Characters of the Genus

Clovers are herbs, with trifoliate leaves. The margins of the leaves may be entire, or toothed, but the tip is free from the sharply pointed projection so characteristic of the Medicks. The stipules have entire margins; they are never toothed as in the Medicks. The flowers are red, white or yellow, in close, usually spherical or globose heads. The petals are long and narrow, and together with the sepals usually remain round the pod after withering. The upper stamen is entirely free (diadelphous). The pod is small, containing from 1 to 4 seeds. The seed is rounded, highly polished, and the position of the radicle is more or less clearly defined.

In all cases, the seedling is sturdy, with the two fleshy cotyledons coming above ground. The first true leaf is simple and almost circular: all subsequent leaves are trifoliate.

The following are the most important species of clover used in this country:

Red Clover (*T. pratense*) Yellow Suckling Clover (*T. dubium*)

Alsike Clover (*T. hybridum*) Subterranean Clover (*T. subterraneum*)

White Clover (*T. repens*)

Crimson Clover (*T. incarnatum*) Strawberry Clover (*T. fragiferum*).

Red Clover (*Trifolium pretense* L.)

General Characters. Members of these spices are short-lived perennials. The root is a strong tap-root with numerous fine lateral branches. Both the main root and the branches bear small cylindrical nodules a few millimeters long, attached at one end.



Fig 1: Red clover plant showing the stipules and lower head

From the crown of the plant spring numerous more or less erect stems, which may be solid or hollow. Some types of red clover have solid stems which become Holi after flowering. The trifoliate leaves are carried on short stalks, and each leaflet has its own, very s petiole: all three of these petioles are the same leng The leaflets are oval, elliptical or ovate: there is but by no means always, a curved or crescent-shape area of lighter green on the upper surface. The margin of the leaf is never toothed. The plant as a whole m be very hairy or almost entirely glabrous (free from hairs).

Red Clover

The stipule is broad, but ends abruptly in a short, sharp point. The veins are conspicuous, purplish - green in colour.

The flower-head is globular, and in cultivated types is borne upon a short stalk, below which are two leaves with extremely short stalks, situated very close together. The lowers are crowded together on this head, and number about 27 on an average. They vary from a pink to mauve; shades of red and purple are commonest, but white flowers are occasionally met with.

The calyx has 5 teeth and 10 nerves, and is hairy: the lower tooth is almost twice as long as the other four. The corolla forms a long, narrow, closed tube at the base: the tube, which is about 10 mm. long, is composed of the fused claws of the 5 petals, which unite with the sheath of the 9 united stamens. Nectar is secreted from the base of the tube, and collects around the ovary. Nine of the stamens are united, but the upper one is entirely free. The ovary is short and thick, with a long, slender, straight style. There are a ovules in the ovary, but only one forms seed. The fruit is a thin-walled, egg-

shaped structure with one seed, enclosed in the brown, shriveled calyx and corolla. Separate the pod splits transversely and the two halves to release the seed: it is called a pyxidium. Seeds are often met with still carrying the upper part of the pod attached to the broad part of the seed, like a close cap.

Seed and Seedling the seed of red clover is a slightly flattened oval, on an average rather more than 1-5 mm. long by about 10 mm, broad: larger and smaller seeds, of course, are common. The radical forms a distinct projection at the broader end, which is usually more or less violet or purple in colour, shading to yellow at the narrow end. Most samples of red clover seed contain numerous seeds which are entirely yellow, or brown, with no trace of purple. As is the case with all seeds, the colour darkens with age, and the highly polished brightness of freshly harvested seeds diminishes during storage.

The seedling¹ has large cotyledons on short, stout stalks. The cotyledons are of a rounded oval shape, about 55 mm. long by 40 mm. broad: the stalks are 1-5-20 mm. long. The first leaf is rounded and hairy, and the veins on the upper surface are indistinct the descriptions of the seedlings given here and elsewhere refer to the young plants after the first leaf has appeared, but before the development of the second leaf. The measurements are only approximate, since considerable variation occurs. As the seedling gets older, a general increase in the size of the cotyledons and first leaves takes place.

Red clover ripens its pollen before the stigma of the same flower is ready to receive it. Recent investigations have shown that red clover is almost completely self-sterile, although a few artificially self-pollinated flowers have been found to set seed. In nature, cross pollination is carried out by bees. In this country bumble-bees are the usual agents, and although hive bees are capable of carrying out the process they do not usually visit red clover flowers in sufficient numbers to influence seed setting. In other countries hive bees are relatively more important. When red clover was first introduced into New Zealand it failed to set seed owing to the absence of suitable insects: the importation of live bumble - bees enabled seed crops to be grown.

In the hybridization of red clovers bumble-bees are frequently employed. They are gently washed in a tube of distilled water to remove any pollen from their bodies, and are then released under a gauze cage containing the two plants it is desired to cross. Owing to the almost complete self-sterility of the plants it can be fairly safely assumed that any resultant seed is a cross.

The diploid number of chromosomes is fourteen.

History

Although red clover has been known for many hundreds of years and has been cultivated on a small scale since the fifteenth century, it did not make much progress as a farm crop until the eighteenth century. It was introduced into England by Sir Richard Weston in 1633, and into America about 1790. With the disappearance of the old manorial systems of farming and the development of new rotations during the eighteenth century, red clover began to assume greater importance in British agriculture. Stebler claims that the development of red clover as a farm crop has had an influence on rural and national life even greater than that of the potato.

True Clovers

Cultivated Types

There are three main types of red clover:

1. Wild Red Clover (*T. pratense spontaneum*).
2. Early Flowering Red Clover (*T. pratense pracow*).
3. Late Flowering Red Clover (*T. pratense serotinum*).

1. Wild Red Clover or Indigenous Red Clover, flowers very early, usually in April and May; it is smaller than the other types, with a few short, slender, wiry stems. The leaves are dark green and, owing to the length of the upper internodes of the stem, are widely spaced, giving the plant a leafless appearance. The stems are usually solid and more or less prostrate.

Wild red clover lasts longer than any of the other clovers, but its yield is scanty, and it ceases growth during the winter. It is cut for hay and gives no aftermath: it is more of a grazing plant, not very palatable. It adds very little to the hay and gives no aftermath: it is more of a grazing plant.

This clover, which exists in a great variety of forms, is at present not worth sowing by the average farmer.

2. Early Flowering Red Clover, or Broad Red Clover, flowers about the middle of June, from 10 days to 3 weeks earlier than the late flowering types. It also flowers in the aftermath. There are from 3 to 6 stems per plant under field conditions: these are hollow, with from 5 to 7 internodes at time of flowering. The leaves are broader than those of the late flowering types. Owing partly to the side branches flowering at the same level as the main stems, the plants appear more erect than the late varieties.

Broad red clover grows rapidly from seed, and after the removal of the nurse crop-usually barley or oats recovers very quickly and affords winter grazing. The following spring it recommences growth early, and after being out for hay, springs again and flowers in the aftermath. Many types of broad red clover are then exhausted, and die away rapidly, giving practically no return in the second harvest year. Strains from the western districts may persist better than those from the eastern districts,

Broad red clover is most suited to one-year leys in the eastern counties. In other parts of the country, especially in the north and along the western seaboard, it is not as reliable as the late flowering types.

Numerous strains of early flowering red clover are now on the market, but all the available evidence goes to show that English and Welsh-grown strains are superior to foreign strains, and that strains from the northern temperate districts are better than those from southern Europe and America.

Amongst the best native strains are English Broad Red from the Cotswold's and Eastern Counties, Dorset Marl, Vale of Clwyd Early Red, Vale of Glamorgan Re, and Aberystwyth S.

Of the foreign strains, Chilean red clover is perhaps the best, but it is not so hardy as English strains. American Medium, Canadian Broad Red, and New Zealand Broad Red give good' bulk, but the quality and winter keep are inferior.

Late Flowering Red Clover

Still called single cut Cow grass in many parts of the country, seldom flowers twice in the season. It has more stems than early flowering red clover, from 5 to 15 under field conditions, and is more tufted in growth. The stems have more internodes (7 to 15 at time of flowering with 6 to 7 as an average), and are solid until after flowering has taken place, when they frequently become more or less hollow. They are longer and weaker than those of broad red clover. The leaves are narrower. There are more side branches, especially towards the top of the stems.

Late flowering red clover does not usually flower in the seedling year, and flowers only once each succeeding year. It starts growth rather slowly in spring, but produces a tremendous bulk of hay, out yielding the early flowering kinds in this respect; it yields comparatively little aftermath. On the other hand, the late flowering red clovers are hardier, less susceptible to clover rot, and longer lived than the early flowering types. Also stand up better to the grazing animal. Persist for six or more years, but their yield after

the first three or four harvest years drops very rapidly. Late red clover is more adaptable than early flowering red clover, and is generally superior to it on soils of moderate fertility, even for one - year leys.

Late flowering red clover will often yield satisfactorily on land which will not support the early flowering type. The introduction of late flowering red clover into certain areas in Devonshire, for example, has made it possible to obtain much better crops of hay than were common when early flowering red clover was used.

English strains are preferable to foreign seed, being more reliable and more productive. Strains from Essex have proved very suitable for one-year leys on rich soils in the Eastern Counties, whilst Cotswold strains are very reliable croppers for all types of soil.

Montgomery late flowering red clover is an extra late flowering strain with an extremely wide range of adaptability to soil and climatic conditions. Aberystwyth S. 123 and Cornish Marl are late-flowering persistent types.

American Mammoth, a very hairy variety with huge leaves, has given fair crops in Eastern and Southern districts; Swedish and Norwegian strains have such a short growing period that their use is not recommended.

Identification of Plants and Seed Despite what has been said to the contrary, it is not possible individual plants of red clover as early-flowering flowering. The mere appearance of stem, leaf does not provide a reliable guide; identification more upon the habit of growth, number of and colour of the flower, and time of flowering the distinguish the two types it is necessary to Ca of plants growing in the field or garden.

Neither is it possible accurately to distinguish between red clover. The seeds of wild red, early flowering red and late flowering red clover.

Samples of home-grown seed, which is usually harvested in worse climatic conditions, contain more brow seeds and fewer yellow seeds than foreign sampics. Home-grown seed is larger and heavier than most foreign seed except Chilian. According to Stapiction, Chilean seed weighs about 2-24 grammes per 1,000 sou British 2-0 gr., Canadian 1-63 gr., Italian 169 g French 1-55 gr. Most foreign samples contain sedu of lucerne, and if seeds of this plant together with chicory and ox - tongue (*Picris echiioides*) are present in sampic it is highly probable that the red clover seed is me: entirely of British origin. Dodder should be, and usually is, nowadays, entirely absent from red clover seed. Ribgrass, or Narrow-leaved Plantain, and Dock seeds are universally found in samples of red clover seed.

Uses Red clover is sometimes sown alone rate of 16 lb. per acre. But owing to the prevalent clover-rot, or the possibility of having a badly apled crop, it is more usual to mix rye-grass seed with the clover seed, using from 5-10 lb. of clover seed and from 7-16 lb. of either perennial or Italian rye-grass. For leys above two years ' duration late flowering red clover only should be used at the rate of from per acre.

Red clover must not be sown on the same land oftener than once in eight years owing to the danger of "clover sickness," caused either by the fungus of clover rot (*Sclerotinia trifoliorum*) or by the eelworm (*Anguillulina dipsaci*). Where the old Norfolk 4-course rotation is fairly strictly adhered to, a trefoil ley can alternate with a red clover ley in order to obtain the necessary separation in time.

Red clover will not succeed on land deficient in lime. If the pH is below 5.5, the soil will not grow red clover. Red clover responds readily to phosphatic manures.

Seed Production when early flowering red clover is grown for seed the first growth is cut for hay, or fed off by sheep until the beginning of May. The first cut is generally useless for seed, as there are so few bumble bees about. A seed crop which follows sheep is earlier than that which comes after a hay crop, and is said to be of better quality.

When the heads on the leading shoots are brown and rub out easily the crop is ready to cut. This is in August or September. The lateral shoots mature later, and must not be taken into consideration. The cobs are stacked in long, narrow stacks until thrashed.

The yield of seed is extremely variable, from 2-13 bushels per acre according to season. An average crop is 260 lb. per acre.

Late flowering red clover is not usually grazed or cut for hay before taking a seed crop, as it flowers only once a season. The yield of seed is almost the same as for early flowering red clover.

In order to maintain the high reputation of their special strains of red clover, growers in certain parts of the country have formed Associations. There are in existence the Montgomery Late Flowering Red Clover Growers, Ltd., the Cornish Marl Clover Growers ' Association, Ltd., the Vale of Clwyd Red Clover Growers Association, and others.

Chemical Compisition

The following percentage analyses of red clover are due to kellner-Fingerling¹ (digestible nutrients in brackets).

Fagan shows the superiority of the leaf over the stem and flower-head with the following percentage figures, calculated upon the dry matter of the hay of Montgomery late flowering red clover.

Alsike Clover

General Character's alsike clover is a perennial plant, having a life of from 3 to 5 years. Its habit of growth is similar to that of late flowering red clover, is an upright growing plant entirely free from hairs. 6-Alsike clovers the shape of the stipules and length of the flower-stalk should be compared with those of red clover. The root system is extensive, but closer to the surface than in red clover. The leaves are on longish stalks. The stipules at the base of the common footstalk are much longer than those of red clover, and taper gradually to a long-drawn-out point: frequently the basal portion the stem. Develops an ear - shaped expansion which partly embraces the stem.

The leaflets have a distinctly toothed margin, and lack the lightish coloured crescent usually found on red clover leaves. They are intermediate in shape between those of white clover and red clover and are of a lighter green than those of the latter.

The flower-heads are axillary and borne on stalks which are always longer than the leaf - stalks. There is no leaf immediately under the head as in red clover. The head is globular, composed of numerous pinkish-white flowers on longish stalks, which after fertilization become brown and shriveled and turn downwards after the fashion of white clover.

The calyx tube is very short and has 5 narrow teeth of equal length. The petals are quite free from each other, not fused into a tube as in red clover. There is a broad, rounded, backwardly projecting appendage where the claw and expanded portion of the wing-petal meet. The wing and keel-petals on either side adhere to each other at a spot close to this appendage. Fertilization is carried out by honey bees. The ovary contains two or three ovules.

Seed and Seedling the seed is heart-shaped since the radicle occupies nearly as much space as the cotyledons and the fruit is a broad, short pod with 2 to 3 seeds; seed is slightly larger than that of white clover but only half the size of red clover seed. It measures approximately 1 mm. in length. The general colour is bright green, often slightly marbled, but this darkens rapidly with age until the seed is almost black.

The seedling has small oval cotyledons approximately 35 X 20 mm situated on stalks about as long as the cotyledons. The first leaf is almost square, with back wardly projecting points at the base. The veins are indistinct on the upper surface except at the margins. All parts are free from hairs. The stipules to the first leaf are narrow and pointed, about 2 mm long.

History alsike clover derives its name from the village of Alsike, close to Uppsala, in Sweden, where it was first cultivated. It was first imported into England by a certain George Stevens in 1834, and during the last 100 years its cultivation has spread over most of the country. It is not a hybrid, as its scientific name implies, but a true species. Linnaeus considered it to be a hybrid between red clover and white clover, but this is not so. The diploid number of chromosomes is 16.

Uses alsike clover has a shorter period of growth than red clover, but it is more adaptable. Besides doing well on all soils which support red clover it will grow in circumstances quite unfavorable to the latter; it stands up to wet and acid conditions much better, and is much less susceptible to both clover rot and stem eelworm. It is as hardy as the best strains of red clover. It is more succulent, and takes longer to cure than red clover hay. Its yield is not quite that of red clover. Alsike clover is not usually sown alone, but occasionally 8-12 lb. per acre of this species constitutes the sole seeding.

For short leys on damp and heavy soils alsike and timothy combine well: on more normal soils alsike and cocksfoot go well together. If alsike is the only clover to be included in these short leys, from 5-7 lb. of seed per acre are sufficient. In longer leys it is customary to use only 1-2 lb. of seed per acre.

Owing to the similarity of growth between alsike clover and late flowering red clover, these two are unlikely to do well if both are included in large amounts in the same seeds mixture. It must be remembered that a pound of alsike seed is likely to give rise to twice as many plants as a pound of red clover seed of the same germination capacity.

Alsike clover, if grazed or fed green, is even more liable to cause "bloat" and "hoven" than red clover unless care is taken to prevent stock from eating too much of it.

Seed Production alsike clover is not as variable as red clover, and little attention has so far been directed to the separation out of different strains. Most of the commercial seed used in this country comes from Canada, and very little seed is grown here.

Chemical Composition the percentage composition of alsike fodder is given by Kellner Fingerling as follows (digestible nutrients in brackets).

General Character's white clover is a perennial plant easily distinguished from all other commonly cultivated clovers on account of its creeping stem. This is solid, and grows close to the surface of the ground, sending out fibrous white roots at the nodes, or portions from which arise the leaves and flower-stalks. These prostrate stems radiate from the crown of the plant which is situated at the top of a strong tap root system. White clover has therefore an extremely well-developed root system of two kinds, a tap-root system and an adventitious root system; this enables it to withstand drought to a remarkable degree. The root nodules are very small and sausage - shaped, attached by the longer side.

The leaves are carried at the end of long, wavy stalks arising at right angles to the stem. The leaflets are variable in shape, sometimes heart - shaped with a notch at the apex, sometimes elliptical. The margin is toothed, and there is usually a lighter green crescent - shaped area on the upper surface. The leaves, like the rest of the plant, are hairless. The stipules are small and sharply pointed.

Each flower - head is borne at the end of a stalk, longer than the leaf - stalk. Flower - heads are produced from May to July: at other periods the runners bear vegetative buds only. The head is globose, but rather flatter on top than in red clover, composed of numerous white or whitish - pink flowers, on short stalks. There may be from 10 to 80 flowers in the head. Usually the flower head appears to consist of two parts, an upper portion of younger unfertilized flowers which point upwards, and a lower portion of downwardly pointing flowers which have been fertilized. The calyx and corolla turn brown and cover the developing fruit.

The calyx tube is about half the length of the corolla, with five almost equal teeth. The standard petal is comparatively large and broad. The wing and keel - petals adhere to each other at one point as they become older, and their claws are fused to the stalk of the stamens for about one - third of their length. The ovary contains numerous ovules: usually only 2 or to release the seeds. 3 seeds develop. The pod splits open along one side to realize the seeds.

White clover is practically self - sterile, but contains more plants capable of producing seed on being artificially self - pollinated than doe's red clover. Hive bees are the usual pollinating agents. The diploid number of chromosomes is given by Karpechenko and Wexelsen as 32, and by Bleier as 28.

Seed and Seedling the seed is heart - shaped, pale yellow or pale brown in colour. As it gets older the seed loses its bright colour and becomes a dull reddish brown. It is very similar in size and shape to alsike clover but is slightly smaller. Samples of the wild type may contain 25 per cent or more of hard seeds. Very common impurities in white clover seed are Yellow Suckling Clover, which may be present to the extent of 50 per cent , Birdsfoot Trefoil, Trefoil Wild Geraniums (*Geranium molle* and *G. pusillum*), Sheeps ' Sorrel (*Rumex acetosella*) and Field Madder (*Sherardia arvensis*) .

The seedling of the wild type of white clover has small oval cotyledons about 3 mm. situated on stalks about half as long long by 2 mm. broad, as the cotyledon. The first leaf is almost circular; with a slightly toothed other veins cannot be easily seen from the upper surface, margin. The mid - rib of this leaf is distinct, but the whole seedling is devoid of hairs.

Cultivated Types white clover exists in a number of different forms, of which the following are the most important:

1. Ladino, Giant, or Mammoth White Clover (race *giganteum*).
 2. Dutch White or Ordinary White Clover (race *hollandicum*).
 3. Wild White Clover (var. *sylvestre*).
 4. Aberystwyth S. 100 and New Zealand White Clover.
- I. Ladino, Lodi, Or Giant White Clover is a cultivated form which comes from Lombardy. It has exactly the same structure as the other white clovers, but grows to an immense size under suitable conditions. It is known as a giga mutation, but has the same number of chromosomes as the other forms. Despite the size of this "mammoth" white clover it is of little use in this country, since it cannot stand the winter.
 - II. Ordinary or Cultivated White Clover is often called Dutch clover because it was first grown as a seed crop in Holland. It is also known as Honeysuckle Clover. It was introduced into England during the seventeenth century. It is intermediate in size between Lodi clover and wild white clover, but it is not a cultivated form of the latter. It is a short - lived plant, with fewer runners, which do not root so plentifully as the wild t type.

It starts to grow earlier in spring; it also flowers earlier, and continues growth later.

Seed comes from Holland, Russia, Central Europe and America. A small amount is grown in Essex.

Dutch white clover is suitable for short leys only, as it dies out in five years at the most. It adds more to the hay, and its seed is cheaper than wild white clover, but since the virtues of the wild type and S. 100 type have become better known, the cultivation of Dutch white clover has diminished very considerably.

3. Wild White Clover which is indigenous or native to this country, is a truly perennial form, and is now recognized as one of the most important plants available to the farmer. It is not always easy to distinguish with certainty between individual plants of wild white clover and cultivated white clover. The wild plant has more nodes, and much shorter internodes than the cultivated type, and roots at every node. It flowers later and has fewer flower - heads. The leaves and their stalks are finer. Its seeds on the whole are smaller. It is not possible to distinguish between the types by the cyanophoric test (p .30) since it has been found that both cultivated and wild forms include cyanophoric and cyanophoric individuals.

Wild white clover possesses many valuable attributes. It grows rapidly from seed and soon mats the grasses into a dense turf. It stands up to grazing extremely well, is very palatable, nutritious, and especially rich in calcium, an element indispensable for bone and milk formation. It is very adaptable to different soils and climates, stands up to drought, and suffers little from fungus and insect pests. It lasts for many years and builds up a great deal of fertility in the soil.

On the other hand wild white clover starts growth in spring much later than some of the valuable grasses like perennial rye-grass and cocksfoot, and it give very little keep during the winter. It is a summer and autumn develop to grazing plant, and should not be allowed to excess. Close grazing of a mixed sward in the spring, I coming into vigorous growth, just as the grasses are to grow weaken these and allow wild white clover to extend. On the other hand, if the grasses are allowed long, they shade the clover and cause it to diminish.

Wild white clover, despite its tap- root, is largely a surface feeder. Generally speaking, it does best on the rainfall is adequate. It responds in a remarkable manner heavier soils, but it will also thrive on light soils if the o applications of phosphatic manures, particularly basic slag. On poor pastures a heavy dressing of 10 cwt. per acre has been found more beneficial than smaller dressings to short intervals.

4. Aberystwyth S. 100 and New Zealand White Clover these two

clovers are very similar and can be considered together. They are much more vigorous and aggressive than wild white clover, with thicker stems and longer internodes which, however, root much more freely than those of Dutch white clover. The leaves are larger and borne on longer stalks, and the plants are more productive than wild white clover plants. The plants are not so long lived as those of wild white clover, but they will persist for at least 4 to 5 years. These clovers have recently become very popular for long leys on account of their earliness, productivity and capacity for covering the ground.

It is desirable to obtain certified seed of S. 100 (which is a hybrid developed by the Welsh Plant Breeding Station), and certified "mother" seed of New Zealand white clover, which is to be preferred to "permanent pasture" seed, which has no special advantages in this country.

Seed Production there are numerous local strains of wild white clover, which, although definitely wild white clover, yet differ remarkably in their rapidity of growth, luxuriance and so forth. Some of these strains may be more valuable than others. Kentish Wild White Clover, for example, harvested from very old Weald pastures, has for many years enjoyed a very high reputation. During 1920 as much as thirty - five shillings per pound was paid for genuine seed. Cotswold Wild White Clover is also well known.

Under the Wild White Clover Certification Scheme, promoted jointly by the Ministry of Agriculture and the National Farmers Union, the production of wild white clover seed is being encouraged in all parts of the country. Two grades of seed are recognized. Grade "A" certificates are issued for seed from genuine old pastures which have been under grass for more than ten years: Grade "B" certificates for seed from crops of once - grown indigenous wild white clover. That is, Grade B seed is the produce of plants which were seeded down from genuine wild white clover seed less than 10 years ago.

Before a pasture can be " approved " for wild white clover seed production its history must be made known to inspectors , who examine the herbage and conduct a growing - on trial with some of the seed . Up to the end of 1945 some 13,660 acres of Grade A pasture and 5,550 acres of Grade B pasture had been approved.

In the harvesting of wild white clover seed in Kent, the pastures are bared down with sheep until the end of May. Mowing is carried out with an ordinary mower. Sometimes a sack is tied to the cutter bar and allowed to

drag on the ground: the cut heads are raked off at intervals by a man walking behind the machine. It is stated that over-ripeness of the heads leads to a high proportion of "hard" seeds.

Old pasture should not be seeded oftener than once in every 2 years. The yield is very variable, from 30 – 100 lb. per acre. Double these amounts may be obtained from grown seed & 100 white clover is now being extensively grown for seed in all parts of the country. Usually in conjunction with Aberystwyth Say late dowering perennial rye grass.

It is not an easy matter to distinguish between the seed of Dutch white clover and wild white clover: there is no single feature which makes this possible. Wild white clover seed is slightly smaller than Dutch white, having on the average 1,900 seeds to the gramme: against about 1,500 in the case of Dutch white. The seeds of wild white clover have a less definite groove between the radicle and cotyledons, and are more rounded in outline. True wild white clover contains such characteristic impurities as yellow suckling clover, birds foot trefoil, crested dog's tail, self-heal, Bent grass and Yorkshire fog.

The Cyanophoric Test it has been known since 1912 that wild white clover contains a cyanogenetic glucoside and its attendant enzyme. If a seedling or a leaf be crushed and anesthetized, the glucoside and enzyme react to produce hydrocyanic acid gas. This reaction can be demonstrated by the fact that yellow sodium picrate is turned red by the cyanide.

The test is usually made with picrate paper, prepared as follows: dissolve 1 gramme of picric acid and 10 grammes of sodium carbonate in 200 c.c. of water; soak strips of filter paper in this solution, drain and dry until just moist. The strips can be stored indefinitely in a stoppered bottle.

To make the test, place a seedling or leaf in a narrow tube (tubes approximately 2 inches long by inch diameter are convenient) with a strip of picrate paper, add a drop or two of chloroform or toluene, and tightly close the tube with, preferably, a rubber bung. Incubate on a radiator, or in a convenient pocket. If cyanide should turn red in about half an hour.

Plants which give this colour reaction are said to be cyanophoric; those that do not are a-cyanophoric.

White clover contains both camphoric and a-cyanophoric individuals. Generally speaking, wild white clover is cyanophoric and ordinary Dutch white clover is a-cyanophoric. The cyanophoric test is used as one of a series of tests to distinguish between seeds of ordinary white clover and wild

white clover. If a sample pur porting to be genuine wild white clover fails to respond to the cyanophoric test, it is regarded with suspicion. But, on the other hand, if a sample of white clover seed proves to be cyanophoric, this is not necessarily a proof that the sample is wild white clover.

In other words, the cyanophoric test, whilst not in itself absolutely convincing, provides useful data to strengthen or weaken conclusions arrived at from other observations.

Chemical Composition the Kellner-Fingerling figures for the percentage composition of the white clover plant are as follows (digestible nutrients in brackets). According to Williams and Evans the protein content of white clover reaches its highest peak in the spring, and gradually decreases to a minimum in July and August. They give the silica - free ash as amounting to 9.06 per cent of the dry matter on an average. The lime content is 2.927 per cent, and the phosphoric acid 0.616 per cent of the dry matter during the first harvest year. White clover was found to have 269 per cent more lime (CaO) than Italian rye - grass, and more than twice as much crude protein.

Chapter - 4

Role of Media and Its Impact on Consumer Motivation and Behaviour

Meenu

Ph.D. Scholar, Department of Family Resource Management, I.C. College of Home Science, Hisar, Haryana, India

Kavita Dua

Assistant Professor, Chaudhary Charan Singh Haryana Agricultural University, Hisar, Haryana, India

Abstract:

In today's increasingly competitive industry, understanding what inspires people to buy is critical. It is crucial to understand consumer behaviour and what drives them to make purchases. Marketers make investments across a range of media outlets to impact customer behaviour. In terms of training and practice, the domains of consumer behaviour and advertising are dynamic. Every media platform's advertisement has a unique composition that engages customers in a particular way. Advertising persuades the target audience of the utility of the goods and creates a sense of urgency for them to purchase it. Effective advertising generates demand, prompting people to visit stores and purchase the product. It encourages novel applications for the product and aids in the comprehension of its usage techniques. The promotion of healthy competition among rivals is one way that media advertising has an impact on the ability of businesses to generate distinctive, imaginative, and innovative goods for consumers.

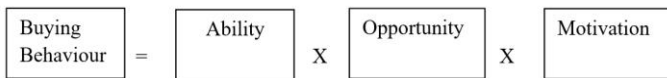
Keywords: Market, consumer behaviour, motivation, advertisement

Introduction

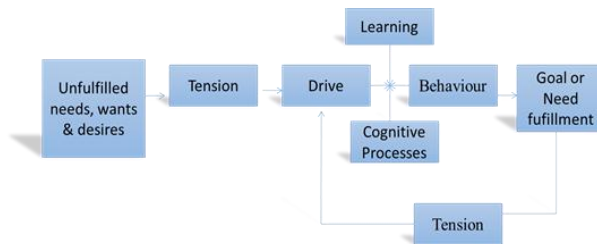
A person is considered to be motivated when their system is energised, made active, and their behaviour is focused toward a desired objective. The processes that influence people's behaviour are referred to as motivation. It happens when a consumer's desire to meet a demand is stimulated. According to Consumer Expert Dianne Bown-Wilson an internal state known as motivation influences people to recognise and purchase goods and services that satisfy both conscious and unconscious needs and desires.

When such wants are met, people may be inspired to make additional purchases or look for different products and services to better meet those needs. It is the desire to satisfy physiological and psychological needs and desires through the purchase and use of goods and services.

Concept of Motivation- Motivation poses the why? Inquiry about how people behave. The ability to buy something, the opportunity to buy it, and the incentive all work together to determine purchasing behaviour. i.e., the intent, requirement, or need to do so.



It is critical to recognise that motivation is merely one of several factors that influence purchasing behaviour. No amount of affection, cash, or other rewards could persuade someone who is unable to walk. Another way to think of motivation is as the internal drive that propels people to do action. This driving force, as depicted in the figure, is the outcome of tension, which in turn results from unfulfilled requirements. Every person seeks to meet their requirements in order to alleviate tension. This fundamentally depends on how each person satisfies their requirements, which includes individual thinking and learning (experiences). Therefore, marketers make an effort to shape consumers' thought processes.



NEEDS- Needs are defined as a perceived lack of some basic satisfaction. The key is that the person must feel this deprivation for it to motivate them to look for fulfillment. Each individual has needs. Some of these requirements are fundamental to maintaining life and come with people at birth. Every person has wants, both innate and learned.

Innate Needs- Innate needs, also known as physiological requirements or first wants, include the need for food, drink, air, shelter, sex, and other basic necessities.

Acquired Needs - Acquired needs are those that we pick up from our environment, culture, or surrounds. These could include the desire for

prestige, love, or power. These are also referred to as secondary demands because of their psychological origin.

Goals- Goals are described as solutions that meet a certain requirement. These are what motivated behaviour leads to. Every person acts in a way that is motivated by goals. There are two categories of goals from the perspective of a marketer:

Generic Goals: Broad categories of objectives that consumers choose to meet their needs. Consider the requirement for hand washing.

Product-Specific Goals: What kind of products is utilized for hand washing? Utilize liquids, soap, etc. as examples.

Motives - People interpret things based on what they need or want. The tendency to overlook unrelated environmental stimuli increases with the intensity of the demand. The perceptual process of an individual becomes more sensitive to the environmental factors that are significant to them. There are two categories of motives:

Rational Motives- Rational motives imply that consumers make decisions based on standards that are completely objective, such as size, weight, price, or miles per gallon.

Irrational (Emotional) Motives- Irrational (emotional) motives imply the choice of objectives based on one's own or subjective standards, such as pride, fear, affection, or status.

Maslow's Hierarchy of Needs

The Abraham H. Maslow hierarchy of needs is widely recognized. Maslow divided requirements into five categories, ranking them from least important (biogenic) to most important (psychogenic), and he hypothesized how much each would affect how people behaved. This theory holds that before higher-level demands become activated, people try to satisfy lower-level needs first. The smallest unmet demand that an individual has is what drives her or his behaviour. When this need is sufficiently satisfied, a new higher-order need emerges and motivates the individual. A lower-order need may momentarily become more intense if it becomes active once again as a result of fresh deprivation.

According to Abraham Maslow, some wants are more important than others and that people are driven to fulfill them. Physical survival is our most fundamental need, and it will always drive our conduct in the beginning. The next step up is what drives us when that level has been reached, and so on. People must attend to individuals at the bottom of the hierarchy before

tending to requirements higher up. Maslow postulated that each person has a hierarchy of five needs that are met in the following order: 1. Physiological needs, 2. Safety needs, 3. Love and belongingness needs, 4. Esteem needs, 5. Self-actualization needs

1. Physiological needs - The first and most fundamental level of needs, according to Maslow, is physiological. These biological necessities- such as air, food, drink, shelter, clothes, warmth, sex and sleep are necessary for human survival. The human body cannot operate at its peak potential if these needs are not met. Maslow saw physiological requirements as being the most crucial since, until these needs are satisfied, all other wants are subordinate.
2. Safety needs - After a person's physiological needs are met, their needs for safety and security become apparent. People desire a sense of control, predictability, and order in their life. The family and society can meet these needs (e.g. police, schools, business and medical care). For instance, financial security, laws and order, fearlessness, societal cohesion, property, health and wellness, and financial security (such as employment and social benefits) (e.g. safety against accidents and injury).
3. Love and belongingness needs - Following the satisfaction of physiological and safety needs, the third level of human needs is social and entails a sense of belonging. Belongingness is the term used to describe a person's emotional demand for group membership, affiliation, and interpersonal connections. Friendship, intimacy, trust and acceptance, receiving and giving love and appreciation are a few examples of belongingness needs.
4. Esteem needs - The fourth level of Maslow's hierarchy, these comprise respect, self-worth, and accomplishment. Maslow divided the demand for esteem into two categories: I. Self-esteem (dignity, accomplishment, mastery, and independence) and

The Need for Respect or Reputation from Others (E.G., Status, Prestige).

According to Maslow, the desire for reputation or respect is more crucial for kids and teenagers than the need for genuine self-worth or decency.

5. Self-actualization needs- At the top of Maslow's hierarchy, these requirements deal with reaching one's full potential, finding fulfillment in oneself, pursuing personal development, and having peak experiences. This level, according to Maslow, is the drive to

achieve one's full potential and maximizes one's potential. This impulse may cause people to concentrate or feel it very strongly. For instance, someone can have a burning desire to be the ideal parent. In another, the impulse can show up in the humanities, sciences, or athletics. Others may use art, such as paintings, photographs, or inventions, to express themselves artistically.

Consumer Behavior

According to James F Engel, "consumer behaviour relates to the actions and decision processes of persons who acquire products and services for personal consumption." Consumer behaviour, as defined by Bearden, is "the mental and emotional processes as well as the physical activities of people who buy and utilize goods and services to meet certain needs and desires." The behaviors that customers perform when deciding whether to buy particular goods and services are referred to as consumer behaviour. The psychological and other variables that influence individuals to either purchase a product or pass it up in favor of another choice are frequently the subject of a study of these phenomena.

The consumer's perception of themselves is one of the major factors that affect their behaviour as a consumer. People who need others' approval to feel good about them will frequently go to great efforts to get their admiration. This frequently prompts people to buy the newest, most fashionable attire. People who care less about what others say, on the other hand, are more inclined to concentrate on choosing purchases that they view as sensible and capable of giving them the comfort and service they need.

Relationship between Consumer Behavior and Motivation

The most evident connection between consumer behaviour and motivation is the fact that motivation is the primary driver of consumer behaviour. There is a reason why customers choose to spend money on products or services. This might be a preexisting desire or need, or it might be the result of successful advertisement. Consumer behaviour and motivation are constantly connected since there is always a reason to make a purchase, regardless of the purchase. There is still a reason for buying even when a customer doesn't really want the goods or services. Customers pay their electricity bills to stay out of the dark. Similar to how people buy new vehicles, homes, clothes, or cosmetics, consumers are driven to make certain purchases.

Consumer behavior and motivation are practical- Consumer motivation and behaviour can occasionally be used in practical ways. There are some

items that individuals always purchase because they are essentials. For a normal, everyday existence, one needs food, water, electricity, gas, and clothing. In many circumstances, the incentive to acquire arises from the human drive to survive and be comfortable. Because there are no other options, they are bought quickly and without much thought.

Consumer motivation and behaviour can be very personal - Other times, consumer motivation and behaviour can be quite complex and personal. Although many people will desire to buy a car at some point, the kind of car is determined by more individualized factors. Because they are useful, safe, and offer decent gas mileage, a mom with three children would wish to purchase a minivan. Teenagers might desire a flashy red sports automobile.

Typically, the reasons go beyond merely finding a good deal or something that would suffice for the task at hand. Advertising aims to increase consumer desire for a certain good. It establishes certain things as status symbols and triggers particular sensations in the minds of consumers in order to influence their decision-making. Corporate branding also comes into play as companies compete to establish themselves as the go-to brand for specific emotions, needs, or services.

Role and Impact of Media

It establishes certain things as status symbols and triggers particular sensations in the minds of consumers in order to influence their decision-making. Additionally, corporate branding is important. Our daily lives are so ingrained with media that we oftentimes aren't even aware of the little and significant influences it has on us. The media has a significant impact on how consumers behave. The annual billions spent on advertising are proof of the influence of media on consumer spending and purchasing preferences. Movies, television shows, and music are just a few examples of the media's ability to influence consumer trends and tastes. Internet-based new media such as blogs and websites comments speed up consumer receptivity to products.

Today's advertisements are a great way to spread business across the globe. Consumers look forward to information from a variety of media, including print media like newspapers, magazines, brochures, and booklets; broadcast media like television and radio; outdoor media like events and sponsorship; and social media like Twitter, Facebook, and website advertisements. The characteristics of various media's long-term effects on consumer purchase behaviour.

1. Advertising Media

2. Entertainment Media

3. Online Media

1. Advertising Media- An advertisement is a paid type of promotion that is carried out through various mass media. There are two parts to advertisement. The first is the conventional method, which entails advertising via traditional media including radio, television, newspapers, and magazines. The second and most recent is online advertising, which includes advertisements on websites, in emails, pop-up windows, text messages, and other dynamic media. Advertising is a practice used to make people aware of a company's goods and services. It is a style of marketing dialogue that a company uses to advertise its products in a proactive and strategic way.

A company's performance and expansion are thought to be directly related to its advertising efforts. We are publicly encouraged to make unnecessary purchases and to believe uncritically the claims made in product advertisements. The public accepts these efforts despite the fact that it is generally understood that they are intended to influence us for financial gain. This is because the media pays for the information and news we read in newspapers and magazines as well as the television programmes and music we listen to. Advertising can have both positive and negative impacts.

Positive effect of Advertising- An effective way to sell the products, Social Benefits, Economic Advantages, Educates people and Increase Awareness

- A successful method of product sales - A company seeks clients who are interested in purchasing its goods and services. A company must advertise its products and services widely enough for people to become aware of it in order to increase sales. A business can effectively showcase its services to the public by using advertising. To make advertising more enticing and captivating for target audiences, various techniques are used. A corporation can showcase the distinctive selling points of its products and services by using advertising techniques.
- Social Benefits- Advertising also has social benefits that it offers to its target audience. Advertising is not only used by commercial enterprises. Social workers also employ this effective tactic to draw attention to a number of social problems and to advance free speech in nations with particular constraints. It is the freedom of advertising-supported information, and speech that encourages numerous forms of social transformations in a person.

- **Economic Benefits:** The International Advertising Association claims that advertising can spur businesses to compete and offer novel products. Because these products satisfy more consumers' needs and wants, more consumers are encouraged to purchase them. As a result, the economy benefits. Additionally, advertising can contribute to job growth. More people are required to produce, supply, ship, and test these goods and services as a result of increased demand brought on by advertising. More jobs are thereby created. Customers' needs are met with higher-quality products.
- **Educates people-** Several advertising are designed expressly for the public's benefit. When a new product is released onto the market, there is no prior knowledge about it. Through advertising, a business or brand can convey the essence of a product to its intended audience, or customers. It enables customers to learn about the most recent market developments that may be very beneficial to them. The goal of advertisements is to promote gender equality, eradicate smoking addiction, encourage a healthy lifestyle, aid victims of disasters, and protect people from bank fraud and phishing scams, among many other goals. All these advertisements are in the best interest of the public to stay safe and protected.
- **Increase Awareness-** The market is filled with businesses. It takes a lot of time to research every company's offers before making a purchase. One effective method for informing customers of a business's finest offers, discounts, and benefits is through advertising. He can compare shops in this way and select the best one to acquire goods and services from.

Negative Effects of Advertising- Confusion about characteristics of products, promotes consumerism, misrepresentation, creates a materialistic world and creates irresistible desire to buy unessential things.

- **Product features are unclear:** Despite the fact that there are many comparable products being advertised on the market, manufacturers tend to place a lot of focus on the formula, manufacturing process, or make of the offered goods. For instance, there are numerous shaving cream brands that provide the same purpose yet are marketed as vastly distinct goods. It is now hard for the typical consumer to determine the quality of the product they are purchasing with any degree of accuracy due to the false information that is being spread through advertising.

- Encourages consumerism: We are constantly taught to buy new clothes, that girls must use makeup to seem pretty, and that we can't be considered "cool" if we don't have the newest iPhone. These and many other habits have been instilled in consumers by advertisements because they encourage us to buy more and make businesses wealthy. There are numerous things that we take for granted but that, upon closer examination, turn out to be completely absurd. They are transforming the way we think. Most advertising promote the idea that increasing our material possessions will make us happier. But this consumerist lifestyle is what is actually ruining our life.
- Misrepresentation - In order to compete with its rivals, business presents its goods and services in the best possible light. The claims made in the commercial may, however, not always be accurate. Disappointment is the sole result of this. People are betrayed by such misleading product and service representation. In response to this problem, the government set up institutions that deal with customer complaints and, if the claims are true, impose heavy fines on corporations. This is how to stop businesses from using people's emotions against them in order to acquire their trust.
- Creates a materialistic world - Advertisements create the illusion of happiness through commercials, magazines, and social media, leading many of us to believe that materialism equals having an enjoyable and happy life. Customers are diverted from their objectives and are exposed to a materialistic society. In an effort to feel good about them, look nice, and impress others, they also start spending money on useless goods.
- Creates irresistible desire to buy unessential things- The phrases "Now Or Never," "Last Chance to Grab The Deal," and similar phrases instill in consumers a sense of urgency that makes them feel compelled to purchase unnecessary items. They accept their techniques and strategies, which pressure them to buy the goods lest they lose the chance to profit greatly. Money is wasted as a result of this.

2. Entertainment Media:

The media can influence both our public and private selves. The viewer's curiosity should be first piqued by entertainment media. Positive entertainment elements, such as humour, lively music, and visual imagery,

can enhance the appeal and persuasiveness of TV advertisements. Entertainment is thought to have a direct impact on purchase intent as it inspires affect from good attitudes about the commercial. Creative advertising directly influences consumers' buying intentions by piquing their interest in the brand or product promises. We must take into consideration the two main ways that entertainment might affect a consumer's decision to buy a product in order to evaluate the impact of an advertisement's entertainment level on its efficacy.

Both directly, by making the advertisement more compelling, and indirectly, by making the advertisement more attractive, entertainment can affect purchasing decisions. For instance, when a famous person wears a particular outfit or makes reference to the creator, producer, or retailer where it was bought, sales of that item immediately soar. Celebrity endorsers immediately raise brand awareness and receptivity, even if they do it subtly. Advertisers spend money to have their products prominently featured on television and film because they believe that these associations, which initially appear to be non-commercial, will have positive impacts and ultimately increase sales.

3. Online media:

The Internet has considerably increased the power of media to sway consumer behaviour. Numerous websites from both governmental and private sources exist and offer a wide range of goods. Consumers are more receptive to being persuaded by bloggers and online forums because they typically perceive these individuals as objective third parties, despite the fact that they still have some cautious concerns about businesses they are aware are only in it for the money. Because advertisers have no influence over the topics, timing, or volume of online talks between users, web-based social networks draw users.

Social Media

Social media is becoming more and more popular as it helps to communicate information and connects people. Consumers can now easily watch an engaging advertisement on YouTube while giving their own thoughts on Twitter and sharing them with friends on Facebook thanks to social media. In many respects, including frequency, interactivity, usability and performance, social media differs from paper-based media completely (such as magazines and newspapers) and mainstream media in addition to radio and television. Advertising on social media has grown to be one of the most crucial instruments for marketing.

The types of Social Media are social networking sites, news website, media sharing sites and blogs

1. **Social Networking Sites:** A social networking website is an online platform used by people to create groups or interactions with people who share their personal or professional interests, careers, backgrounds, or actual connections. Typically, social networking sites let a user add a list of coworkers and then let others check the names to see if specific affiliate websites, like LinkedIn, are being used to establish competent businesses. Facebook has defined the boundaries between personal and work life.
2. **News Website:** Social media communities encourage their members to post news, articles, and material and then share it with other members. Users' comments and the proportion of those stories are taken into account when determining which stories receive the most recognition from other website users.
3. **Media sharing websites:** These websites enable users to upload and share interactive media files (such as pictures, audio files, and music). Any web system can play or display media, and either a public key or a private key can be used to access it directly.
4. **Blogs:** A blog is an online discussion that features free-form posts that are similar to diaries. We can post thoughts on a given topic on a blog.

Impact of Social Media on Consumer Buying Behaviour

The market has been at the centre of technological developments and the emergence of social media. Businesses now perceive enormous global opportunity. Social media now plays a big part in communication. Social media is used by people all over the world to connect with other people and organizations. People have begun using social media sites like Facebook, Twitter, Instagram, and LinkedIn all around the world to share their experiences. In recent years, social media has completely changed consumer purchasing patterns. With changes in consumer behavior, the effects of social media on consumers are clearly visible. Started out as a site for sharing pictures and videos with friends and family but quickly evolved into a powerful marketing tool. Social media usage has increased significantly during the past few years.

On social media, people have many "connections," and as a result, many people consume information. Consumers and their purchasing decisions are influenced by this information. It's no secret that marketing and social media

have come together. Without a doubt, social media marketing has a significant impact on how consumers behave. Giving our company a social media presence allows us to better interact with clients, increase sales, and provide them with top-notch customer service. Businesses can use social media marketing techniques to market a brand, move inventory, and boost customer engagement.

People contribute product reviews, details about a service, dietary or health-related advice, product warnings, usage instructions, and a wide range of other information as consumers. Many people use the information and opinions posted on social media as a resource for making future purchasing decisions. One of the key elements in determining a customer's purchasing intent is the feedback they leave on social media advertisements. These reviews are easily accessible for evaluating any good or service, and they also add a lot of value for both businesses and clients. Social media networks are now used by more consumers than ever before. Consumers are looking for reviews and recommendations. Having a strong online presence across numerous social media platforms is crucial. The use of social media is the newest marketing trend. Potential clients can be influenced by social media before they even make a purchase and afterward as well.

Social Media Affects Consumer Behavior in Different Ways

Promotion of brands: Posting on social media increases brand visibility. Users may view the products and features, and if they are brand loyal, they are more inclined to purchase the goods or services. Utilizing an eye-catching presentation template, businesses may use social media to advertise their brands and draw attention to new items, deals, etc.

Increases Brand Loyalty: We won't spend our money on an unproven brand out of concern for fraud or poor quality, as consumers. Social media brand visibility also improves customer loyalty. Customers constantly want to see their favorite brands prosper. Every time they come across the blogs, they always provide favorable feedback.

Discounts: An excellent forum for promoting the deals is social media. Customers won't search for the special offers on Google and scroll down page after page. Social networking is a useful tool for finding deals, business hours, addresses, etc.

Review from Influencers: Social influencers are those who have a large following on social media. Companies can pay social media influencers to promote their goods. When an influencer promotes a product on social media, the followers frequently become curious in the products.

Social media increases the likelihood of purchase: Rather than chatting with a salesman or perusing merchandise for hours. Before making purchases, customers use social media to peruse the newest collection and get information. When using social media to make decisions, 29% of consumers are more inclined to make a purchase the same day. Create appealing brochures and promotions using social media info graphics that are accessible online.

Referral: If a customer likes a product, they are inclined to tell their friends or family about it. 93 percent of respondents to the study said they have either given or received recommendations for a good or service.

Word of Mouth Marketing: Word of mouth marketing has been the most powerful marketing tool since the dawn of time. The consumer can learn about the goods prior to advertisements on television, in newspapers, or on billboards. But the internet and social media have raised the bar. Customer reviews have become quite accessible and widely used through online means. Through social media, customers can learn more about the product's attributes and features.

Social media can either help or hurt a business: Keep in mind that the consumer has enormous power in the modern era. By leaving a negative review about the brand, customers who are displeased with the service might stop traffic by making others less likely to trust that particular brand.

Conclusion

The motivation examines why a consumer purchases a specific well or service, as well as from whom, in other words, what drives consumer purchasing behaviour. Each person has wants that are either self-developed or learned from their environment, culture, or surrounds. These needs can be both material and non-material, such as those for power and affection. Each good or service fills a certain need, and it is up to the customer to decide what that need is. Consumer needs and goals are dynamic and constantly changing, and because there are many different needs, one goal may replace another or new needs may arise even before the other needs are met. Social media, which consists of content, images, advertisements, deals, and influencers, has the power to affect customers' purchasing decisions. Consumer positioning in the market has changed as a result of media's accessibility and transparency, making it imperative and crucial for businesses to equip themselves with a new marketing mindset. Regardless of the user's age or gender, people use social media in some capacity when making purchases. Either to read reviews, to learn about available discounts

and promotions, or to learn more about the brand in general. Businesses and brands cannot ignore how the media affects consumer behaviour. With media, both consumers and brands can learn about and interact with each other much more rapidly and simply. Brands can listen to their audience's concerns at the most personal level. Brands can help people solve problems more quickly by paying close attention to what matters to their audience on a personal level.

References

1. Anonymous https://www.clootrack.com/knowledge_base/how-does-social-media-influence-consumer-behavior. Retrieved on 21-11-2022.
2. Anonymous <https://myessaybook.com/positive-and-negative-effects-of-advertising/>. Retrieved on 23-11-2022.
3. Chauhan, S., Chaturvedi, S. and Hussain, F. Q. 2022. To study the influence of social-media on consumer buying behavior. International Journal for Research in Applied Science & Engineering Technology. 10 (V): 3473- 3485.
4. Currie, M. 2022. The role of media in shaping consumer behavior. <https://bizfluent.com/info-8241485-role-media-shaping-consumer-behavior.html>. Retrieved on 21-11-2022.
5. Devasree, M.V. 2019. Impact of social media on consumer buying behavior. <https://slidebazaar.com/blog/impact-of-social-media-on-consumer/>. Retrieved on 21-11-2022.
6. Jain, C. P. and Bhatt, M. 2010. Consumer behaviour in Indian context. S. Chand & Company LTD. New Delhi.
7. Lavuri, R. 2017. Media strategy analysis of the effects of media strategies on consumer buying behaviour. Munich, GRIN Verlag. 243. <https://www.grin.com/document/435637>. Retrieved on 25-10-2022.
8. Singh, P. 2021. What is buying motivation - Use these 10 customer motivators. <https://www.revechat.com/blog/buying-motivation/>. Retrieved on 23-11-2022.

Chapter - 5

Biochemistry and Their Chemistry with Dentistry

Anamika Mishra (BDS Student)

Chahat (BDS Student)

Dr. Sahil Thaka

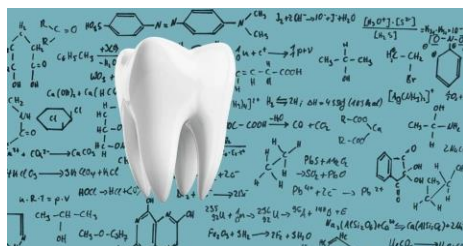
Reader, Himachal Dental College Sundernagar, Himachal Pradesh, India

Dr. Pankaj Dhiman

Assistant Professor, Himachal Dental College Sundernagar, Himachal Pradesh, India

Dr. Mansimaranjit Kaur Uppal

Reader, Shri Bankey Bihari Dental College, Ghaziabad, Uttar Pradesh, India



Abstract

The basic biochemical processes that occur in the oral cavity are the same as those that occur in other tissues and organs of the body, which should be emphasised in biochemistry lessons for dental students. The study of lipids and carbohydrates is crucial because oral cavity enzymes like amylase and lipase cause the digestion of lipids and starches to start there. Weak acids, bases, and buffers should play a role in biochemistry for dental sciences, since this will aid students in understanding the saliva's ability to act as a buffer and what it means for dental health. Saliva is a complex fluid with a variety of proteins, enzymes (lysozyme, lactoferrin, peroxidases), and secretory immunoglobulins that are crucial for maintaining oral health. Patients with poor glycemic control are more likely to experience oral symptoms of diabetes. Patients with diabetes are also more likely to experience an intraoperative diabetic emergency in a dental office. Therefore, when treating diabetes patients, dentists must understand and put into practise crucial dental management issues.

Keyword- Saliva, Dental caries, Clinical biochemistry, Diabetes, Biomarkers

Introduction

It should be crucial for dental students to comprehend and value fundamental biochemistry concepts in order for their professional and scientific knowledge to reflect in their clinical abilities developed through laboratory training and patient interaction. Today, medical and dental disciplines must include knowledge of advances in biochemistry and medical biochemistry. Since many diseases have a molecular basis, understanding biochemistry helps us to comprehend the mechanisms underlying problems like dental fluorosis, dental caries, periodontal diseases, diabetes, and atherosclerosis.

Objective

Dental students learning biochemistry should lay a strong emphasis on the fact that the basic biochemical processes occurring in the oral cavity are identical to those occurring in other tissues and organs of the body. Saliva is a complex and distinctive oral fluid with about 2300 proteins, peptides, and enzymes (such as amylase, lingual lipase, protease, lysozymes, and peroxidase), and secretory immunoglobulins (IgA) are primarily in charge of innate immunity. Saliva is essential for maintaining oral and general health. The significance of weak acids, bases, and buffers in understanding saliva's ability to act as a buffer and its relationship to dental health. When providing dental care to diabetic patients, care and management are necessary due to the poor glycemic index of these patients, therefore studies of biochemistry also focus on the role of carbohydrates in the onset and development of oral difficulties.

Biochemistry in Dentistry

It is important to comprehend the biochemistry of the oral cavity in order to comprehend diseases like dental caries, periodontal diseases, and other diseases of the oral cavity. Management of the disease may then be established in accordance with the biochemistry of the disease.

Because saliva contains a variety of biological indicators, it is a useful diagnostic tool for many systemic and oral disorders like Diabetes, AIDS, oral cancer, and Hepatitis B.

The biological markers found in GCF can be a reliable and efficient technique for identifying a variety of inflammatory and periodontal disorders.

Biochemistry of Tooth Structure

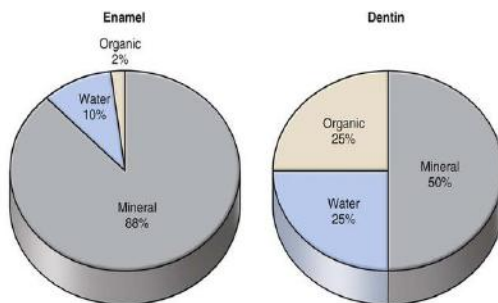
The enamel, which is the tooth's outermost covering, is primarily

composed of calcium hydroxyapatite crystals, which are an inorganic calcium compound, together with phosphate. This substance has a firm, transparent, and porous texture. Amelogenin, which makes up 90% of all enamel protein, is one of the proteins found in the organic component of enamel. Ameloblastin, Enamelin, and Tuftelin are other enamel-related proteins. Amelogenesis Imperfecta results from an Amelogenin mutation.

Calcium phosphate that is amorphous and non-crystalline makes up the structure of dentin. The hexagonally shaped phosphate ions are densely packed and spherical in shape. They are stacked in layers so that every alternate layer's phosphate ion center is precisely above the layer's first layer's phosphate ion center. As a result, a crystal structure with an octahedral channel runs through it.

Traces elements in tooth structure contain zinc, copper, magnesium and iron accumulate near the surface of tooth.

The organic components of tooth structure include collagen types VII, I, and III. Insoluble protein that is found in dentin. Glycine makes up 30% of the amino acids in collagen, whereas proline and lysine make up the remaining 30%. The lysine and hydroxylysine residue of opposing fibers form a covalent cross link, strengthening the collagen fibers. Acidic glycoproteins and proteoglycans are additional proteins found in dentin.



Biochemistry of Saliva-

A biological fluid called saliva is released by the salivary gland. It is crucial for swallowing, lubrication, defence, digestion, and tooth integrity maintenance. It comprises protein, electrolytes, enzymes, immunoglobulins, antibacterial agents, urea, mucosal glycoprotein, etc. It is 95–99 percent water. Salivary proteins contain antibacterial properties and are essential for preventing calcium and phosphate from spontaneously precipitating in the salivary gland. The electrolytes present, such as hydrogen ions and bicarbonates, are what determine the pH and buffering capacity that protect

the enamel from dental caries. Immunoglobulins like IgA and lysozyme are crucial components of innate immunity. The biochemistry of saliva is altered as a result of medicine, oral lesions, intracellular diffusion, and host immunological interactions, which affects how polysaccharides are digested in the mouth cavity.

Importance of Diagnosis of Saliva in Clinical Biochemistry

Saliva's biomolecules support early identification of numerous systemic and dental diseases. Saliva is examined for RNA and DNA, lipids, carbohydrates, microorganisms, and metabolites to aid in diagnosis. The term for this is salivomics.

In the diagnosis, prognosis, and management of many diseases, saliva is an excellent source of diagnostic information and can be used in place of blood and serum. Saliva offers a number of benefits due to its simplicity in collection and non-invasive nature, which eliminates the risk of needle stick injuries. Saliva also offers a cost-effective method for screening a large population and eradicating various infectious diseases among patients and other medical personnel.

Saliva is used as a diagnostic tool for a variety of systemic diseases, including cancer, CVS diseases, immune problems, and hereditary disorders, according to numerous research. Saliva is also used to diagnose dental ailments.

It is quick and easy to diagnose an oral infection by looking for particular antibodies to viruses like Hepatitis B and HIV in mucosal transudate-enriched saliva.

Salivary tumour indicators like the p53 antigen and CA125 may aid in the early detection of malignancies.

Forensic analysis and oral bacterial profiling both may benefit from the DNA information found in mouth fluid.

The idea of salivomics—the examination of proteins, RNA, DNA, lipids, carbohydrates, metabolites, and microbes in saliva—is expanding as a result of improvements in diagnostic criteria. Salivary molecules aid in the early diagnosis of a number of oral and systemic disorders. Biomarkers are present in saliva. Saliva contains a wide variety of components that reflect the composition of plasma as well as the level of biomarkers in real time. Saliva diagnosis has the benefit of being simple to collect, non-invasive, and injury-free. Compared to blood, salivary chemicals have a longer shelf life. This method of screening a huge population is economical.

According to studies, saliva can also be used to diagnose many malignancies, cardiovascular conditions, and immunological disorders in addition to diagnosing oral problems. Specific antibodies against viruses (HIV, hepatitis) can be found following viral infections in mucosal transudate-enriched saliva.

Salivary tumor indicators, such as c-erbB-e, CA125, and p53 antigen, can also be utilised to diagnose and screen for malignancies in many regions of the body. Testing methods for measuring salivary bacteria like Lactobacilli and Streptococci have been developed.

Acute and Chronic Dental Disorders' Biochemistry

The oral mucosa maintains immunological homeostasis, a relative state of health, and a complex immune system. The relationship between systemic, inflammatory illness and chronic inflammatory circumstances imply a connection between periodontal health, diabetes mellitus, preterm birth, and neonates with low birth weight and obesity ^[14] Various tissue-specific signals, commensal microorganisms and their metabolites, tissue damage from mastication, and antigens from food and airborne particles are all constantly present in the oral cavity ^[26]. Additionally, saliva is crucial for the control of immunological responses on the oral mucosa as well as the recovery of lesions, wounds, and ulcers on the mucosa. Saliva contains a variety of defensive proteins that are involved in either innate or acquired immunity, including immunoglobulins, streptokinase, cationic peptides, lysozyme, bactericidal/permeability-increasing proteins, salivary amylase, cystatins, PRPs, mucins, peroxidases, , and others. Along with direct antibacterial activity, salivary secretions in the oral cavity also serve important immunological and non-immunological protective roles ^[27–30]. Degradation of the extracellular matrix (ECM) brought on by the release of enzymes by host and bacterial cells, phagocytosis of matrix components, and release of cytokines, inflammatory mediators, and apoptotic proteins are the major changes to connective tissue in dental disease, particularly pulpitis, gingivitis, and periodontitis. Dental inflammation is brought on by elevated amounts of biomolecules and enzymes, which implies that periodontal and inflammatory illnesses are brought on by host-derived biomarkers ^[31]. An inflammatory condition called periodontitis results in tissue destruction when pathogenic bacteria and the human immune system interact. The growth of dental plaque biofilm causes the periodontal attachment to break down, which can lead to tooth loss. Growth factors, cytokines, and MMPs are examples of proinflammatory mediators that are involved in the etiopathogenesis. Due to their function in the destruction of ECM, MMPs are the most significant

factors in tissue damage related to periodontal disease. Dental plaque infections induce host cells to release MMPs, which causes tissue damage ^[32]. Enzymes produced by host cells, such as MMPs are a significant class of proteinases connected to periodontal illness. Inflammation of the periodontium occurs in the reaction of gingival tissue to bacterial biofilm. Gum disease is characterised by a sudden rise in blood flow, improved vascular permeability, cell inflow (neutrophils and other cells), and from the peripheral circulation to the bone marrow (monocyte-macrophages). These cells then release cytokines such as tumor necrosis factor alpha, interleukin (IL)-1, and IL-6(TNF), immunoglobulins, etc. How severe periodontitis linked to an increase in prostaglandins, TNF-, and IL-1 (PE2) whereas their inhibition results in a decrease in periodontal disease ^[33, 34]. The oral mucosa guards against the through a complex immune system made up of multiple defense and protective proteins in the saliva that are able to defend the host against external antigens and pathogenic germs implicated in immunity, tolerance, and oral homeostasis.

Lab Diagnosis of Disorders for Dental Treatment

The development of automated analyzers and computerised systems has greatly increased the usage of laboratory diagnostics over the last few decades. Through pathological examinations, routine testing to check on organ health, disease status, or medication effects have helped to enhance treatment. The patient's demographic information, the date and time the specimen was collected, the name of the consulting physician, and the findings of any pathological tests are all often included in a laboratory report ^[35-37]. Many patients seek dental treatment when they are suffering or recovering from acute and chronic conditions or when experiencing the effects of medications. The laboratory report provides significant information regarding a patient's health that is beneficial in the diagnosis and management of oral diseases.

The physician can alter the course of therapy and deliver dental care in a way that minimises difficulties using the information received from laboratory testing. Using clinical laboratory testing in addition to radiography, a dentist can diagnose oral disease, evaluate the severity of an infection, or modify medication use in accordance with underlying problems and recommended dental therapy ^[35-37]

Physicians have access to a variety of diagnostic methods to determine a patient's blood glucose level. After an overnight fast, the blood glucose level is normally measured using a fasting blood glucose analysis, and a postprandial sample is taken after breakfast. Physicians use the HbA1c

measurement to assess and manage DM because it offers an estimate of the average blood glucose level over the previous few months ^[38, 39]. DM has been linked to a number of problems, including periodontal disease, salivary gland dysfunction, halitosis, a burning mouth feeling, and taste abnormalities. People with DM are more likely to develop bacterial and fungal infections, soft tissue lesions in the mouth, impaired oral wound healing, dental caries, and tooth loss ^[40].

Dentists should therefore consider haematological and biochemical markers and their potential effects on mouth hygiene and health. Dentists must take the test results into account before beginning treatment for a diabetic patient to reduce the possibility of a diabetic emergency.

The dentist should examine the patient's current DM management as well plan, which should include the timing and dosage of drugs as any alterations to one's way of life, like physical activity or dietary changes. Dentists need to be concerned about their patients' wellbeing usage of medication and records ^[41].

When a person has a personal or family history of bleeding and lab results point to the likelihood of a hereditary or acquired bleeding condition, laboratory testing for bleeding disorders are advised. The concomitant testing for von Willebrand disease is frequently helpful to detect any other bleeding abnormalities. When a rare bleeding illness, such as those affecting factor XIII, antiplasmin beta-2, or plasminogen activator inhibitor-1 is suspected, an examination is necessary.

An structured approach to investigating bleeding disorders takes into account the crucial issues, validates anomalous findings, and encourages accurate interpretation of the outcomes provide a useful framework for evaluating the haemorrhage reason ^[42].

Conclusion

Students of medicine, including but not limited to dentistry, will benefit from having a solid understanding of contemporary biochemistry and molecular biology, which would also enable more effective research and instruction. Consequently, a crucial component of biochemistry training is a focus on the fact that the Basic biochemical procedures that take place in the mouth include similar to those that are occurring in different tissues and organs of your body. The salivary glands secrete saliva, which has numerous purposes, such as mouth protection and cleaning, assistance with digestion and antimicrobial action.

Saliva is now widely acknowledged as a source of biological markers, including DNA, RNA, and proteins, thanks to the rapid advancements in salivaomics, also the microbes in microbial biofilm, big alterations that take place In situations of oral illnesses, including pulpitis, gingivitis, and periodontitis, the deterioration of connective tissue extracellular matrix as a result of the host's release of enzymes and bacterial cells, matrix component phagocytosis, and the cytokine, inflammatory, and apoptotic mediators are released proteins.

Inflammatory and periodontal disorders can occur as a result of host cell-derived chemicals because of the elevated amounts of these molecules and enzymes, which are a reflection of the severity of oral inflammation. Given the variety of possible oral DM symptoms and the possibility of a diabetic emergency, it is crucial for dentists to understand how this disorder affects dental care. Comprehensive knowledge of DM and its effects on dental care are essential for a dentist to deliver the best oral health treatment to people with diabetes.

When a patient has a personal or family history of bleeding and laboratory tests indicate there may be a bleeding issue, it is advised to test for bleeding problem that is either inherited or acquired. The use of laboratory testing is beneficial in the diagnosis of several problems of the blood, such as those related to coagulation factors, fibrinolysis, or clot stabilisation. The development of dentistry and medical sciences has been considerably aided by clinical and biomedical research. Clinical biochemistry in medicine involves becoming more important in dentistry and ought to be acknowledged in both research and teaching.

References

1. Guven Y. Scientific basis of dentistry. J Istanbul Univ Fac Dent 2017;51(3):64–71. [CrossRef]
2. Dominiczak MH. Contribution of biochemistry to medicine: medical biochemistry and clinical biochemistry. Encyclopedia of life support systems (EOLSS). p. 1–9. Available at: [https:// www.eolss.net/sample-chapters/C17/E6-58-10-12.pdf](https://www.eolss.net/sample-chapters/C17/E6-58-10-12.pdf). Accessed Mar 16, 2021.
3. Loesche WJ. Microbiology of dental decay and periodontal disease. In: Baron S, editor. Medical microbiology. 4th ed. Galveston (TX): University of Texas Medical Branch at Galveston; 1996. Chapter 99.
4. Ahsan H. Biomolecules and biomarkers in oral cavity: bioassays and immunopathology. J Immunoassay Immunochem 2019;40(1):52–69.

[CrossRef]

5. Kochhar A, Larian B, Azizzadeh B. Facial nerve and parotid gland anatomy. *Otolaryngol Clin North Am* 2016;49(2):273–84. [CrossRef]
6. Ahsan H. The role of biochemistry in dental sciences. *J Med Erud* 2014;2(2):43–9.
7. Gewargis J. The biochemical basis of dental caries in action. *Acta Scientific Dental Sci* 2019;3(3):32–6.
8. Beeley JA. The teaching of biochemistry to dental students. *Biochem Edu* 1974;2(1):9–11. [CrossRef]
9. Peng Y, Chen X, Sato T, Rankin SA, Tsuji RF, Ge Y. Purification and high-resolution top-down mass spectrometric characterization of human salivary α -amylase. *Anal Chem* 2012;84(7):3339–46. [CrossRef]
10. Spielmann N, Wong DT. Saliva: diagnostics and therapeutic perspectives. *Oral Dis* 2011;17(4):345–54. [CrossRef]
11. Pfaffe T, Cooper-White J, Beyerlein P, Kostner K, Punyadeera C. Diagnostic potential of saliva: current state and future applications. *Clin Chem* 2011;57(5):675–87. [CrossRef]
12. Chen YC, Li TY, Tsai MF. Analysis of the saliva from patients with oral cancer by matrix-assisted laser desorption/ionization time-of-flight mass spectrometry. *Rapid Commun Mass Spectrom* 2002;16(5):364–9. [CrossRef]
13. de Almeida Pdel V, Grégio AM, Machado MA, de Lima AA, Azevedo LR. Saliva composition and functions: a comprehensive review. *J Contemp Dent Pract* 2008;9(3):72–80. [CrossRef]
14. Acevedo AC. Saliva and oral health. *Rev Assoc Med Bras* 2010;56(1):2. [CrossRef]
15. Baron M, Norman DG, Campbell ID. Protein modules. *Trends Biochem Sci* 1991;16:13–7. [CrossRef]
16. Levine MJ. Salivary macromolecules. A structure/function synopsis. *Ann N Y Acad Sci* 1993;694:11–6. [CrossRef]
17. Schenkels LC, Veerman EC, Nieuw Amerongen AV. Biochemical composition of human saliva in relation to other mucosal fluids. *Crit Rev Oral Biol Med* 1995;6(2):161–75. [CrossRef]
18. Zhang CZ, Cheng XQ, Li JY, Zhang P, Yi P, Xu X, et al. Saliva in the

- diagnosis of diseases. *Int J Oral Sci* 2016;8(3):133–7. [CrossRef]
19. Zalewska A, Waszkiewicz N, López-Pintor RM. The use of saliva in the diagnosis of oral and systemic diseases. *Dis Markers* 2019;2019:9149503. [CrossRef]
 20. Miočević O, Cole CR, Laughlin MJ, Buck RL, Slowey PD, Shirtcliff EA. Quantitative lateral flow assays for salivary biomarker assessment: a review. *Front Public Health* 2017;5:133. [CrossRef]
 21. Podzimek S, Vondrackova L, Duskova J, Janatova T, Broukal Z. Salivary markers for periodontal and general diseases. *Dis Markers* 2016;2016:9179632. [CrossRef]
 22. Fábíán TK, Fejérdy P, Csermely P. Salivary genomics, transcriptomics and proteomics: the emerging concept of the oral ecosystem and their use in the early diagnosis of cancer and other diseases. *Curr Genomics* 2008;9(1):11–21. [CrossRef]
 23. Whelton H. Introduction: the anatomy and physiology of salivary glands. In: Edgar M, Dawes C, O'Mullane D, editors. *Duns Tew, UK: Stephen Hancocks Limited*; 2012.
 24. Nunes LA, Mussavira S, Bindhu OS. Clinical and diagnostic utility of saliva as a non-invasive diagnostic fluid: a systematic review. *Biochem Med (Zagreb)* 2015;25(2):177–92. [CrossRef]
 25. Hovav AH. Dendritic cells of the oral mucosa. *Mucosal Immunol* 2014;7(1):27–37. [CrossRef]
 26. Moutsopoulos NM, Konkel JE. Tissue-Specific Immunity at the Oral Mucosal Barrier. *Trends Immunol* 2018;39(4):276–87.
 27. Fábíán TK, Fejérdy P, Nguyen MT, Soti C, Csermely P. Potential immunological functions of salivary Hsp70 in mucosal and periodontal defense mechanisms. *Arch Immunol Ther Exp (Warsz)* 2007;55(2):91–8. [CrossRef]
 28. Fábíán TK, Fejérdy P, Csermely P. Saliva in health and disease. In: Begley TP, editor. *Wiley encyclopedia of chemical biology*. 1st ed. Hoboken, NJ: John Wiley & Sons; 2008. vol. 4, p. 1–9.
 29. Fábíán TK, Gótai L, Beck A, Fábíán TK, Fejérdy P. The role of molecular chaperones (Hspas/Hsp70s) in oral health and oral inflammatory diseases: a review. *Eur J Inflamm* 2009;7:53–61.
 30. Fábíán TK, Hermann P, Beck A, Fejérdy P, Fábíán G. Salivary defense

- proteins: their network and role in innate and acquired oral immunity. *Int J Mol Sci* 2012;13(4):4295–320. [CrossRef]
31. Aksoy Y. Biochemical approach to dental diseases. *Clin Dent Res* 2011;35(1):57–64.
 32. Checchi V, Maravic T, Bellini P, Generali L, Consolo U, Breschi L, et al. The role of matrix metalloproteinases in periodontal disease. *Int J Environ Res Public Health* 2020;17(14):4923.
 33. Taba M Jr, Kinney J, Kim AS, Giannobile WV. Diagnostic biomarkers for oral and periodontal diseases. *Dent Clin North Am* 2005;49(3):551–71, vi. [CrossRef]
 34. Zia A, Khan S, Bey A, Gupta ND, Mukhtar-Un-Nisar S. Oral biomarkers in the diagnosis and progression of periodontal diseases. *Biol Med* 2011;3(2):45–52.
 35. Hupp WS, Firriolo FJ, De Rossi SS. Laboratory evaluation of chronic medical conditions for dental treatment: part III. Hematology. *Compend Contin Educ Dent* 2011;32(7):10–2, 14–8; quiz 20, 32
 36. Hupp WS, Firriolo FJ, DeRossi SS. Laboratory evaluation of chronic medical conditions for dental treatment, part I: HIV/AIDS, hemostasis, and liver disease. *Inside Dentistry* 2010;6(9):60–70.
 37. Hupp WS, Firriolo FJ, DeRossi SS. Laboratory evaluation of chronic medical conditions for dental treatment, part II: diabetes and renal function. *Inside Dentistry* 2010;6(10):48–58.
 38. Janghorbani M, Amini M. Normal fasting plasma glucose and risk of prediabetes and type 2 diabetes: the Isfahan diabetes prevention study. *Rev Diabet Stud* 2011;8(4):490–8. [CrossRef]
 39. American Diabetes Association. Diagnosis and classification of diabetes mellitus. *Diabetes Care* 2011;34(Suppl 1):S62–9.
 40. Al-Maskari AY, Al-Maskari MY, Al-Sudairy S. Oral manifestations and complications of diabetes mellitus: a review. *Sultan Qaboos Univ Med J* 2011;11(2):179–86. [CrossRef]
 41. Miller A, Ouanounou A. Diagnosis, management, and dental considerations for the diabetic patient. *J Can Dent Assoc* 2020;86:k8. 42. Hayward CPM. How I investigate for bleeding disorders. *Int J Lab Hematol* 2018;40 Suppl 1:6–14. [CrossRef]

Chapter - 6

The Buying Patterns of Today's Consumers and Consumer Behavior

Aysha Be

Ph.D Scholar, Department of Family Resource Management, I.C. College of Home Science Hisar, Haryana, India

Dr. Kavita Dua

Assistant Professor, Chaudhary Charan Singh Haryana Agricultural University, Hisar, Haryana, India

Abstract

Consumer behaviour refers to how people decide to allocate their available resources, such as time, money and effort, to the consumption of various goods and services.

It comprises what people purchase, their motivations, when and place of purchase, frequency of purchase, and frequency of use. A person visits the market to purchase the items in exchange for money in order to meet their desire. An important skill for marketers to have been knowledge of consumer behaviour. The study of consumer behaviour focuses on how people choose the products they buy. The Consumer Buying Decision Process Has Five Stages (For complex decisions). The act of buying is merely one step in the process. Not every decision-making process result in a purchase. Depending on the level of complexity, not every customer decision will involve all five steps. The five processes include the identification of the need, information search, alternative evaluation, evaluation search, and post-purchase decision. In the decision-making process, human behaviour is also crucial. There are certain behaviourist theories that can be used to determine how human behaviourism develops.

Introduction

A consumer is somebody who is participating in the consumption process. Consumers are those who make purchases for their own use or to fulfil the needs of their families and households as a whole. Consumer behaviour refers to how people decide how to allocate their available resources, such as time, money, and effort, to the consumption of various goods and services. It

comprises what people purchase, their motivations, when and place of purchase, frequency of purchase, and frequency of use. Consumer behaviour includes both the mental and social processes that occur before and after a person makes a purchase or uses a product or service. Leon G. Schiffman and Leslie Lazar Kanuk, consumer behaviour is defined as the actions that consumers take when looking for, selecting, using, assessing, and discarding goods, services, and concepts that they believe will meet their requirements. Consumer behaviour refers to how a person behaves when acquiring and utilising goods and services. The decision-making process involved in this action is impacted by the individual's personality traits and external circumstances. Consumer behaviour is a broadly study field.

Consumer behaviour is the study for explaining the consumer why, what, when and how buy a product or a brand (Kumar, John, & Senith, 2014) the understanding of consumer buying behaviour completely is still impossible because it is related very closely to human mind. However, the understanding of consumer buying behaviour on digital platform quite possible through several analytical software. But completely understanding of consumer buying behaviour are still impossible. Consumer behaviour is a behaviour towards purchasing of goods. Every person wants to satisfy its needs. Needs is a part of human life. Consumer behaviour is a broadly study field. Consumer behaviour is the study for explaining the consumer why, what, when and how buy a product or a brand (Kumar, John, & Senith, 2014). The understanding of consumer buying behaviour completely is still impossible because it is related very closely to human mind. However, the understanding of consumer buying behaviour on digital platform quite possible through several analytical software. But completely understanding of consumer buying behaviour are still impossible. Consumer behaviour is a behaviour towards purchasing of goods. Every person wants to satisfy its needs. Needs is a part of human life.

Because it is so closely tied to the human mind, it is still impossible to fully explain consumer purchasing behaviour. However, there are a number of analytical tools available that make it easy to understand customer purchasing patterns on digital platforms. But a thorough understanding of consumer purchasing patterns is still elusive. Consumer behaviour is a way of thinking about making purchases. Everybody strives to fulfil their requirements. Needs are a natural element of life. A person visits the market to purchase the items in exchange for money in order to meet their desire. An important skill for marketers to have is knowledge of consumer behaviour. The study of consumer behaviour focuses on how people choose the products they buy. Both pre- and post-purchase behaviours are possible. Additionally, it aids

businesses in locating possibilities. Researchers have long been interested in consumer decision-making. Early economists led by Nicholas Bernoulli, John von Neumann, and Oskar Morgenstern began to investigate the factors influencing consumer choice some 300 years ago. (Richarme 2007). By giving value and meeting customers' exchange expectations, marketers have long worked to not only attract new clientele but also keep hold of their current clientele. Customer satisfaction has been proven to be closely related to customer retention, and client happiness not only keeps the customer with the business but also influences earnings per share, revenue, and stock price (Williams and Naumann, 2011).

Steps of Consumer Decision Making Process

The Consumer Buying Decision Process Has Five Stages (For complex decisions). The act of buying is merely one step in the process. Not every decision-making process results in a purchase. Depending on the level of complexity, not every customer decision will involve all five steps.

1) Need Recognition

It is the initial phase of the consumer purchasing process. It also goes by the name "Problem recognition." Beginning with the necessities of life like air, water, food, and shelter it could also begin with a step beyond a necessity (Kotler & Keller 2016, p. 195; Kotler et al. 2017, p. 155-156.). The company should understand the consumer need and focus on to satisfy it (Shma, 2012). By identifying customer needs, businesses can develop marketing tactics. For instance, when someone is hungry, they naturally want food, but a satisfying meal may satisfy their craving. Therefore, the organisation should concentrate on meeting customer needs. Information search comes next after this stage.

2) Information Search

It is the second step in the decision-making process for consumers. When a consumer goes to the market to purchase products or services, the consumer thinks back on his or her previous experiences with the product. If those experiences were positive or satisfying, the consumer will purchase that thing and the quest for information will come to an end. However, if a consumer has had a bad or unfavourable encounter with a product in the past, they will start looking for information about it. When a customer wants to try a new product, they also look up product information. (Clow& Baack 2016, p.76). At this point, the consumer starts researching the product using several resources. According to The Kotler, "Consumers can acquire information from a variety of sources.

3) Evaluation of Alternatives

The third stage of the purchasing decision-making process for consumers is this. It follows the second stage of the purchasing decision-making process, information research. After gathering information about a product or brand, a consumer ranks the item or entity before moving on to analyse it. For instance, if a consumer wants to purchase a car, they will first gather brand information before comparing their preferred brand to the alternatives. Although understanding customer behaviour can be challenging, marketers tend to concentrate on certain steps, such as the consumer's desire to first fulfil their needs and wants and then to further profit from a certain brand (Kotler & Keller 2016, p. 197).

4) Purchase Decision

The fourth stage of the purchasing decision-making process for consumers is this. After gathering data from many sources, assessing it, and deciding where to buy and what to buy, the customer has made the decision to acquire a product. The brand or item that the consumer rates highly throughout the evaluation stage is the one they choose to buy. The surrounding surroundings also had an impact on the decision to buy.

5) Post-Purchase Decision

The fifth and last step in the consumer purchasing decision-making process is the post-purchase decision. If a customer purchases a product, the company's effort does not end. The businesses should be aware of how consumers behave or perceive their items. The customer may feel satisfied or unsatisfied after using the goods. If a customer is content, there is a potential that they will purchase more of the same goods, and a happy customer may even persuade others to do the same. The likelihood of a consumer being more devoted to a product is greatest, and if that happens, the likelihood that a delighted customer would keep the product is greatest. Consumer expectations and perceptions are the two main factors that determine whether a consumer is satisfied or unsatisfied. Consumers may be satisfied if what they expected from the goods matches what they really received. Consumers will become dissatisfied if their expectations are not met by the goods they perceive. (Kotler et al. 2017, p. 157.)

Factors Influencing Consumer Behaviour

Cultural, social, personal, and psychological traits have a big impact on consumer purchasing.

I. Cultural Factors

Culture is the collection of fundamental beliefs, values, desires, and

behaviours that a person of a community learns from their family and other significant institutions. In essence, culture is an integral component of every community and a key driver of personal desires and actions. Marketers must be very careful when assessing the cultures of various groups, regions, or even entire countries because the impact of culture on purchasing behaviour varies from country to country.

Subculture: Every civilization has various subcultures, including those related to various religions, countries, geographical locations, racial groups, etc. By breaking up the market into numerous tiny sections, marketers can use these groups. Products can be created by marketers taking into account the necessities of a specific region.

Social Class: Social class is the hierarchical partition of society into groups, each of which denotes a particular social status or standing. Consumer behaviour is significantly influenced by social class, which has an impact on consumer buying habits, lifestyles, media habits, activities, and interests.

Social Factors

Social considerations have an impact on customers' purchasing decisions as well. Family, role, status, and peer groups are crucial social influences.

Reference Groups: People's reference groups are those that either directly or indirectly affect their attitudes and behaviours. People absorb attitudes, ideas, and behaviours from these organisations and then adapt them to their own lives. Due to their frequent interactions with the individual and the prominence of these significant others in the individual's life, family and close friends are regarded as the key reference groups in an individual's life. Schoolmates, neighbours, co-workers, and other acquaintances make up a person's secondary reference groups.

Family: The family member has a big impact on the buying behaviour. The roles and impact of the husband, wife, and children are so sought after by marketers. If a woman influences a husband's decision to purchase a certain product, marketers will attempt to target women in their advertising. It is important to recognise that as consumer lives evolve, so do the functions that buyers play.

Roles and Status: Depending on the groups, clubs, families, organisations, etc. to which he belongs, each person has a different function and prestige in society. The consumer's behaviour and purchase choices are significantly influenced by his or her social role and status.

II. Personal Factors

Personal factors can also affect the consumer behavior. Some of the important personal factors that influence the buying behavior are: lifestyle, economic situation, occupation, age, personality and self-concept.

Age: The customer buying behaviour may be impacted by age and life cycle. With time, consumers alter the products and services they buy. The stages of the family life cycle, including childhood, singlehood, newlywed hood, motherhood, etc., aid marketers in creating items that are suited for each stage.

Occupation: A person's purchasing behaviour is significantly influenced by his or her profession. For instance, a marketing manager of a company would strive to buy business suits, whereas a low-level employee of the same company might buy tough labour clothes.

Economic Situation: The financial position of the consumer greatly affects his purchasing decisions. Customers that earn a lot of money and have a lot of savings tend to buy more expensive goods. A person with little money saved up will, on the other hand, buy cheap goods.

Lifestyle: Customers' way of life has a significant impact on their purchasing decisions. Lifestyle is the term used to describe how a person interacts with his or her environment and how they live in a society. It shapes the customer's entire pattern of acting and interacting in the world and is determined by the customer's interests, opinions, and other activities.

Personality: From person to person, season to season, and location to location, personalities vary. As a result, it has a big impact on how customers behave when they shop. Actually, one's personality is not determined by what they wear; rather, it is the sum of a man's actions under various conditions. It has several traits like dominance, aggression, self-assurance, etc. that can be used to predict consumer behaviour for a specific good or service.

III. Psychological Factors

There are four important psychological factors affecting the consumer buying behavior. These are: motivation, perception, learning, beliefs and attitudes.

Motivation: Customers' purchasing behaviour is also influenced by their amount of motivation. Every person has unique needs, including physiologic, biological, social, and other demands. The way that needs work is that some of them are more urgent than others. Therefore, when a need is more urgent, it transforms into a motive and pushes the person to seek fulfilment.

Learning- Learning might be cognitive or conditioned. In conditional learning, the customer is repeatedly exposed to a circumstance, which causes the consumer to form an opinion about it. Contrarily, in cognitive learning, the buyer will use his knowledge and abilities to find fulfilment and a solution in the product he purchases.

Perception: Perception is the process of choosing, arranging, and interpreting data to create a meaningful experience of the outside world. An individual's perspective of a given good or service is based on what they believe about it. Due to perceptual differences, people with the same needs might not purchase comparable things. Selective attention, selective distortion, and selective retention are three distinct perceptual processes. When selective attention is present, people focus on knowledge that will be helpful to them or their close family members. Contrarily, when information is selectively distorted, consumers are more likely to interpret it in a way that supports their pre-existing ideas and opinions. Similar to selective retention, consumers retain information that they would find valuable and promptly forget the rest.

Beliefs and Attitudes: Customers have particular attitudes and perceptions about distinct products. Marketers are interested in these ideas because they shape brand image and influence consumer purchasing behaviour. By initiating targeted initiatives in this area, marketers can influence the attitudes and beliefs of their target audience.

Human Behaviour

Human behaviour is the potential and expressed capacity of human individuals or groups to react to internal and external stimuli during the course of their lifetimes (mentally, physically, and socially). An individual's genetic makeup and the environment they live in influence their behaviour. Behavior is also influenced by thoughts and feelings, which offer insight into the psychology of an individual and indicate things like attitudes and values. Psychological characteristics influence human behaviour because personality types varies from person to person and result in a range of actions and behaviour.

Classification of Human Behaviour

Human conduct can be categorised into numerous sorts based on how individuals respond or behave in various contexts and in reaction to various inputs.

Molecular Behavior

Molecular behaviour is the quick, thoughtless behaviour that takes place.

Example: Kuddus immediately closes his eyes after Abul strikes them with a stick. The behaviour here is molecular. Unpredictable circumstance in which Kuddus is unprepared for his eyes or face.

Moler Behavior

The opposite of molecular behaviour is moler behaviour. Human behaviour is referred to as molecular behaviour when it involves thought. For instance, counter attract.

Overt & Covert Behavior

Overt Behavior

Overt conduct is defined as actions that are obvious and take place without the presence of a human. An illustration of overt conduct is playing football and eating.

Covert Behavior

The term "covert behaviour" refers to internal human conduct that is not visible to others. Consider thinking.

Voluntary and Involuntary Behavior

Voluntary Behavior

Voluntary behaviour is defined as behaviour that is motivated by human desires. Humans are constantly in charge of voluntary activity. For instance, talking, moving, writing, etc.

Involuntary Behavior

Behavior what occurs naturally is called involuntary behavior. Example: Movement of heart, taking oxygen and giving up carbon dioxide.

There are Some Theories of Human Behaviour:

A) Classical Conditioning Theory

Learning by association is known as Classical conditioning, which was first described by the Russian physiologist Pavlov. It is sometimes referred to as responder conditioning or Pavlovian conditioning. Simply said, two stimuli are combined to cause a person or animal to learn a new learnt response. The following definitions will aid in understanding the theory.

Unconditioned Stimulus

A stimulus or trigger that causes an instinctive response is known as an unconditioned stimulus. For example, if a cold breeze causes you to shudder,

the cold breeze is an unconditioned stimulus that results in an automatic reaction (the shivering).

Neutral Stimulus

A neutral stimulus is one that does not immediately cause a reaction. For instance, you wouldn't automatically react if you heard a fan but didn't feel the breeze. As a result, it would be a neutral stimulus.

Conditioned Stimulus

A conditioned stimulus is one that initially was neutral (did not elicit a reaction), but now elicits one. A person has developed a conditioned response to a stimulus when they previously ignored dogs but later became afraid of them after being bitten by one.

Unconditioned Response

When an unconditioned stimulus is present, an unconditioned response is an instinctive or unplanned reaction that takes place. If someone smells their favorite cuisine and their mouth begins to wet, this is an unconditioned reaction.

Conditioned Response

A conditioned response is one that has been taught or that has been induced where none previously existed. Returning to the dog bite example, the terror you feel as a result of the bite is a conditioned reaction.

The Three Stages of Classical Conditioning: The process of classical conditioning occurs in three basic stages:

Before Conditioning

Unconditional Stimulus (UCS) and Conditional Stimulus (CS) do not currently interact in any way. The environment presents the unconditional stimulus, which naturally prompts an equally unconditional reaction. The Unconditional Response (UCR) is a wholly natural reaction that cannot be taught or acquired. For instance, a person may experience seasickness the first time they go on a boat (UCS) (UCR). The conditional stimulus is a neutral stimulus at this moment (NS). It hasn't yet been conditioned, thus it hasn't produced any form of response.

During Conditioning

The second stage involves pairing the unconditional and non-conditional stimuli, which causes the initially neutral stimulus to change into a conditional stimulus (CS). The Conditional Response (CR) happens just before or

simultaneously with the Unconditional Response (UCS), and as a result, the UCS and, consequently, the UCR are linked to the CS. To strengthen the link between the two stimuli, the UCS and CS must often be paired multiple times. There are occasions, though, when doing so is unnecessary. For instance, if someone becomes sick after eating a certain cuisine once, they might continue to feel queasy after eating that item in the future. So the person on the boat could have become sick (UCR) if they drank fruit punch (CS) just before.

After Conditioning

The CS will cause a reaction once the Unconditional Stimulus (UCS) and Conditional Stimulus (CS) have been linked, therefore the UCS is no longer required to be presented with it. The Conditional Response is now elicited by the CS (CR). The person has mastered the art of connecting a particular reaction to a previously neutral input. Thus, even though fruit punch had nothing to do with the person becoming seasick on the boat, they may discover that in the future it makes them feel ill (CR) if they drink it.

B) Operant Conditioning Theory

The phrase "operant conditioning" was first used by B.F. Skinner in 1938; it basically refers to the modification of behaviour through the use of rewards that are given following the desired response. Three different operant response types that can follow behaviour were identified by Skinner.

- Neutral operants are environmental cues that neither raise nor diminish the likelihood that a behaviour will be repeated.
- Reinforcers: Environmental cues that make it more likely that a behaviour will be repeated. Positive or negative reinforcers are also possible.
- Punishers: environmental responses that make it less likely that a conduct will be repeated. Penalties erode conduct.

Positive Reinforcement

Skinner put a hungry rat in his Skinner box to demonstrate the effectiveness of positive reinforcement. As the rat went around the box, it would unintentionally knock a lever that was attached to the side. A food pellet would immediately fall into a receptacle close to the lever as soon as it had done so. After being placed in the box a few times, the rats soon learnt to immediately go to the lever. They would keep pressing the lever since doing it would result in food, which made them more likely to keep doing it.

Negative Reinforcement

Unfavorable Reinforcement a negative reinforcer's removal can also

make a behaviour stronger. Because an unfavourable stimulus that is "rewarding" to the person or animal is removed, this is referred to as negative reinforcement. Positive reinforcement reinforces behaviour positively by preventing or removing negative experiences.

Punishment (Weakens Behavior)

Since punishment is intended to reduce or remove a reaction rather than increase it, it is referred to as the antithesis of reinforcement. It is an unpleasant experience that reduces the behaviour it causes. Like reinforcement, punishment also works by either eliminating a potentially rewarding stimulus, such as taking money out of someone's purse to deter bad behaviour, or by immediately providing an unpleasant stimulus, such as a shock following a response.

C) Theory of John. B. Watson

The Behaviorism school of psychology was codified and made popular by American psychologist J.B. Watson. Watson claimed that psychology should examine observable actions that are measurable using the scientific approach, in contrast to the "original" Freudian psychology which explored the unconscious, emotional, and other intangible ideas.

In the "Little Albert" experiment, Watson programmed an infant to fear a lab rat using the classical conditioning technique. Pavlov already shown how training can cause biological reactions that are genetically passed down. Watson proposed that humans can also teach ourselves brand-new, non-inherited behaviour.

D) Theory of E.L.Thorndike

- The initial S-R framework of behavioural psychology is represented by the learning theory developed by Thorndike. As relationships between inputs and responses develop, learning occurs. The characteristics and frequency of the S-R pairings influence whether these connections or habits are strengthened or decreased. Also known as the theory of trial and error. According to Thorndike, learning is a phenomenon that strengthens the connections between one event and another, known as the stimulus (S) with response (R). A stimulus is a change in the external environment that signals an organism to respond and take action. Additionally, a response is an action that a stimulus raises.
- The experiment with the caged, hungry cat shows that selecting a valuable response through trial and error is necessary to establish a

relationship between stimulus and response. Some scholars refer to Thorndike in this context as instrumental conditioning.

- One of the well-known Thorndike experiments involved placing hungry cats in a cage with an automatic door that could be opened and shut by pressing a button under the cage. In the trial stage, cats frequently exhibit unsettled behaviour. Every response creates a fresh stimulus, and this fresh stimulus creates still another response, and so on. This scheme best describes it.
- In this experiment, if food is placed outside of the cage, the cat will attempt to get to it. The door of the cage will suddenly open when the cat touches the button, allowing it to run out and consume the food. If there is food outside of the cage, the cat will purposefully touch the button after this experiment is repeated ten to twelve times.
- Thorndike regularly applies this experiment on the same cat and circumstance. First of all, cats will only circle a cage while attempting to get out of it. A response to the stimulus—food—is an attempt to escape from the cat. Finally, the stimulus will match the cat's response, which is escape (getting the food outside the cage).
- According to Thorndike, every creature's behaviour exhibits a correlation between the stimulus it receives and the action it takes. According to this view, a learner is a person who has mastered the relationships between stimuli and response. Additionally, it is common practice to establish a connection between stimuli and response.

Reference

1. Cherry, K. (2022). What is personality? <https://www.verywellmind.com/what-is-personality-2795416>
2. Clow, E. K & Baack, D. 2016. Integrated Advertising, Promotion, and Marketing Communications. Pearson Education. Seventh Edition.
3. Farnsworth, B. (2022). Human behaviour research the complete guide <https://imotions.com/blog/learning/research-fundamentals/human-behavior/>
4. Islam, M. H. (2015). Thorndike theory and it's application in learning. *At-Ta'lim: Jurnal Pendidikan*, 1(1), 37-47.
5. Jisana, T. K. (2014). Consumer behaviour models: an overview. *Sai Om Journal of Commerce & Management*, 1(5), 34-43.
6. Koblin, J. (2021). Watson's Theory of Behaviorism,

7. Kotler, P. 2017. Principles of Marketing. Pearson Education. Seventh European Edition. Kotler, P. & Keller, L.K. 2016. Marketing Management. Pearson Education. Fifteenth Edition.
8. Leon G.Schiffman, Leslie I. Kanuk (2002), "Consumer behavior", Sixth edition, Prentice Hall of India private limited, New Delhi.
9. McLeod, S. A. (2007). B.F. Skinner: Operant conditioning. *Retrieved September, 9(2009)*, 115-144.
10. Sayed, A. (2010). Human Behavior: Classification, Characteristics And Causation, A guide to Textile and Clothing, <https://textileapex.blogspot.com/2014/08/human-behavior.html>
11. Vinney, C. (2020). What Is Classical Conditioning? A Learning Process Discovered by Ivan Pavlov <https://www.thoughtco.com/classical-conditioning-definition-examples-4424672>
12. Williams, P., & Naumann, E. (2011). Customer satisfaction and business performance: a firm-level analysis. *Journal of services marketing*.

Chapter - 7

Microbial Expansins: Structure, Biological Functions and Applications

Dr. P. Jayamma

Assistant Professor, Department of Food Safety and Quality Assurance, College of Food Science and Technology, ANGRAU, Pulivendula, Andhra Pradesh, India

Dr. J. Sai Prasad

Assistant Professor, Department of Food Safety and Quality Assurance, College of Food Science and Technology, Rudrur, Niambad, Telangana, India

Smt. R. Aruna

Assistant Professor, Department of Food Safety and Quality Assurance, College of Food Science and Technology, ANGRAU, Pulivendula, Andhra Pradesh, India

Abstract

Expansins are small proteins that loosen plant cell walls and cellulosic materials without lytic activity. Expansins comprise a large gene super-family which codes for small (225–300 amino acid residues) cell wall proteins, they can be divided into four sub families α -expansin or expansin A (referred to as “EXPA”), β -expansin or expansin B (referred to as “EXPB”), expansin-like A (referred to as “EXPLA”) and expansin-like B (referred to as “EXPLB”). Horizontal gene transfer (HGT) might have played an important role in the distribution of these proteins in many diverse phyla. Although the remarkable similarities between plant and bacterial expansin structures as well as the tree topologies strongly support the HGT model of evolution, they do not unequivocally determine which organism is the donor. The fact that expansins exist in all plants (universal representation) while they are present only in a few bacterial and fungal species (sporadic representation) strongly suggests that the expansin domain originated in plants and was transmitted to other groups by HGT. Bacterial expansins have recently drawn considerable attention for their potential in processing of cellulosic biomass with reduced enzymatic applications. *Clostridium clariflavum* is a plant cell wall degrading bacterium with a highly elaborate cellulosomal system. Among its numerous dockerin-containing genes, two expansin-like proteins, Clocl_1862 and Clocl_1298 (termed herein *Cc/EXL1* and *Cc/EXL2*) were identified, and *Cc/EXL1* was

found to be expressed as part of the cellulosome system. Microbial expansin activity have relied on non enzymatic assays; induction of plant cell wall creep, weakening of filter paper, synergistic enhancement of cellulose action, binding to cellulose and cell walls. Expansins are very important to cellulose deconstruction for biofuels and breeding for resistance to pathogenic attack if the microbes rely solely on the action of their expansin genes.

Keywords: Microbial expansins, Horizontal gene transfer, Cellulosomal expansin, applications

Introduction

Expansins were originally identified as plant cell wall loosening proteins isolated from growing cucumber and oat tissues. These proteins act as mediators of acid growth, which refers to the pH-dependent enlargement of plant cells. Expansins bind to plant cell walls and induce stress relaxation and creep of primary cell walls, but without detectable hydrolytic or other enzymatic modification of the cell walls. Cloning of cDNAs for the cucumber proteins eventually led to the discovery that expansins are encoded by two major gene families in plant genome. The first group is now called α -expansin, designated EXPA, whereas the second group is called β -expansin, designed EXPB.

How Are Expansins Defined?

The major criteria used to judge a protein to be an expansin include its sequence relatedness to known expansins, its structural similarity to the distinctive two domain structure of canonical expansins, and its ability to loosen plant cell walls in the unique manner of expansins. The original definition based on the ability to induce time-dependent, irreversible extension (creep) of plant cell walls (Fig.1).

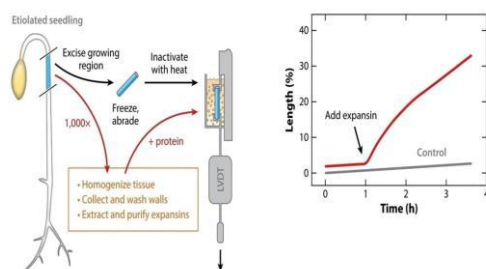


Fig. 1: Schematic diagram of the plant cell wall creep assay originally used to assay and identify plant expansins, (a) A cell wall specimen (blue) is prepared from the growing region of a young seedling (e.g., an etiolated

hypocotyl from a cucumber seedling) and clamped in a constant force extensometer that measures changes in the length of a cell wall specimen with a sensitive position transducer (LVDT). (*Orange box*) Expansins are extracted from a large mass of hypocotyl tissue and added to the cuvette surrounding the cell wall specimen. (b) Time course for changes in cell wall length in an untreated control cell wall specimen and a cell wall specimen treated with plant α -expansin. Expansins rapidly induce irreversible, time-dependent extension (creep) of the cell wall.

Classification and Nomenclature of Expansions

The definition of expansins and the convention for naming them were settled a decade ago. The terms expansin and expansin-like were reserved for proteins containing the two-domain structure characteristic of plant expansins. They typically are made of ~225 amino acids (~26 kD) plus an N-terminal signal peptide that directs the protein to the secretory pathway. Four families of expansins and expansin-like genes and their protein products were recognized in plants at that time (designated EXPA, EXPB, EXLA, and EXLB) based on sequence-based phylogenetic analysis, and this grouping has not changed, although the number of sequenced genes falling into these families has increased enormously. The designation *EXLX* was reserved for genes that fulfilled three criteria: (i) they occur in nonplant organisms, (ii) their protein products are homologous to both expansin domains, and (iii) they do not fall within the established expansin gene families by phylogenetic analysis. In cases where multiple expansin genes are found in a genome, they would be numbered consecutively *EXLX1*, *EXLX2*, and so on, in order of discovery.

Microbial Expansins

Expansins are so diverse that nearly all of the motifs conserved in plant expansins are absent in microbial expansins; consequently, structural analysis and functional testing are often needed to validate identification of divergent expansins. The massive growth of sequence databases continues to reveal novel sequences in microbes with a distant but uncertain relationship to canonical expansins, stretching and blurring the envelope that defines expansin sequences. This trend promises to continue, with the potential to reshape our definition of expansions binding (Figure 2).

At the N terminus is a six-stranded double- ψ β -barrel domain (designated domain-1, D1) and at the C terminus is a β -sandwich domain (domain-2, D2) with a distinctive topological fold. A short linker connects the two domains. D1 falls into the same structural class as family 45 glycosyl

hydrolases [Cel45, which are inverting β -1,4-endoglucanases. However, the catalytic machinery of Cel45 is only partially conserved in expansins and no bona fide lytic activity has been documented for any purified expansin. Moreover, unlike typical endoglucanases that possess a deep cleft or tunnel surrounding the catalytic site, enabling numerous binding interactions with glucan chains, expansin structures solved to date have only a shallow groove in D1, which exhibits negligible binding to polysaccharides in the case of BsEXLX1.

Binding of BsEXLX1 to cellulose is entirely determined by an open surface on D2, which constitutes the founding member of carbohydrate-binding module family. Three aromatic residues are arranged in a linear fashion on the D2 surface of BsEXLX1, binding the hydrophobic planes of alternate glucose residues in a β -1, 4-glucan chain of cellulose. This aligns the glucan chain directly toward the presumptive catalytic site of D1, which, however, does not appreciably bind glucans in BsEXLX1.

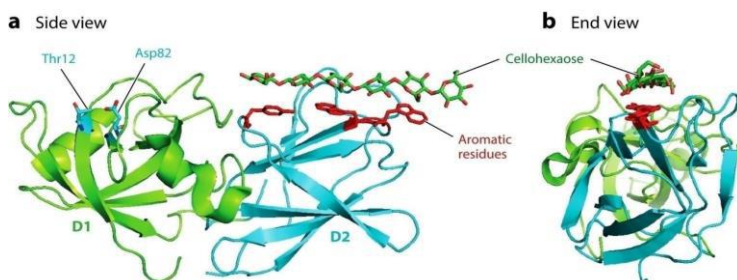


Fig. 2: Structure of BsEXLX1 complexed with cellohexaose (PDB 4FER). (a) Side view showing the conserved Thr12-Asp82 residues at the surface of domain D1 and the three aligned aromatic residues at the surface of domain D2. The D1 fold resembles that of Cel45 endoglucanases, with partial conservation of residues in the catalytic site, including Thr12-Asp82. Cellohexaose interacts with the protein primarily via hydrophobic interactions with the three aromatic residues. (b) End view of the same structure, showing the open surface that binds cellulose.

Structure-Function Analysis of Bacterial Expansins

Crystallographic Structures

Alignments between BsEXLX1 and plant expansin protein sequences show statistically significant alignment, but with multiple short gaps and overall low identity throughout the length of the protein ($\sim 12\%$ or less, depending on the proteins selected) (Fig. 3). Despite the low sequence identity, the crystallographic structures can be superimposed with very low

divergence (low root-mean-square distance between the back- bone carbons), indicating congruent protein structure. Both plant and bacterial expansins consist of two tightly packed domains with an open surface suitable for docking a polysaccharide chain that could span the two domains

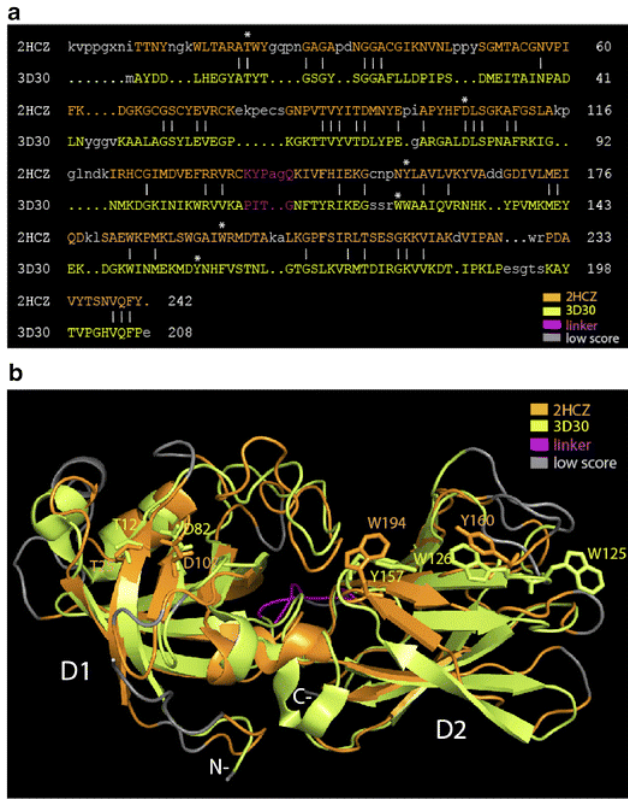


Fig. 3: Structure-based sequence alignment and structure superposition of BsEXLX1 (PDB ID: 3D30; light green color) with maize β-expansin (PDB ID: 2HCZ; orange color). Uppercase letters indicate close alignment of the protein backbones (structurally equivalent residues); identical residues are marked by vertical bars; lowercase letters indicate poor alignment of protein backbones (low-score alignments of structurally nonequivalent residues).b Corresponding superposition of protein structures shows that they have the same two-domain structure (D1 and D2), with each domain folded in the same way. The linker is shown in magenta, and low-score alignments are in gray.

Crystallographic structures have also been obtained for BsEXLX1 in complex with various cellulose-like β1,4-D-glu- can oligosaccharides

Cocrystallization with cellohexaose (a six-residue oligosaccharide of cellulose) showed an uncommon sandwich-like arrangement, with one cellohexaose packed between the D2 domains of two proteins (Fig. 4a). This sandwich structure was obtained with several cellulose-like ligands and was also obtained with another expansin from *C. michiganensis*, indicating that this sandwich configuration is a favorable packing arrangement for expansin-oligosaccharide complexes. It is made possible by the open binding surface of D2; most other proteins that bind polysaccharides make use of a groove or cleft that facilitates protein-polysaccharide interaction but sterically prevents the sandwich-like dimerization seen with expansins.

Dynamic light scattering showed that in the presence of cellohexaose, BsEXLX1 is a monomer in solution, so the dimer structure is most likely the result of packing during the crystallization process and may not be a stable structure found under biological conditions. The lack of ligand-mediated dimerization in solution is also consistent with the weak affinity (>1 mM) of BsEXLX1 for cellohexaose, as evaluated by isothermal titration calorimetry. BsEXLX1 binds more strongly to cellulose, with a $K_d \sim 1$ μ M. Despite the weak cellohexaose protein interaction, the structure has provided valuable insights into the nature of BsEXLX1 binding to cellulose.

In its natural context, BsEXLX1 binds cellulose to loosen cell walls. Crystallographic analysis of this interaction is not feasible because of the size and irregularity of cellulose microfibrils, but such interactions can be assessed by molecular dynamics simulations (Fig. 4b, c). This approach shows direct binding of aromatic residues in the D2 domain to glucose rings exposed on the edge of the hydrophobic surface of cellulose microfibrils. Such binding brings the aromatic residues close enough to the internal residues of the microfibril to allow nuclear magnetic spin diffusion, which was verified by experimental means. The results also show that the D1 domain has little or no interaction with the cellulose surface, which is supported by in-vitro binding results.

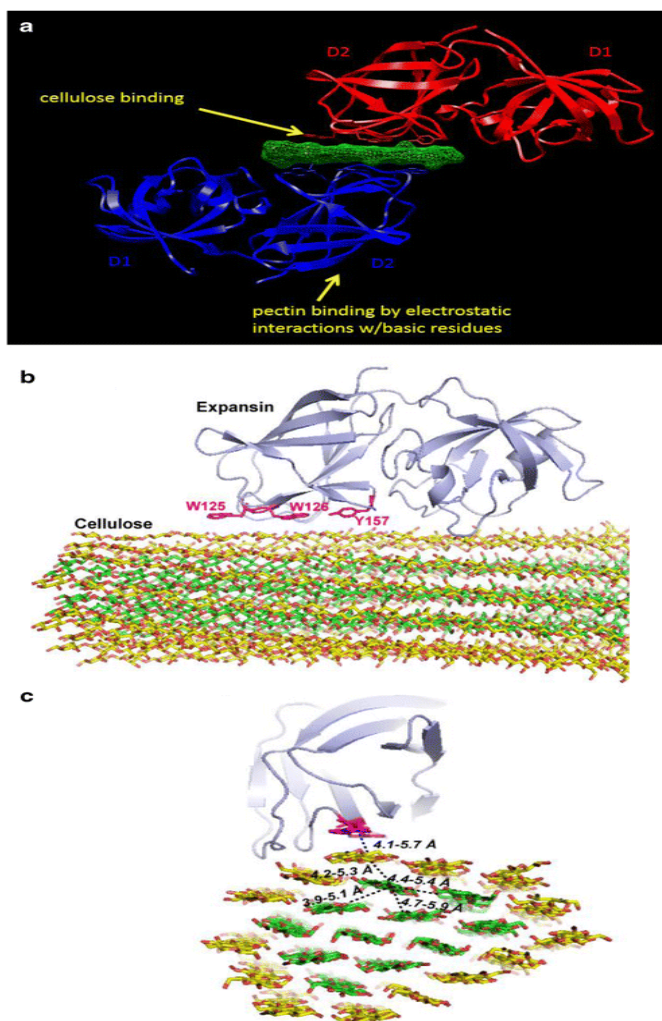


Fig. 3: Structure of BsEXLX1 bound to cellohexaose (a) and to a cellulose microfibril (b, c). a In the crystallographic structure based on protein/ligand crystals, a single cellohexaose (green) is sandwiched between the D2 domains of two BsEXLX1 proteins (red, blue). The regions that control binding to cellulose and to pectins are located on opposite surface of the D2 domain. b, c BsEXLX1 docked onto the surface of a cellulose microfibril (two views).

Analysis of the structure revealed a unique protein:ligand arrangement. One molecule of cellohexaose is packed between the aromatic surfaces of domain D2 of two EXLX1 molecules, designated (A) and (B), with the

reducing end of cellohexaose pointing toward the D1 domain of EXLX1(B) (Fig. 5a). Dynamic light scattering of EXLX1 in solution showed that EXLX1 is a mono- mer (size estimated as 19 kDa) both in the absence and presence of cellohexaose, indicating dimerization by cellohexaose does not occur in solution, at least under the conditions tested.

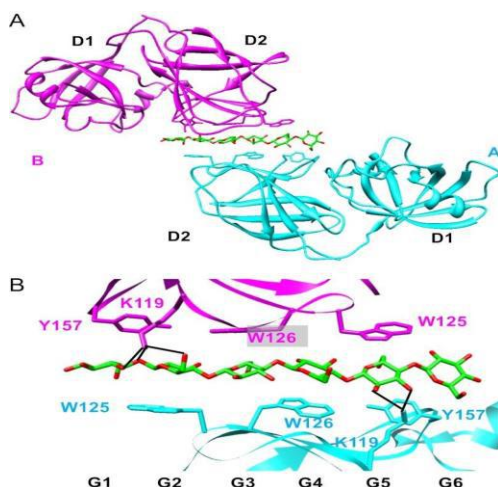


Fig. 5: Structure of EXLX1 with cellohexaose. (a) Sandwich structure consisting of two molecules of EXLX1 (A and B) and one molecule of cellohexaose (green). (b) Direct hydrogen bonds and CH- π interactions between each EXLX1 molecule and cellohexaose. Glucose numbering starts from the reducing end of cellohexaose.

Activities of Microbial Expansins

Despite extensive study, no bona fide enzymatic activity (defined as a change in the covalent structure of a substrate) has been identified for either plant expansins or microbial expansins, and for this reason we call them wall-loosening proteins, not enzymes. Because of the structural resemblance of D1 to Cel45 endoglucanase, tested BsEXLX1 for lytic activity against a wide range of plant cell wall polysaccharides using highly sensitive assays with dye-coupled substrates, with negative results.

Plant Cell Wall Creep

The most diagnostic, specific, and sensitive expansin assay is based on the rapid induction of irreversible extension (creep) of cell wall samples clamped at constant force. This assay originated with the discovery of plant α -expansins and is diagnostic because false positives have not been detected with other proteins, including enzymes that digest plant cell walls. The only

known exception is a limited group of endoglucanases that stimulate wall creep by a hydrolytic mechanism. The lytic mechanism, however, is readily distinguished from expansin action by distinctive changes in wall mechanics and by its kinetics. It is noteworthy that GH45 endoglucanases, which are homologous to expansin D1, have negligible activity in this assay.

Weakening of Filter Paper

Filter paper is made of pure cellulosic fibers bonded together noncovalently. Plant α -expansins weaken filter paper by a nonhydrolytic mechanism, and this activity in the form of a breaking-force assay was developed into a semiquantitative assay of the activity of BsEXLX1 and selected mutants. The assay involves soaking filter paper strips in buffered solutions containing expansins, clamping the strips in a stretching device, and extending the strips at a constant rate while measuring the applied force.

Plant Expansins in Bacteria and Fungi: Evolution by Horizontal Gene Transfer and Independent Domain Fusion

Horizontal gene transfer (HGT) has been described as a common mechanism of transferring genetic material between prokaryotes, whereas genetic transfers from eukaryotes to prokaryotes have been rarely documented. Here we report a rare case of HGT in which plant expansin genes that code for plant cell-wall loosening proteins were transferred from plants to bacteria, fungi, and amoebozoia. In several cases, the species in which the expansin gene was found is either in intimate association with plants or is a known plant pathogen. Our analyses suggest that at least two independent genetic transfers occurred from plants to bacteria and fungi. These events were followed by multiple HGT events within bacteria and fungi. We have also observed that in bacteria expansin genes have been independently fused to DNA fragments that code for an endoglucanase domain or for a carbohydrate binding module, pointing to functional convergence at the molecular level.

Furthermore, the functional similarities between microbial expansins and their plant xenologs suggest that these proteins mediate microbial-plant interactions by altering the plant cell wall and therefore may provide adaptive advantages to these species. The evolution of these nonplant expansins represents a unique case in which bacteria and fungi have found innovative and adaptive ways to interact with and infect plants by acquiring genes from their host. This evolutionary paradigm suggests that despite their low frequency such HGT events may have significantly contributed to the evolution of prokaryotic and eukaryotic species.

Homologs of EXLX1 in Nonplant Species

Three major observations can be deduced from the phylogenetic analysis of EXLX1 homologs. First, the distribution of the EXLX1 homologs is sporadic (Fig. 6). Second, observed that in some cases the EXLX1 homologous proteins contain additional domains (fig. 6b). In all cases, these domains are either cellulase GH5 or carbohydrate-binding modules (CBMs). Third, many of the EXLX1 homologs exist in species that are plant pathogens (40% of species) (fig. 6a). Most of the remaining proteins exist in species that either live in soil having a direct relationship with plants (e.g., *Bacillus*, *Frankia*) or produce cellulose during their life cycle (e.g., *Dictyostelium*).

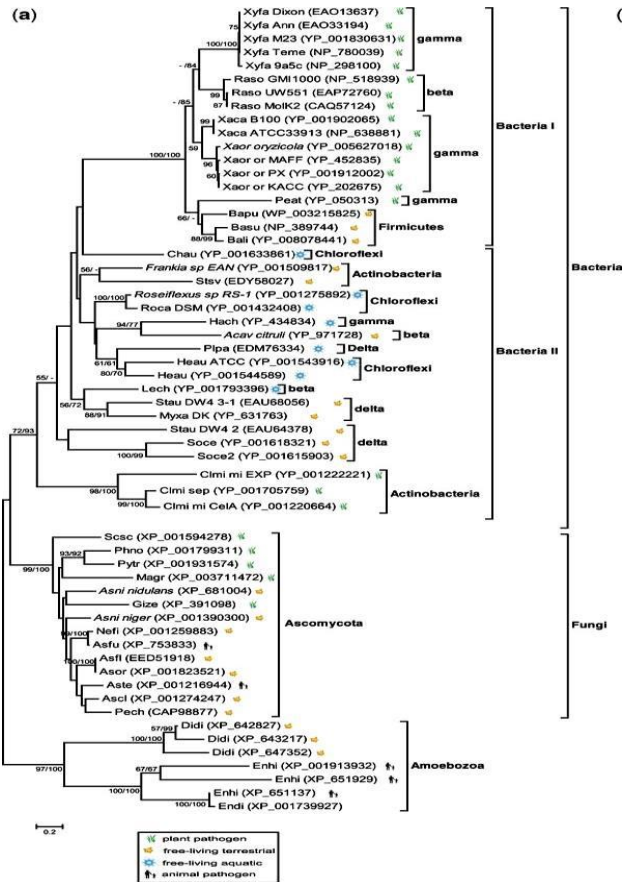


Fig. 6: The *Bacillus subtilis* EXLX1 protein has many homologs in bacteria, fungi, and amoebzoa. Phylogenetic relationships of representative *B. subtilis* EXLX1 homologs.

The analyses of the tertiary and the primary sequences strongly support the conclusion that EXLX1 has many homologs in phylogenetically diverged species. Tree derived from the EXLX1 and its homologs in both bacteria and fungi is different from the species trees. A plausible explanation of the observed phylogenetic pattern of the EXLX1 homologs is HGT between different bacterial and fungal species. The most plausible scenario that explains the evolution of these proteins is ancient HGTs followed by vertical transmission in some instances (Fig. 7).

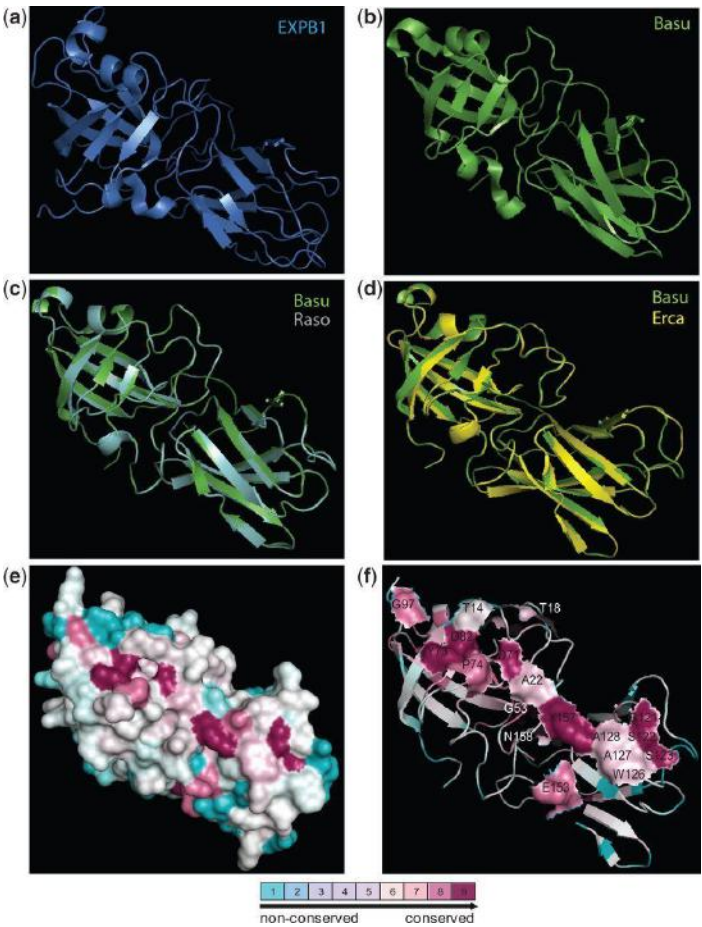


Fig. 7: The EXLX1 homologs are predicted to contain two domains, fold similarly to the Zea mays EXPB1 (a) and the B. subtilis EXLX1 (b), and contain a conserved long hydrophobic surface. (c, d) Structural alignments of the three-dimensional models of the EXLX1 homologs from Ralstonia and Erwinia with the EXLX1 structure. Surface (e) and ribbon (f) representations

of the EXLX1 structure are colored according to conservation in 70 EXP domain sequences from bacteria and fungi (blue to red with increasing conservation).

HGT must have played an important role in the distribution of these proteins in many diverse phyla. Although the remarkable similarities between plant and bacterial expansin structures as well as the tree topologies strongly support the HGT model of evolution, they do not unequivocally determine which organism is the donor. The fact that expansins exist in all plants (universal representation) while they are present only in a few bacterial and fungal species (sporadic representation) strongly suggests that the expansin domain originated in plants and was transmitted to other groups by HGT.

Plant expansin genes were transferred from plants to bacteria, fungi, and amoebozoia. In bacteria expansin genes have been independently fused to DNA fragments that code for an endoglucanase domain or for a carbohydrate binding module, pointing to functional convergence at the molecular level. Expansin proteins mediate microbial–plant interactions by altering the plant cell wall and therefore may provide adaptive advantages to these species. The evolution of nonplant expansins represents a unique case in which bacteria and fungi have found innovative and adaptive ways to interact with and infect plants by acquiring genes from their host.

Cellulosomal Expansin: Functionality and Incorporation into the Complex

Expansins are relatively small proteins that lack enzymatic activity and are found in plants and micro-organisms. The function of these proteins is to disrupt the plant cell walls by interfering with the non-covalent interchain bonding of the polysaccharides. Expansins were found to be important for plant growth, but they are also expressed by various bacteria known to have interactions with plants. *Clostridium clariflavum* is a plant cell wall-degrading bacterium with a highly elaborate cellulosomal system. Among its numerous dockerin-containing genes, two expansin-like proteins, Clocl_1862 and Clocl_1298 (termed herein *CclEXL1* and *CclEXL2*) were identified, and *CclEXL1* was found to be expressed as part of the cellulosome system. This is the first time that an expansin-like protein is identified in a cellulosome complex, which implicates its possible role in biomass deconstruction.

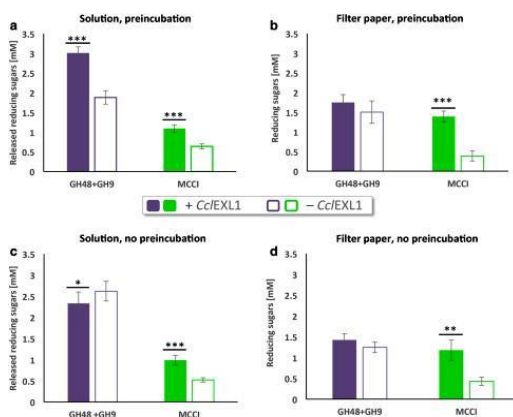
Enhancement of filter paper hydrolysis by cellulases as a result of preincubation with CclEXL1

Tensile-stress examination of filter paper after different treatments has

shown that filter paper weakens as a result of preincubation with expansin. Our aim was thus to determine whether this effect can result in enhancement of cellulose hydrolysis by cellulases. For this purpose, we incubated filter paper strips with CclEXL1 or with acetate buffer for 1 h at 55 °C (as described for the tensile-stress measurements above). Immediately after incubation with CclEXL1, the filter paper was supplemented either by two purified cellulases or by the purified *C. clariflavum* cellulosomes (i.e., the high-molecular-weight fraction cel- lulosomes isolated from microcrystalline cellulose-grown cells, MCCI) for 24 h at 55 °C (Fig. 8a). As a control, the same experiment was performed with CclEXL1 but without preincubation, whereby CclEXL1 was added to the reaction at the same time with either the enzymes or with the cellulosome preparation (Fig. 8 c, d).

For this experiment, cloned, expressed, and purified the putative *C. clariflavum* exoglucanase GH48-Doc (Clocl_4007) and the putative processive endoglucanase GH9-CBM3- Doc (Clocl_2225). Like in the majority of cellulosomes, the GH48 enzyme was found to be the most abundant enzyme in the cellulosome of *C. clariflavum*, and the GH9 enzyme is predicted to be a processive endoglucanase, similar to CelQ from *C. thermocellum*, and is also one of the highly expressed enzymes in the *C. clariflavum* cellulosome.

Examination of their catalytic activity on PASC showed that they work synergistically. The samples of filter paper that were pretreated with CclEXL1 and hydrolyzed by either GH9 and GH48 or the MCCI cellulosome fraction showed a substantial increase in the level of the released reducing sugars in the reaction solution (59.71 or 71.14 %, respectively), compared to control samples that were incubated in buffer instead of CclEXL1 (Fig. 8a).



Filter paper samples that were not pre-incubated with *Cc/EXL1* prior to the addition to the enzymes and cellulosome to the reaction (*Cc/EXL1* was added together with the enzymes/cellulosome) revealed additional information (Fig. 8c, d). The levels of released reducing sugars in the solution as a result of the hydrolysis by the two enzymes was not increased by the addition of *Cc/EXL1*, and was even slightly reduced (Fig. 8c).

However, hydrolysis of the filter paper by MCCI was enhanced by *Cc/EXL1*, independent of preincubation. An explanation for this phenomenon can be that the two enzymes and *Cc/EXL1* compete for the same binding sites on the filter paper, and their simultaneous addition to the reaction prevents access of the enzymes to the filter paper. Upon preincubation of filter paper with *Cc/EXL1*, binding of *Cc/EXL1* occurs earlier, and *Cc/EXL1* can disrupt the filter paper and provide the enzymes with more exposed sites for degradation.

Examination of the reducing sugars found on the filter paper did not reflect the same increased hydrolysis effect by the GH48 and the GH9 enzymes, since the amounts of reducing sugars on the *Cc/EXL1*-treated filter paper and the non-treated filter paper were similar (Fig. 8b). However, filter paper samples that were hydrolyzed by the MCCI cellulosome preparation displayed a similar effect on the levels of reducing sugars as found in the reaction solution.

These findings can be explained by the fact that the two enzymes have a lower capacity to hydrolyze and disrupt the structure of filter paper in comparison to the cellulosome, which contains a diversity of enzymes that work synergistically and together disrupt the filter paper more effectively. Preincubation with *Cc/EXL1* assists both the enzymes and the cellulosomes in disrupting and hydrolyzing the filter paper, as shown in Fig. 8a. The high levels of released reducing sugars in the hydrolysis reaction with the two enzymes, compared to those remaining on the filter paper itself, can be explained by the fact that there is a high concentration of exoglucanase GH48 (compared to the amount of this enzyme in the MCCI fraction) that hydrolyzes the oligosaccharides released by endoglucanase GH9 to cellobiose subunits, which thus increases the levels of reducing ends in solution.

When the cellulosome fraction is used instead of the two purified enzymes, the concentration of each enzyme in the complex is much lower, but a greater diversity of enzymes participate in hydrolysis of the filter paper. The enzymes work via different mechanisms and react on different

sites of the filter paper, so in this case, *Cc*/EXL1 does not interfere with the hydrolysis, and hydrolysis is enhanced.

These observations reinforce the results of the tensile- strength measurements that show a weakening of the filter paper strips. These findings presumably reflect the disruption of hydrogen bonding between cellulose chains, which renders the substrate more accessible for enzymes, and cellulose hydrolysis is thus enhanced. No release of reducing sugars was detected for filter paper that was incubated under similar conditions with *Cc*/EXL1 alone without subsequent addition of enzymes, thus confirming its lack of catalytic activity.

Potential Applications of Expansins in Crop Improvement

Table 1 Selected examples of studies reporting the effects of expansins on plant development and stress adaptation

Expansin name	Sub-family	Mode of expression	Observed phenotype	References
<i>AtEXP1</i>	α-Expansin	Overexpression and inhibition	Increased rate of light-induced stomatal opening and reduced sensitivity of stomata to the stimuli, respectively	Wei et al. (2011a, b)
<i>AtEXP2</i>	α-Expansin	Overexpression and suppression	Overexpressors germinated faster than wild type plants while germination was delayed in mutant lines	Yan et al. (2014)
<i>AtEXP3</i>	α-Expansin	Overexpression	Enhanced growth and larger leaves under normal growth conditions	Kwon et al. (2008)
<i>AtEXP4</i>	α-Expansin	Expression profile analyses	Thought to soften the cell wall of the stigma	Moller et al. (2013)
<i>AtEXP7</i>	α-Expansin	Overexpression	Influenced root hair initiation and root growth	Cho and Cogroove (2002)
<i>AtEXP10</i>	α-Expansin	Overexpression	Large plant cells, larger leaves and longer stems	Kulnev et al. (2012)
<i>AtEXP17</i>	α-Expansin	Overexpression and knock down	Enhanced and reduced lateral root formation, respectively	Lee and Kim (2015)
<i>AtEXP18</i>	α-Expansin	Overexpression	Influenced root hair initiation and root growth	Cho and Cogroove (2002)
<i>LeEXP1</i>	α-Expansin	Expression analysis	Proposed to be involved in fruit softening	Rose et al. (1997, 2000)
<i>LeEXP1</i>	α-Expansin	Overexpression and Suppression	Overexpression of the gene resulted in softer fruits while its suppression produced firmer fruits in transgenic tomatoes	Brammell et al. (1999)
<i>LeEXP8</i>	α-Expansin	mRNA expression analysis	Thought to influence germination since it is expressed in germinating seeds only and appears to be involved during the initial elongation of the radicle	Chen et al. (2001)
<i>LeEXP10</i>	α-Expansin	mRNA expression analysis	Thought to influence germination as well as seed development	Chen et al. (2001)
<i>SIL1p1</i>	α-Expansin	Knockout	Increased fruit firmness	Mitsuta et al. (2015)
<i>OsEXP1</i>	α-Expansin	Expression analysis	Thought to influence coleoptile and internode development	Cho and Kende (1997b)
<i>OsEXP4</i>	α-Expansin	Overexpression	Pleiotropic phenotypes in plant height, leaf number, flowering time and seed set as well as enhanced coleoptile growth	Choi et al. (2003)
		Antisense (RNAi)	Shorter plants, decreased coleoptile and microcotyl lengths	Zou et al. (2015)
<i>OsEXP8</i>	α-Expansin	Overexpression	Increased root mass, number and size of leaves as well as plant height	Mia et al. (2013)
<i>OsEXP17</i>	α-Expansin	Overexpression	Influenced rice root development	Yu et al. (2011)
<i>OsEXP1</i>	α-Expansin	Expression analysis	Thought to be involved in fruit/pulp softening and peel dehiscence	Palapol et al. (2015)
<i>NtEXP5</i>	α-Expansin	Overexpression	Increased organ size especially the leaves and the stem	Kulnev et al. (2013)
<i>DsEXP2</i>	α-Expansin	Expression analysis	Thought to be involved in fruit/pulp softening as well as peel dehiscence	Palapol et al. (2015)

Table 1 continued

Expansin name	Sub-family	Mode of expression	Observed phenotype	References
<i>OsEXP02</i>	β-Expansin	Expression analysis	Thought to influence root hair and internodes development	Cho and Kende (1997b)
		Silenced	Confirmed the earlier suggested role as shown by physiological changes including reduced root and leaf sizes	Zou et al. (2015)
<i>OsEXP03</i>	β-Expansin	Expression analysis	Thought to be involved in internode elongation as well as root development	Cho and Kende (1997b; Li and Kende (2001)
<i>OsEXP04</i>	β-Expansin	Expression analysis	mRNA accumulation correlated well with internode elongation	Lee and Kende (2001)
<i>OsEXP06</i>	β-Expansin	Expression analysis	mRNA accumulation correlated well with internode elongation	Lee and Kende (2001)
<i>OsEXP011</i>	β-Expansin	Expression analysis	mRNA accumulation correlated well with internode elongation	Lee and Kende (2001)
<i>GmEXP02</i>	β-Expansin	Overexpression	Enhanced overall plant growth, higher root cell division and elongation. Enhanced phosphorus uptake	Gao et al. (2011)
<i>GmEXP02</i>	β-Expansin	Overexpression	Increase in phosphorus efficiency	Zhou et al. (2014)
<i>TaEXP023</i>	β-Expansin	Overexpression	Improved tolerance of transgenic tobacco plants to oxidative stress	Han et al. (2015)
			Overexpressors performed better under drought. They showed enhanced root growth and water stress tolerance	Li et al. (2015a)
<i>TaEXP023</i>	β-Expansin	Overexpression	Longer internodes, larger leaf blades, more leaves, more roots	Xing et al. (2009)
<i>HvEXP01</i>	β-Expansin	Promoter deletion	Shown to influence root hair formation	Woo et al. (2010)
<i>AtEXLA2</i>	Expansin-like A	Overexpression	Longer roots which were significantly longer than the wild type roots	Boon et al. (2015)
<i>AtEXLA2</i>	Expansin-like A	Overexpression and mutant lines	Reduced EXLA2 transcript levels enhanced resistance to necrotrophic pathogens (<i>Botrytis cinerea</i> ; <i>Alternaria brassicae</i>)	Abuqumar et al. (2013)

Conclusion

Microbial expansin activity have relied on non enzymatic assays: (a) induction of plant cell wall creep, (b) weakening of filter paper, (c) synergistic enhancement of cellulose action, (d) binding to cellulose and cell walls and (e) promotion of bacterial colonization of plant tissues.

References

1. Cosgrove, D.J., 2017, Microbial expansins. *Annu Rev Microbiol.*, 71: 479-497.
2. Sampedro, J. and Cosgrove, D.J., 2005, The expansin superfamily. *Genome boil.*, 6(12): 242.
3. Georgelis, N., Nikolaidis, N. and Cosgrove, D.J., 2015, Bacterial expansins and related proteins from the world of microbes. *Appl microbiol biotechnol.*, 99(9): 3807-3823.
4. Nikolaidis, N., Doran, N. and Cosgrove, D.J., 2014, Plant expansins in bacteria and fungi: evolution by horizontal gene transfer and independent domain fusion. *Mol biol and evol.*, 31(2): 376-386.
5. Artzi, L., Morag, E., Shamshoum, M. and Bayer, E.A., 2016, Cellulosomal expansin: functionality and incorporation into the complex. *Biotechnol biofuels.*, 9(1): 1-15.

Chapter - 8

Ayushman Bharat: India towards Achieving Universal Health Coverage

Swati Chaudhary

Intern, Department of Public Health Dentistry, Himachal Dental College,
Sundernagar, Himachal Pradesh, India

Bhumika

BDS Final year student, Department of Public Health Dentistry, Himachal
Dental College, Sundernagar, Himachal Pradesh, India

Dr. Sahil Thakar

Reader, Department of Public Health Dentistry, Himachal Dental College,
Sundernagar, Himachal Pradesh, India

Dr. Swati Sharma

Reader, Department of Public Health Dentistry, School of Dental Sciences,
Sharda University, Greater Noida, India

Abstract

Ayushman Bharat, also known as, PM-JAY (Pradhan Mantri Jan Arogya Yojana), is a healthcare scheme endorsed by National Health Policy 2017. The key pillars of the AB-NHPM are cooperative unionism and flexibility for the states. Due to India's historically underdeveloped healthcare infrastructure, such kind of plan was crucially needed. Although there are many of the private players on the ground, there was a need for a programme that could cover the general populace without requiring them to make any significant financial commitments. Goals and objectives: The investigation of the PMJAY programme and evaluation of its potential for achieving universal health coverage are the main goals of this review. The Government of India has taken a significant step towards achieving the aim of universal health care, therefore, if properly implemented, it might be a game-changer.

Introduction

India is in a transitional position with respect to epidemiology, it continues to be at risk for both communicable and non-communicable diseases, which pose a threat to both economic and health security. This diverse group of health-related changes and diseases are in occurrence due to several factors, which may include variable population density, analysis,

growth and size, climatic variability and changing socio-economic status of population across the India.

Keywords: AB-NHPM- Ayushman Bharat-National Health Protection Mission, Universal Health Coverage, Health Policy.

Due to lack of awareness and poor quality of medical facilities, many Indians become sufferers of various chronic and lethal diseases. According to ICE- India Consumer Economy 360° Survey, the average yearly total medical expense is at Rs. 9,373. In towns with population under 1 million, households spend an average of Rs.13,198 annually on health care, compared to Rs.11,387 for those in metro areas and Rs.6,371 for those who live in underdeveloped rural areas. It is evident that 30% of the rural populace did not receive medical care owing to financial limitations, and most of the hospital admissions, whether in rural or metropolitan areas, are paid by either taking out loans or selling assets. Based on WHO's 2014 health profile report for India, the country's 3.2% of people live in poverty on a yearly basis due to high out-of-pocket (OOP) costs ^[1]. The Indian Health System is characterized by substantial shortcomings relating to manpower, armature and the quality and availability of services.

The Government of India launched an icebreaker scheme Ayushman Bharat, as recommended by the National Health Policy 2017. The goal is to achieve the vision of Universal Health Coverage (UHC). This programme has been implemented so as to fulfil the Sustainable Development Goals-SDGs, and its central commitment, "Leaving No One Behind" ^[2].

It is a fundamental restructuring of the manner in which beneficiaries access healthcare services at the primary, secondary and tertiary case levels. It symbolises a transformation from segmented, sector-specific and dispersed programme implementation modals towards a comprehensive, holistic system of health care based on need.

This scheme is considered to be the biggest in world, sponsored insurance scheme for maximum numbers of recipients till now. According to the current scenario, AB-NHPM will merge all on-going government schemes like RSBY (Rashtriya Swasthya Bima Yojana) and SCHIS (Senior Citizen Health Insurance Scheme).

Roughly, the bottom 40% of the country qualifies the scheme as announced by Indian Government in February 2018 ^[3]. This scheme was launched on September 2018 by the Ministry of Health and Family Welfare. This ministry later found the National Health Authority (NHA) as an organization to look into the program. The scheme is a centrally sponsored one, jointly funded by both the union and the state governments. The

programme is the world's largest healthcare program that is being funded by government, having a target more than 50 crore recipients.

Components

Ayushman Bharat embraces a “continuum of care” approach, which comprises of two inter-linked components, as follows

- Health and Wellness Centres (HWCs)
- Pradhan Mantri Jan Arogya Yojana (PM-JAY)

Health and Wellness Centres (HWCs)

By modernising the existing sub-centres and primary health centres, the Indian government would establish 1,50,000 HWCs, as announced in February 2018. These would offer Comprehensive Primary Health Care (CPHC) through bringing healthcare services, including non-communicable diseases and maternity and child health comprising free diagnostic services and essential drugs, closer to the doors of people. The first HWC was established at Bijapur, Chattisgarh on April 14th, 2018 by Prime Minister Narendra Modi and by March 31st 2020, a total of 38,595 AB-HWCs were operational across the country^[4].

Through primary level access to HWCs and secondary and tertiary level financial protection for receiving curative care through collaboration with the public and private sectors, PMJAY embodies a progression towards the promotional, salutary, preventive and rehabilitative aspects of Universal Health Coverage.

The notion of HWCs comprises of -

- Expanded package of services
- Health promotion and wellness
- Reaching the last mile
- Team based approach
- Ensuring continuum of care

Essential Package of Services includes^[5]

- Maternal and child-birth care
- Medical services for neonates and infants
- Children & Adolescents medical services
- Reproductive health care-based services including family planning, contraceptive services

- Management of Communicable Diseases (National Health Programs)
- General Out-patient care for minor ailments & Acute Simple Illness
- Non- Communicable Diseases: Screening, Prevention, Control & Management
- Common Ophthalmic and ENT care
- General Oral care services
- Health Care Services for elderly and palliative care
- Emergency Services (burns and trauma)
- Mental Health Disorders: Screening and basic management

For the primary healthcare system to be better equipped to provide a wider range of services, a core of Community Health Officers (CHO) is being created ^[5-7]. ANMs (Auxiliary Nurse Midwives), MPHW-Ms (Male Multipurpose Health Workers) and ASHAs (Accredited Social Health Activist) are some of the human resources currently employed in India's primary health care system ^[6, 7]. A Dentist, AYUSH doctor or a nursing officer can be designated as a CHO.

Pradhan Mantri Jan Arogya Yojana (PM-JAY)

The Pradhan Mantri Jan Arogya Yojana is Ayushman Bharat's second component. On September 23rd 2018, the anniversary of Pandit Deendayal Upadhyay's birth, the scheme was unveiled at Ranchi, Jharkhand by Shri Narendra Modi, and the respected prime minister of India.

Key attributes of PM-JAY-

- World's greatest health insurance / assurance scheme, entirely financed by government.
- A package of Rs.5lakh rupees annually per family, for the hospitalization in secondary & tertiary care amongst hospitals with public and private funding.
- The benefits cover will also include both ante and post hospitalization benefits.
- 10.74 crore poor & vulnerable families entitled as per SECC ^[8]. Family size or age is not capped.
- The recipient of PM-JAY can get services based on health care without having to pay cash.
- Government will make the payment for treatment based on the

package rate. The package rate will include the complete treatment cost.

- States have discretion over the method of implementation.
- Benefits are accessible nationwide.

Inclusions and exclusions under PM-JAY ^{19]}

PM-JAY Rural

In rural areas (covering around 85% of rural families), the PMJAY health cover is accessible to:

- a) Those living in SC & ST households.
- b) Families with no male member aged 16 to 59 years.
- c) Beggars and those who survive on alms.
- d) Families without members between the ages of 16 to 59 years.
- e) Families with no less than one physically disabled member but no adults who are able to care for themselves.
- f) Primitive communities like tribes.
- g) Families residing in a single space improvised structures with poor walls and roofs.
- h) Legally freed bond workers.
- i) Scavenger families.
- j) Households without land who earn their living through performing manual labour.

PM-JAY Urban

Beneficiaries from this programme in urban settings includes-

- a) Ragmen, Washermen, Watchmen
- b) Technicians, Repairmen, Electricians
- c) Cordwainers, Hawkers and other providing services by working on lanes or pavements
- d) Day-care providers
- e) Sanitation workers, Sweepers, Gardeners
- f) Auxiliaries, peons in tiny establishments, courier men, shopkeepers and servers
- g) Architects, Plumbers, construction workers, painters, welders, porters and doorkeepers
- h) Home-based artists or handicraft men, tailors

- i) Transport workers such as drivers, conductors, cart or rickshaw pullers

Individuals Who Cannot Avail the Health Cover under PM-JAY:

- a) Those having a motorised fishing boat or two, three or four-wheeler
- b) Owners of mechanised farming machinery
- c) Owners of landlines and refrigerators
- d) People using Kisan cards with a Rs.50,000 credit limit
- e) Those who have decent, well-built homes
- f) Government employees
- g) Those who are employed by government-run non-agricultural business
- h) Those with monthly income greater than Rs.10,000
- i) People who own 5 acres or more of land used for agricultural purposes

PM-JAY Illness Coverage

More than 1,350 medical packages are covered by PMJAY at accredited public and private hospitals^[11]. There are some of the critical illnesses covered are as -

- a) Carcinoma Prostate
- b) Grafting of coronary artery
- c) Heart valve replacement - Double
- d) Carotid angioplasty along with stent implantation
- e) Anterior spine fusion
- f) Replacement of Pulmonary valve
- g) Surgery of base of Skull
- h) Tissue expander for burns-related deformity
- i) Laryngopharyngectomy with gastric transposition^[10]

According to reports, the numbers of PM-JAY e-cards issued are tremendously increasing with time^[12].

	By September 22 nd ,2019	By September 6 th ,2020	By February 5 th ,2021
No. of e-cards issued	10.3 crore	12.6 crore	13.6 crore

Funding Pattern

Ayushman Bharat is centrally sponsored scheme. The funding pattern is depicted in the following -

- 60:40 funding is given with subject to Centre and States, Centre and Union Territories with legislature.
- 90:10 funding is given with subject to Centre and Himalayan, North-Eastern States.
- 100% funding is given with subject to Union Territories without legislature.

Ayushman Bharat Programme Eligibility

AB-NHPM is a claim-based scheme which will identify the recipients by deprivation criteria as described in the Socio-Economic Caste Status (SECC) database 2011^[13]. The insurance beneficiaries are recognized as D1, D2, D3, D4, D5 and D7 in terms of rural areas; on the other hand, for urban settings the recipient's occupation will be definable for entitlement or the claim. A population and certain groupings that were included in RSBY but excluded from SECC are now automatically included. In all, 10.74 crore families under SECC are eligible for the programme. There are state-run health insurance programmes in up to 24 states, with various levels of coverage for the people in each and with some states providing universal health care. Nearly 55% to 60% of the population will be covered by the PM-JAY and state programmes combined^[13]. As an entitlement-based scheme, the mission's design ensures that all individuals whose names recognized in the database are automatically eligible and that no mandate for enrolling an eligible beneficiary exists.

To check the eligibility of a user of PMJAY, the steps include-

- 1) Check out the PMJAY website first and then select 'Am I Eligible'
- 2) Enter contact number, the Captcha code and click upon 'Generate OTP'
- 3) After that opt for the respective state and search by name/HHD number/ration card number/contact number.
- 4) One can determine if their family is eligible for the PMJAY programme based on the search results.
- 5) Alternatively, if one needs to know that he/she is entitled for PMJAY, one can approach any allotted Health Care Source or dial the Ayushman Bharat Yojana call centre number which is 14555 or 1800-111-565.

Implementation Models

The Centre government is represented by National Health Agency (NHA) and state government is represented by State Health Agency (SHA). The execution of the scheme is centred on three models and can be chosen by SHA.

- 1) Trust/Assurance Model- the Union Government make a trust through State Health Authority (SHA) and all payments are done by that trust only.
- 2) Insurance Model- State governments invite various insurance companies and select them and then all claim settlement are looked upon by the selected insurance company.
- 3) Mixed/ Hybrid Model- The insurance companies do claim settlements and the state governments manage the funds.

For PM-JAY to function, a variety of stakeholders who are connected to each other through a variety of enforceable contracts and agreements must interact in order for them to play their part in the intended way. A stakeholder's departure from their expected position will result in a malpractice which can be classified as an abuse, fraud, waste or error.

States that have opted out of PM-JAY ^[14]

State	Existing Scheme
West Bengal	Swasthyasathi
Delhi	Delhi model healthcare
Odisha	Biju Swasthya Kalyan Yojana

Ayushman Bharat Registration

The PMJAY has not employed any particular procedure for registration in the Ayushman Bharat programme. All SECC 2011 recipients and those who have previously signed up for the RSBY Scheme are qualified for PM-JAY.

Conclusion

Universal Health Coverage has emerged as a major worldwide health care goal under the Sustainable Development Goals to improve population health and combat the scourge of medical-related poverty. If funds are managed properly and the recipients of this scheme are given quality care, PMJAY can be a success. To move the programme ahead, the public and private sectors should collaborate. These kind of health insurance programmes are crucial in developing countries because new diseases are constantly emerging. Ayushman Bharat and similar programmes can only succeed when the populace is aware of its social responsibilities and forthright with the government.

References

1. Dhaka R, Verma R, Agrawal G, Kumar G. Ayushman Bharat Yojana: a memorable health initiative for Indians. *Int J Community Med Public Health* 2018;5:3152-3.
2. Weber H. Politics of 'Leaving No One Behind': Contesting the 2030 Sustainable Development Goals Agenda. *Globalizations* 2017;14:3:399-414 DOI: 10.1080/14747731.2016.1275404.
3. Lahariya C. 'Ayushman Bharat' Program and Universal Health Coverage in India. *Indian Pediatr* 2018;55:495–506. doi: 10.1007/s13312-018-1341-1.
4. Lahariya C. Health & Wellness Centres to Strengthen Primary Health Care in India: Concept, progress and Ways Forward. *Indian J Pediatr* 2020;87:916-929.
5. Ayushman Bharat Comprehensive Primary Health Care through Health and Wellness Centers Operational Guidelines. Available from: <https://ab-hwc.nhp.gov.in/download/document/45a4ab64b74ab124cfd853ec9a0127e4.pdf>. [Last accessed on 2020 Aug 17]
6. Indian Public Health Standards (IPHS) Guidelines for Sub-Centres Directorate General of Health Services Ministry of Health and Family Welfare Government of India; 2012. Available from: <http://nhm.gov.in/images/pdf/guidelines/iphs/iphs-revised-guidlines-2012/sub-centers.pdf>. [Last accessed on 2020 Aug 17]
7. Brar S, Purohit N, Prinja S, Singh G, Bahuguna P, Kaur M. What and how much do the community health officers and auxiliary nurse midwives do in health and wellness centres in a block in Punjab? A time-motion study. *Indian J Public Health* 2021;65:275-9.
8. Building Safeguards and System Fencing Against Opportunistic Malpractice in AB:PMJAY:NHPM; Report on Multi-level healthcare insurance Fraud in Government Sponsored Health Insurance Schemes and Methods of Prevention and Mitigation Based on National and International Best Practices, August 24, 2018
9. Chellaiyan VG, Rajasekar H, Taneja N. Pradhan Mantri Jan Arogya Yojana - Ayushman Bharat. *Indian J Comm Health*. 2020;32(2):337-340
10. Press Information Bureau. Government of India. Ministry of Health and Family Welfare. 11-February-2020
11. Keshri VR, Gupta SS. Ayushman bharat and road to universal health

- coverage in India. J Mahatma Gandhi Inst Med Sci 2019;24:65-7
12. Prasad S. Pradhan Mantri Jan Arogya Yojana (PM-JAY): The Scheme and it's Potential to Reform India's Healthcare System. 2021 Retrieved from <https://www.dvara.com/research/wp-content/uploads/2021/02/Pradhan-Mantri-Jan-Arogya-Yojana-PM-JAY-The-Scheme-and-its-Potential-to-Reform-Indias-Healthcare-System.pdf>
 13. Tabish SA. Transforming Health Care in India: Ayushman Bharat-National Health Protection Mission. International Journal of Scientific Research 2018;7(12):16-25
 14. Prinja S, Singh MP, Aggarwal V, Rajeskar K, Gedam P, Goyal A, Bahuguna P. Impact of India's publicly financed health insurance scheme on public sector district hospitals: a health financing perspective. The Lancet Regional Health-Southeast Asia 2023;9:100123. DOI: <https://doi.org/10.1016/j.lansea.2022.100123>

Chapter - 9

Updates in Scrub Typhus

Somnath Maitra

Associate Professor, General Medicine, JIMSH, Budge,
Kolkata, West Bengal, India

Abstract

Scrub typhus is a common disease occurring in various parts of the World during a specified period of the year. It presents with fever with multi system involvement causing diagnostic and treatment challenges. Isolation of the organism is difficult and diagnosis is done by serology. The antibiotic treatment is specific with response to particular classes of antibiotics and so prompt diagnosis and treatment are essential to prevent complications. This book chapter is an attempt to understand the disease in a lucid way.

Introduction

Scrub typhus is a common cause of fever in different regions of the world including Asia. It is caused by *Orientia tsutsugamushi* and occurs by the bite of the larva or chigger of various species of trombiculid mite belonging to *Leptotrombidium* genus. Infected mites are found in “mite islands” in scrub vegetation (coarse and tall growing grass), gardens, primary forests, paddy fields, beaches, oil palm, bamboo patches and rubber estates.

O. tsutsugamushi is an obligate intracellular bacterium which remains transovarially in the mites and rodents on which the larva of the mite feeds. Human beings are accidental hosts. There is genotypic and phenotypic variability among the strains isolated from Asia and *Q. chuto* is a new species found in the UAE ^[1, 2].

The earliest cases are mentioned in a Chinese manual in 313 BC. In Japan in 1810, tsutsugamushi fever was first defined clinically. Scrub typhus, historically was predominantly found in Asia in the “Tsutsugamushi Triangle” area, but now cases are reported throughout regions of Europe, Africa, and South America. In the present day, it is the most important rickettsial disease in the world, due to the burden of the disease, but there is limited data and literature about the subject ^[3, 4].

Ecology and Epidemiology

Mites are vectors as well as reservoirs of *Orientia* Bacteria remain transovarially in many generations. The mites maintain their life cycle in the soil, mountains, river banks, jungles and beaches. Humans have no role in the life cycle of the *Orientia* mite and so vaccines or treatment will not affect the incidence of the disease. Scrub typhus shows seasonal variation, peaking before and after the rainy season in South East Asian region, but transmission may occur throughout the year ^[5].

Scrub typhus should not be neglected as a tropical disease as it is a very important cause of malaria negative, treatable febrile illness in mostly rural populations of Asia and also in the metropolitan regions of the urban area ^[6, 7]. Seroprevalence is approximately 22% in Asia. It is endemic in Eastern Asia, South western Pacific region and in India, Pakistan and Japan ^[8-14]. Recently, the infection has increased in Northern India.

Men and women are affected equally and there are no racial differences.

Clinical Features

Clinical features are non-specific in the beginning with fever, frontal headache, myalgia, cough, insomnia, restlessness representing a flu like illness. A lesion of inoculation may appear called eschar or “tache noire”. In endemic areas eschar is uncommon and is also difficult to detect in dark skinned individuals. Pre-existing cellular immunity may cause lack of eschar. Incidence varies among different regions of the world. Incidence of eschar was 75.6% by Inamdar *et al* and 46% by Vivekanandan *et al* ^[15, 16]. Kim *et al* from Korea and Sirisanthana *et al* from Thailand reported incidence of 85.5% and 68% respectively ^[17-18]. The presence of eschar ranges from 9.5% to 86% in various studies ^[19, 20]. Previously it was thought that load of inoculum of *Orientia* has a direct correlation with an eschar leading to disease severity, but Kim *et al* concluded that presence of eschar lead to earlier identification and treatment leading to milder disease. The eschar is pathognomonic and appears 7 days approximately after inoculation. It is painless, not noticed by the patient due to the painless bite. There was a wide variation in the presence of eschar due to different strains, difference in skin colour and different population. There was an incidence of acute renal failure in 12-33% patients in India ^[21, 22]. In Indian studies, ARDS incidence was 8-25% and most of them required invasive ventilation ^[23-25]. No association was there with eschar and pulmonary involvement in the study by Tsay and Chang. Aseptic meningitis was present in 12.5-26% of cases ^[26, 27]. Absence of eschar indicates a poor prognosis ^[28]. Viswanathan *et al* in 2012 showed that in South India, scrub

typhus was associated with meningitis and eschar in 25% and 20% of cases respectively ^[29]. Travel history from endemic areas is important. Incubation period is 6-20 days with an average of 10 days. Post incubation symptoms are chills, headache, lymphadenopathy, fever (104-105 degree F), apathy, anorexia and lymphadenopathy. Eschar is pathognomonic and may lead to early consultation ^[30-34].

Eschar is present in 68-87% of patients in prospective studies ^[35]. The eschar is usually truncal in adults, but children may have perineal lesions ^[36]. Eschar in head, face and neck may occur in 5% of cases approximately ^[37]. There may be multiple eschars also. Fever occurs in more than 98% of cases, tender lymphadenopathy is seen in 40-97% of cases. Ocular pain, productive cough, conjunctival suffusion and malaise are uncommon ³⁸. At the end of the first week, 35% of cases have a macular centrifugal rash on the trunk. The rash may become papular, may be transient and can also be missed. Splenomegaly, cough and delirium may occur. Encephalitis and pneumonia may develop in the second week. CNS involvement like nervousness, tremors, nuchal rigidity, slurring of speech, deafness occurs during the second week of illness. CSF may show low or normal number of monocytes. Coma or seizures, myelitis, encephalitis and cerebellitis are rare ^[39].

Lung involvement in the form of tachypnoea, cough and infiltrates is found ^[40]. ARDS occurs in the elderly and population

Clinical laboratory features of severity are hypothermia, tachycardia, crepitations, albuminuria, and low percentage of lymphocytes, elevated AST and serum creatinine.

Cardiac involvement rarely occurs with severe myocarditis ^[41]. Relative bradycardia ^[42] with rash may create diagnostic confusion with enteric fever.

Scrub typhus may cause AKI, DIC and shock. Causes of AKI are impaired perfusion due to hypovolemia, shock, impaired vascular permeability, vasculitis, rhabdomyolysis, and acute interstitial nephritis, DIC causing thrombotic microangiopathy and ATN due to direct bacterial invasion of the renal tubules ^[43-45]. Histopathology usually revealed ATN, interstitial nephritis and mesangial glomerulonephritis ^[46, 47].

Gastrointestinal features are vomiting, nausea, diarrhoea, hematemesis and melena ^[48] in the study by Aung-Thu *et al.* Erosion and ulcers may occur according to a Korean study ^[49].

Pathogenesis

Bacterial multiplies at the site of inoculation and a papule is formed. It ulcerates and eventually becomes necrotic forming an eschar with regional

enlargement of lymph nodes, which may later become generalized. Humans developed fever within 8-10 days following the bite of chigger with development of bacteremia 1-3 days before fever onset ^[50]. There is small vessel perivasculitis with involvement of the endothelium with involvement of the macrophages. *Orientia* stimulates the immune cells for phagocytosis and then escapes the phagosome. Cytoplasmic replication occurs along with budding from the cells. Bacteria opsonised by the antibody may escape the phagosome and the infectivity is decreased as it is unable to move on the microtubule. Scrub spreads into different organs via macrophages and endothelial cells, leading to severe complications ^[51, 52]. *Orientia* meets all the criteria of *Rickettsia*, but cell walls lack lipopolysaccharide and peptidoglycan. Lacking a vacuolar membrane, it grows freely in the cytoplasm of affected cells. Among the numerous ^[53] serotypes, 5 are helpful in serological diagnosis. South Korean individuals with Boryong genotype had a higher incidence of eschar and skin rash compared with the Karp genotype ^[54].

Risk Factors

Wearing short sleeves during work, resting directly on the grass, squatting to urinate or defecate and using bare hands while work are risk factors. Using a mat in outdoors, wearing long sleeved shirts offer protection.

Diagnosis

PCR and serology combination is used in the early stage of the disease. The previously used Weil-Felix agglutination test (1916) was based on cross reactivity of anti- *Orientia* antibodies to *Proteus mirabilis*, specifically the OX-K (Kinsbury strain). In 1960, it was superseded by the indirect immunofluorescence assay (IFA). With some modifications IFA was the gold standard test for a long period of time ^[55-56]. Due to lack of antigen standardisation criteria and diagnostic positivity issue, there was a need for dynamic rise of titre of paired fourfold IGM and IGG titres ^[57]. ELISA using culture derived *Orientia tsutsugamushi* antigens as well as recombinant proteins to detect specific antibodies have improved the diagnosis. Anti *Orientia* IGM and IGG antibody detection by RDT (Rapid diagnostic tests) will help in rapid bedside diagnosis. Pre-existing IGM and IGG antibodies in endemic regions may affect serological diagnosis in the acute stage. Repeated exposure can lead to false positivity.

ELISA with PCR combination helps in detection of the disease in the early stage. Common target genes in PCR are the 47-KDa, 56-kDa, 16SrRNA and GROEL genes. It helps in the early diagnosis, treatment and also may play a role in the development of vaccines.

The window of bacteremia can last upto 10 days from the onset of fever and the antibody response is not generated until after approximately 7- 10 days of fever in immune-naïve individuals ^[58-59]. PCR-serology combination is the ideal test.

Coinfections and Scrub Typhus

When eschars are present, testing for leptospirosis serology is not needed as treatment with doxycycline or azithromycin is effective for both infections in the study by Lee and Liu ^[60, 61].

Management Challenges

Absence of eschars and atypical presentation pose diagnostic challenges. Scrub responds quickly to treatment with patients becoming afebrile within 24-48 hours ^[62, 63]. Empiric treatment with doxycycline is needed when malaria, septicemia and enteric are ruled out⁶⁴.Doxycycline achieves a good concentration in CSF, as well as minocycline. But minocycline causes dose related vestibular side effects⁶⁵.Fluoroquinolones, penicillin, cephalosporin, clarithromycin are not useful for treatment ^[66-68]. Reduced susceptibility to doxycycline and chloramphenicol has been observed in Northern Thailand, which may not be true resistance, but may occur due to delayed treatment or due to tolerance ^[69-71].

According to the study by Mc Gready *et al*, scrub typhus in pregnancy was associated with 2.5% maternal mortality, 17% miscarriage and 42% poor neonatal outcomes. Azithromycin is safe in pregnancy. In the recent study by Jang *et al*, it was proved that intravenous azithromycin was effective in the treatment of severe scrub typhus ^[72].

Management

Treatment is by doxycycline, azithromycin, chloramphenicol or a combination of any two antibiotic, though doxycycline is preferred. Treatment should be early and empirical and if fever reduces within 48 hours of doxycycline therapy, diagnosis of scrub is imminent. Dose is doxycycline 100 mg BD for 7 days. Tetracycline 500 mg q6 h for 7 days may be an alternative. Azithromycin is equally effective with a loading dose of 500 mg or 1000 mg on the first day followed by 500 mg or 250 mg daily for another 2 days respectively. In pregnancy or children, azithromycin is preferred owing to the side effects of tetracycline. Chloramphenicol may be given 500 mg q6h in adults or 50-75 mg/kg/day for 7 days in children. But hematologic side effects and the rare occurrence of gray baby syndrome has led to the reduced use of this drug.

Doxycycline combined with either azithromycin or chloramphenicol are useful in patients with a delayed response to therapy. Combination treatment including co treatment with rifampicin needs consideration of potential reduction of drug levels and dose adjustment must be done adequately.

For uncomplicated infections, 3 days of doxycycline therapy performed equally with 7 days of therapy with no difference in fever clearance times and no treatment failure ^[73]. Median time of fever clearance was longer in azithromycin treated patients than in treatment with chloramphenicol in a metaanalysis⁷⁴ Clearance times for headache, fever and rash were shorter in doxycycline treated cases than with chloramphenicol. This led to a search for newer antibiotics. Rifampicin inhibits bacterial DNA dependant RNA polymerase and effectively treats intracellular pathogens as it achieves high levels of intracellular penetration. It has got in vitro activity against *Staphylococcus*, *Streptococcus*, *Chlamydia*, *Listeria*, *Brucella*, and *Legionella*. An RCT found clinical superiority of rifampicin monotherapy over other therapeutic modalities ^[75]. But definitive study is lacking to understand the benefits of rifampicin treatment in areas of doxycycline resistance.

CNS invasion occurs with scrub and DNA has been detected in CSF ^[76]

Meningoencephalitis may occur while on doxycycline ^[77]. Rifampicin is useful in patients with CNS affection as it achieves high levels in the CSF ^[78]. Side effects are hepatotoxicity and hematologic. Cerebral hemorrhage and infarction can occur following treatment of rifampicin. Dose is 600 mg of rifampicin for 5 days.

Prevention

Cases are mostly reported from South-East Asia with history of travel. Prevention is done by use of insect repellents such as N, N-diethyl-metoluamide (DEET), which provides effective protection against ticks, but is short lasting.

Complications

1. Myocarditis
2. Hepatitis
3. Meningoencephalitis
4. AKI
5. Hypoalbuminemia
6. Thrombocytopenia

7. Hyponatremia
8. Pneumonia
9. ARDS

Myocarditis

Myocarditis is inflammation of the myocardium. Manifestations are heart failure and cardiac arrhythmias. Acute decompensated heart failure may occur.

- Clinical Features
- Chest pain
- Sweats
- Fever
- Chills
- Dyspnoea
- Palpitations
- Syncope
- Sudden cardiac death may occur due to ventricular arrhythmias.
- Diagnosis
- CBC
- ESR
- Cardiac enzymes
- ECG
- Echocardiography
- Antimyosin Scintigraphy
- CAG
- Gadolinium enhanced MRI

In patients of acute myocardial deterioration of myocardial origin, non-responsive to medical treatment, endomyocardial biopsy is recommended as advised by The Heart Failure Society of America.

Hepatitis

Hepatitis is a complication of scrub typhus. ALT levels more than 500 U/L were commoner in hepatitis A patients. Kupffer cells and hepatocytes are affected directly in scrub typhus and sinusoidal endothelial vasculitis also occurs causing rise of ALT, AST and Gamma GGT. Cholestasis and hepatocyte necrosis are commoner in hepatitis A patients. Fever, headache,

rash and older age and eschar indicates scrub typhus infection whereas bilirubin > 1.3 mg/dl, ALT > 500 U/L and ALT: LDH > 5 indicate hepatitis A⁷⁹. IgM hepatitis an antibody, IGM Hepatitis E antibody and tests of other viral markers help to differentiate scrub from viral hepatitis. Also prompt clinical response to doxycycline diagnoses scrub typhus with the serologic tests.

Meningo Encephalitis

CNS involvement may occur in scrub typhus which may vary from meningitis to meningo encephalitis^[80-81]. Typhos' means stupor. Other CNS manifestations are cranial nerve palsies, seizures, cerebral vasculitic infarct, intracranial hemorrhage, polyneuropathy, sensorineural hearing loss^[82-85]. Mechanism is direct CNS invasion diagnosed by CSF PCR or infection of the vascular endothelial cells leading to micro infarct^[86]. Diagnosing meningo encephalitis in scrub is a challenge with the presence of eschar with typical history, clinical features and laboratory diagnosis aiding in the diagnosis. Prompt diagnosis and treatment with doxycycline helps to avoid complications. CSF ADA and clinical presentation helps to differentiate patients with TB meningitis from scrub typhus which is very important in India.

Headache is a common symptom of scrub typhus, Studies show that headache is present in 46-77% of patients^[87-89]. Headache without meningitis is less severe and may also occur. Presence of signs of meningeal irritation in the form of neck rigidity, Kernig's sign, and Brudzinski's sign varies among different studies. Incidence of seizures varies ranging from 22-50%. Myoclonus is rare and only a case is reported with myoclonus and parkinsonism. 6th nerve palsy, unilateral and bilateral can occur as a false localising sign. Otalgia, tinnitus and sensorineural hearing loss can occur. CSF analysis in scrub reveals mild to moderate increase in protein levels, low to normal glucose with mild increase of lymphocytes differentiating it from bacterial meningitis. Differentiation from TBM is difficult as is a close differential diagnosis. Injectable doxycycline is useful, but when contraindicated injectable azithromycin is useful in scrub meningitis. Cerebellitis and myelitis occurs rarely^[90].

Scrub typhus may present as fever with myocarditis as a serious complication. The history including the travel history along with the characteristic eschar helps in the diagnosis. Incidence varies according to different age groups and studies. In the study by Santosh Pathak *et al* in Nepal, incidence was 72.4% in children in Nepal. In the study by Kumar *et al*,

incidence of myocarditis was 34%^[91]. Doxycycline treatment produces a favourable outcome.

Acute Kidney Injury

Several infections cause AKI in India. Malaria, leptospira, dengue, enteric and other viral and bacterial infections cause AKI. Scrub typhus rarely causes AKI even in endemic areas. Renal involvement may be a part of MODS due to sepsis ^[92, 93]. In Taiwan, incidence of AKI was 8.1% and 6.6% in 2 series ^[94, 95]. Two studies from South India has shown the incidence of AKI to be 19% and 42% ^[96-99]. In a study from Vietnam, proteinuria was present in 20% of patients ^[100]. Mild proteinuria with microscopic hematuria may occur in patients of acute renal failure. Abnormal urinalysis was present in 57% of patients from a study in India. Tubulo interstitial involvement presents with low grade albumin excretion, microscopic hematuria, glycosuria and pyuria.

Mechanisms of AKI

1. Impaired renal perfusion ^[101]
 - a) Volume depletion
 - b) Increased vascular permeability
2. Direct tubular toxicity
 - a) ATN
 - b) Interstitial nephritis
 - c) Pigment nephropathy

Pneumonia

Scrub typhus may cause pneumonia due to vasculitis causing an immunological reaction secondary to direct endothelial injury or direct injury by the organism ^[102]. Chest x ray findings are seen in 78% of patients ^[103]. Diffuse bilateral reticulonodular opacities and septal lines were common findings and presence of pneumonia was associated with severity and morbidity ^[104].

ARDS

It is a serious complication of scrub typhus Wang CC *et al* showed that ARDS in scrub typhus was associated with 25% mortality and timely treatment with doxycycline or chloramphenicol decreased the morbidity and mortality ^[105]. 15% cases with fever in the Tropics admitted in ICU were scrub typhus patients as per ISCCM (Indian Society of Critical Care Medicine) data in 2014 ^[106]. Invasive and non-invasive ventilation may be required with the

basic principles remaining same for ARDS management, but prompt diagnosis and timely treatment by appropriate antibiotics are very important.

Thrombocytopenia

Thrombocytopenia may occur with many infections and often may be detected incidentally in febrile or non-febrile patients. Fever with thrombocytopenia may occur in scrub typhus patients presenting with fever, rashes, eschar along with travel history to endemic areas. Severe fever with thrombocytopenia syndrome (SFTS) is an infectious disease caused by Bunyaviridae ^[107, 108]. It is associated with fever, gastrointestinal tract symptoms, low WBC and low platelet count ^[107, 108] and transmitted by the tick *Hemophysalis longicornis*. In endemic areas of South Korea, scrub typhus SFTS occurs in 23% of patients. Independent predictors are hypoalbuminemia and anorexia. Though presentations may be serious, but deaths or duration of hospital stay was similar with non SFTS cases. Sometimes it is also essential to differentiate between SFTS and scrub typhus thrombocytopenia. Laboratory tests differentiate between the two. Viral RNA detection by RT-PCR diagnoses SFTS ^[109]. Early phase or mild presentation reduces diagnostic efficacy of RT-PCR ^[110]. Plasma exchange may be beneficial in the early stage of the disease ^[111]. Anemia, leukopenia are other hematologic manifestations. Reactive thrombocytosis may rarely occur due to acute phase reaction. Thrombocytopenia causes elevated thrombopoietin levels which stimulates secondary or reactive thrombocytosis. Thrombocytosis with platelet counts more than 1000000/microlitre, aspirin treatment reduces stroke or thrombosis ^[112-114].

Hypoalbuminemia

Acute infectious disease with low albumin levels in blood has been associated with complications and mortality ^[115]. Hypoalbuminemia is present in 25-69.2% patients of scrub typhus ^[116, 117]. Causes are

1. Decreased albumin synthesis due to liver dysfunction
2. Increased protein catabolism
3. Albuminuria
4. Decreased intestinal absorption of protein due to reduced food intake
5. Increased vascular permeability leading to vascular leakage of serum protein

In the study by Chang-Seop *et al*, hypoalbuminemia was not associated with higher mortality in scrub typhus, but hospital stay was longer. Whether albumin administration is useful is not documented in literature.

Hyponatremia

May occur due to SIADH or cerebral salt wasting. SIADH is diagnosed by urine spot sodium and osmolality. Hyponatremia may be an additional factor for confusion in scrub typhus cases and responds to treatment.

Control measures Treatment Vector control

Vegetations which are habitats of rats and mice should be cleared with application of lindane and chlordane insecticides to the vegetations and the ground.

Personal Prophylaxis

Blankets and clothes should be impregnated with benzyl benzoate which kills the mites and application of diethyltoluamide as a repellent for mites should be administered on exposed surfaces of the skin ^[118]

Vaccination

There is no effective vaccine for scrub typhus. Approaches are tried by

1. Formalin killed ^[119, 120]
2. Viable organisms are inoculated and followed by treatment with ^[121]
3. Irradiated ^[122]
4. Subunit ^[123, 124] 5. DNA ^[125]

Most vaccines resulted in protection of less than a year, homologous strain of immunity and no significant outcome in human infections. Immunity after both natural infections and vaccinations, is short lasting and cross reactivity is poor among different strains ^[126, 127]. Major outer membrane protein was analysed genetically and the 56 kDa type specific antigen of *O. tsutsugamushi* revealed 11 genotype strains which are definable. Boryong and Ikeda strains revealed four conserved genes (Sca A, C, D and E) which encodes auto-transporter proteins ^[128]. Specific antibody response against Sca A and C are seen in scrub typhus patients ^[129]. Sca-C leads to adhesion of the bacteria to host cells by interacting with fibronectin ^[130]. They play a role in pathogenesis and may play a role in development of vaccines.

Rickettsial outer membrane protein B elicits humoral immune response ^[131]. TSA (Type specific antigen)-56 provides protective immunity in infection models of mouse which is limited to homologous strain ^[132]. Studies on the virulence mechanisms of bacteria ^[133, 134, 135] and the immune pathogenesis mechanisms in human infections should be understood for the development of effective vaccines ^[136]

Scrub Typhus in Paediatric Population

Rickettsial infections may affect children and may lead to several complications.

Suspected Case

Patients with compatible clinical manifestations, suggestive epidemiological factors and absence of other diagnosis is a suspected case.

Compatible clinical features are >1 of the following

1. Undifferentiated fever for ≥ 5 days
2. Fever associated with rash
3. Fever along with edema
4. Sepsis without any clear etiology
5. Fever with myalgia and headache
6. Fever with lymphadenopathy and or hepatosplenomegaly
7. Disease like dengue
8. Aseptic meningitis, acute encephalitis, meningo encephalitis
9. Community acquired pneumonia, fever with infiltrates and cough
10. Fever with AKI
11. Fever associated with gastrointestinal and hepatic involvement

Suggestive epidemiological factors are >1 of the following within 14 days of onset

1. Bite by tick
2. Ticks found around playing areas of children and clothes
3. Visits to areas of weeds, bushes, high uncut grasses
4. Animal sheds near habitations
5. Contact with stray or pet dogs with tick infestation
6. Travelling or living in endemic areas
7. Similar clinical cases occurring sequentially or simultaneously
8. History of rodent exposure

Rickettsial diseases may occur in all age groups including neonates ^[137, 138]

1. Clinical features
2. Fever

3. Rash (30-43%)
4. Eschar (7-97%)
5. Hepatoplenomegaly
6. Lymphadenopathy
7. Edema
8. Conjunctival injection
9. It also affects CNS, respiratory, gastrointestinal and renal system
10. Complications
11. DIC, ARDS, HLH, purpura fulminans, gangrene ^[139] and myocarditis
12. Laboratory diagnosis
13. Serology-IgM ELISA is highly sensitive and specific. Though IFA is gold standard, but is difficult to perform.

Treatment

Doxycycline is the drug of choice for children of any age without any controversy and with the required dose and duration of therapy donot cause enamel hypoplasia or staining of teeth ^[140, 141]. It may be used orally or intravenously with 2.2 mg/kg twice daily in children<40 kg and 100 mg twice a day in more than 40 kg weight. Duration of therapy is 3 days after cessation of fever of for a total of seven days. Complicated cases may need 10 days of therapy. Prompt response within 48 hours is the rule, failure of which should suggest an alternative or additional diagnosis ^[142].

Alternatively, oral clarithromycin, oral or azithromycin, rifampicin or chloramphenicol may be used. Azithromycin is used in the dose of 10 mg/kg/day for 5 days.

1. Poor prognostic factors
2. G-6PD deficiency
3. Younger age
4. Sulphonamide therapy
5. Short incubation period
6. No rash
7. Diabetes
8. Delay of treatment
9. Prevention
10. No vaccines are there.

11. Vector control
12. Preventing vector bite
13. Promptly removing the attached ticks

Chemoprophylaxis for pre exposure is recommended for a short duration with high risk exposure. Weekly doxycycline started before and should continue for 6 weeks after exposure is recommended.

References

1. Izzard L, Fuller A, Blacksell SD, *et al.* Isolation of a novel *Orientia* species (*O. chuto* sp. nov.) from a patient infected in Dubai. *J Clin Microbiol* 2010;48:4404–9.
2. Kelly DJ, Fuerst PA, Ching W-M, *et al.* Scrub typhus: the geographic distribution of phenotypic and genotypic variants of *Orientia tsutsugamushi*. *Clin Infect Dis* 2009;48(Suppl 3): S203–30.
3. Weitzel T, Dittrich S, Lopez J, *et al.* Endemic scrub typhus in South America. *N Engl J Med.* 2016;375:954–961.
4. Bonell A, Lubell Y, Newton PN, *et al.* Estimating the burden of scrub typhus: a systematic review. *PLoS Negl Trop Dis.* 2017;11:e0005838.
5. Mayxay M, Castonguay-Vanier J, Chansamouth V, *et al.* Causes of non-malarial fever in Laos: a prospective study. *Lancet Glob Health.* 2013;1:e46–e54.
6. Taylor AJ, Paris DH, Newton PN. A systematic review of mortality from untreated scrub typhus (*Orientia tsutsugamushi*). *PLoS Negl Trop Dis.* 2015;9:e0003971.
7. McGready R, Ashley EA, Wuthiekanun V, *et al.* Arthropod borne disease: the leading cause of fever in pregnancy on the Thai-Burmese border. *PLoS Negl Trop Dis.* 2010;4:e888.
6. Sharma PK, Ramakrishnan R, Hutin YJ, *et al.* Scrub typhus in Darjeeling, India: opportunities for simple, practical prevention measures. *Trans R Soc Trop Med Hyg.* 2009 Mar [QxMD MEDLINE Link].
7. Suputtamongkol Y, Suttinont C, Niwatayakul K, *et al.* Epidemiology and clinical aspects of rickettsioses in Thailand. *Ann N Y Acad Sci.* 2009 May.1166:172-9. [QxMD MEDLINE Link].
8. Matsumura Y, Shimizu T. [Case of imported scrub typhus contracted in Myanmar]. *Kansenshogaku Zasshi.* 2009 May. 83(3):256-60. [QxMD MEDLINE Link].

9. Liu Y, Feng D, Suo J, *et al.* Clinical characteristics of the autumn-winter type scrub typhus cases in south of Shandong province, northern China. *BMC Infect Dis.* 2009 Jun 4. 9(1):82. [QxMD MEDLINE Link]. [Full Text].
10. McGready R, Blacksell SD, Luksameetanasan R, *et al.* First Report of an *Orientia tsutsugamushi* Type TA716-Related Scrub Typhus Infection in Thailand. *Vector Borne Zoonotic Dis.* 2009 Jun 3. [QxMD MEDLINE Link].
11. Kramme S, An le V, Khoa ND, *et al.* *Orientia tsutsugamushi* bacteremia and cytokine levels in Vietnamese scrub typhus patients. *J Clin Microbiol.* 2009 Mar. 47(3):586-9. [QxMD MEDLINE Link]. [Full Text].
12. Xu G, Walker DH, Jupiter D, Melby PC, Arcari CM. A review of the global epidemiology of scrub typhus. *PLoS Negl Trop Dis.* 2017 Nov. 11 (11):e0006062. [QxMD MEDLINE Link].
13. Vivekanandan M, Mani A, Priya YS, Singh AP, Jayakumar S, Purty S. Outbreak of scrub typhus in Pondicherry. *J Assoc Physicians India* 2010;58:24-8.
14. Inamdar S Acharya R, Vijayanarayana K, Shridharan N, Bhargu P. Study of clinical characteristics and treatment pattern of scrub typhus in tertiary care hospital. *J Pharm Sci Res* 2013;5: 107-10.
15. Kim DM, Kim SW, Choi SH, Yun NR. Clinical and laboratory findings associated with severe scrub typhus. *BMC Infect Dis* 2010;10:108.
16. Sirisanthana V, Puthanakit T, Sirisanthana T. Epidemiologic, clinical and laboratory features of scrub typhus in thirty Thai children. *Pediatr Infect Dis J* 2003;22:341-5.
17. Kim DM, Kim SW, Choi SH, Yun NR. Clinical and laboratory findings associated with severe scrub typhus. *BMC Infect Dis* 2010;10:108.
18. Vivekanandan M, Mani A, Priya YS, Singh AP, Jayakumar S, Purty S. Outbreak of scrub typhus in Pondicherry. *J Assoc Physicians India* 2010;58:24-8.
19. Chrispal A, Boorugu H, Gopinath KG, Prakash JA, Chandy S, Abraham OC, *et al.* Scrub typhus: An unrecognized threat in South India - Clinical profile and predictors of mortality. *Trop Doct* 2010;40:129-33.
20. Narvencar KP, Rodrigues S, Nevrekar RP, Dias L, Dias A, Vaz M, *et al.* Scrub typhus in patients reporting with acute febrile illness at a tertiary

- health care institution in Goa. *Indian J Med Res* 2012;136:1020-4.
21. Kumar V, Kumar V, Yadav AK, Iyengar S, Bhalla A, Sharma N, *et al* Scrub typhus is an under-recognized cause of acute febrile illness with acute kidney injury in India. *PLoS Negl Trop Dis* 2014;8:e2605.
 22. Wang CC, Liu SF, Liu JW, Chung YH, Su MC, Lin MC. Acute respiratory distress syndrome in scrub typhus. *Am J Trop Med Hyg* 2007;76:1148-52.
 23. Tsay RW, Chang FY. Acute respiratory distress syndrome in scrub typhus. *QJM* 2002;95:126-8.14,15 does eschar
 24. Pai H, Sohn S, Seong Y, Kee S, Chang WH, Choe KW. Central nervous system involvement in patients with scrub typhus. *Clin Infect Dis* 1997;24:436-40.
 25. Varghese GM, Mathew A, Kumar S, Abraham OC, Trowbridge P, Mathai E. Differential diagnosis of scrub typhus meningitis from bacterial meningitis using clinical and laboratory features. *Neurol India* 2013;61:17-20.
 26. Lee CS, Hwang JH, Lee HB, Kwon KS. Risk factors leading to fatal outcome in[7]scrub typhus patients. *Am J Trop Med Hyg.* 2009;81(3):484-88.
 27. Viswanathan S, Muthu V, Iqbal N, Remalayam B, George T. Scrub typhus[10]meningitis in South India-A retrospective study. *Plos One.* 2013;8(6):e66595.(PMID-23799119).
 28. Watt G, Walker DH. Scrub typhus. Guerrant RL, Walker DH, Weller PF, eds. *Tropical Infectious Diseases Principles, Pathogens and Practice.* 2nd ed. Philadelphia, PA: Elsevier Churchill Livingstone; 2006. Vol 1: Chapter 52.
 29. Berman SJ, Kundim WD. Scrub Typhus in South Vietnam: A Study of 87 Cases. *Annals Internal Med.* July 1973. 79:26-30.
 30. Ogawa M, Hagiwara T, Kishimoto T, Shiga S, Yoshida Y, Furuya Y. Scrub typhus in Japan: epidemiology and clinical features of cases reported in 1998. *Am J Trop Med Hyg.* 2002 Aug. 67(2):162-5. [QxMD MEDLINE Link].
 31. Chanta C, Chanta S. Clinical study of 20 children with scrub typhus at Chiang Rai Regional Hospital. *J Med Assoc Thai.* 2005 Dec. 88(12):1867-72. [QxMD MEDLINE Link].

32. Sirisanthana V, Puthanakit T, Sirisanthana T. Epidemiologic, clinical and laboratory features of scrub typhus in thirty Thai children. *Pediatr Infect Dis J*. 2003 Apr. 22(4):341-5. [QxMD MEDLINE Link].
33. Watt G, Chouriyagune C, Ruangweerayud R, Watcharapichat P, Phulsuksombati D, Jongsakul K, *et al*. Scrub typhus infections poorly responsive to antibiotics in northern Thailand. *Lancet*. 1996 Jul 13. 348(9020):86-9. [QxMD MEDLINE Link].
34. Kim DM, Won KJ, Park CY, Yu KD, Kim HS, Yang TY. Distribution of eschars on the body of scrub typhus patients: a prospective study. *Am J Trop Med Hyg*. 2007 May. 76(5):806-9. [QxMD MEDLINE Link].
35. Lee BJ, Chen CY, Hu SY, Tsan YT, Lin TC, Wang LM. Otagia and eschar in the external auditory canal in scrub typhus complicated by acute respiratory distress syndrome and multiple organ failure. *BMC Infect Dis*. 2011 Mar 30. 11:79. [QxMD MEDLINE Link]. [Full Text].
36. Edwards MS, Feigin RD. Rickettsial and Erlichial Diseases. Feigin RD, Cherry JD, Demmler-Harrison GJ, Kaplan SL. Feigin and Cherry's Textbook of Pediatric Infectious Diseases. 6th ed. Philadelphia, PA: Elsevier Saunders; 2009. Vol 2: 2677-2678.
37. Allan H Ropper. Martina A Samuels: Adams and Victor's Principles of Neurology[8]9th Edition pg. 702
38. Wang CC, Liu SF, Liu JW, Chung YH, Su MC, Lin MC. Acute respiratory distress syndrome in scrub typhus. *Am J Trop Med Hyg*. 2007 Jun. 76(6):1148-52. [QxMD MEDLINE Link].
39. Sittiwangkul R, Pongprot Y, Silvilarat S, Oberdorfer P, Jittamala P, Sirisanthana V. Acute fulminant myocarditis in scrub typhus. *Ann Trop Paediatr*. 2008 Jun. 28(2):149-54. [QxMD MEDLINE Link].
40. Aronoff DM, Watt G. Prevalence of relative bradycardia in Orientia tsutsugamushi infection. *Am J Trop Med Hyg*. 2003 Apr. 68(4):477-9. [QxMD MEDLINE Link].
41. Lee S, Kang KP, Kim W, Kang SK, Lee HB, Park SK. A case of acute renal failure, rhabdomyolysis and disseminated intravascular coagulation associated with scrub typhus. *Clin Nephrol*. 2003;60:59–61. [PubMed] [Google Scholar]
42. Young PC, Hae CC, Lee KH, Hoon CJ. Tsutsugamushi infection-associated acute rhabdomyolysis and acute renal failure. *Korean J Intern*

- Med. 2003;18:248–50. [PMC free article] [PubMed] [Google Scholar]
43. Kim DM, Kang DW, Kim JO, Chung JH, Kim HL, Park CY, *et al.* Acute renal failure due to acute tubular necrosis caused by direct invasion of *Orientia tsutsugamushi*. *J Clin Microbiol.* 2008;46:1548– [PMC free article] [PubMed] [Google Scholar]
 44. Attur RP, Kuppasamy S, Bairy M, Nagaraju SP, Pammidi NR, Kamath V, *et al.* Acute kidney injury in scrub typhus. *Clin Exp Nephrol.* 2013;17:725–9. [PubMed] [Google Scholar]
 45. Chi WC, Huang JJ, Sung JM, Lan RR, Ko WC, Chen FF. Scrub typhus associated with multiorgan failure: A case report. *Scand J Infect Dis.* 1997;29:634–35. [PubMed] [Google Scholar]
 46. Aung T, Supanaranond W, Phumiratanaprapin W, Phonrat B, Chinprasatsak S, Ratanajaratroj N. Gastrointestinal manifestations of septic patients with scrub typhus in Maharat Nakhon Ratchasima Hospital. *Southeast Asian J Trop Med Public Health.* 2004; 35: 845–851. PMID: 15916079
 47. Kim SJ, Chung IK, Chung IS, Song DH, Park SH, Kim HS, *et al.* The clinical significance of upper gastrointestinal endoscopy in gastrointestinal vasculitis related to scrub typhus. *Endoscopy.* 2000; 32: 950–955. doi: 10.1055/s-2000-9621 PMID: 11147943 14,16,17 MEDSCAPE
 48. Shirai A, Saunders JP, Dohany AL, *et al.* Transmission of Scrub Typhus to Human Volunteers by Laboratory Raised Chiggers. *Jpn J Med Sci Biol.* 1982. 35(9):
 49. Cracco C, Delafosse C, Baril L, Lefort Y, Morelot C, Derenne JP, *et al.* Multiple organ failure complicating probable scrub typhus. *Clin Infect Dis.* 2000 Jul. 31(1):191-2. [QxMD MEDLINE Link].
 50. Tseng BY, Yang HH, Liou JH, Chen LK, Hsu YH. Immunohistochemical study of scrub typhus: a report of two cases. *Kaohsiung J Med Sci.* 2008 Feb. 24(2):92-8. [QxMD MEDLINE Link].
 51. MKelly DJ, Fuerst PA, Ching WM, Richards AL. Scrub typhus: the geographic distribution of phenotypic and genotypic variants of *Orientia tsutsugamushi*. *Clin Infect Dis.* 2009 Mar 15. 48 Suppl 3:S203- 30. [QxMD MEDLINE Link].MEDSCAPE
 52. Kim DM, Yun NR, Neupane GP, *et al.* Differences in clinical features according to boryoung and karp genotypes of *Orientia tsutsugamushi*.

53. Brown GW, Shirai A, Rogers C, *et al.* Diagnostic criteria for scrub typhus: probability values for immunofluorescent antibody and *Proteus* OXK agglutinin titers. *Am J Trop Med Hyg.* 1983;32:1101–1107.
54. Robinson DM, Brown G, Gan E, *et al.* Adaptation of a microimmunofluorescence test to the study of human *Rickettsia tsutsugamushi* antibody. *Am J Trop Med Hyg.* 1976;25:900–905.
55. Blacksell SD, Bryant NJ, Paris DH, *et al.* Scrub typhus serologic testing with the indirect immunofluorescence method as a diagnostic gold standard: a lack of consensus leads to a lot of confusion. *Clin Infect Dis.* 2007;44:391–401.
56. Blacksell SD, Paris DH, Chierakul W, *et al.* Prospective evaluation of commercial antibody-based rapid tests in combination with a loop-mediated isothermal amplification PCR assay for detection of *Orientia tsutsugamushi* during the acute phase of scrub typhus infection. *Clin Vaccine Immunol.* 2012;19:391–395.
57. Paris DH, Blacksell SD, Nawtaisong P, *et al.* Diagnostic accuracy of a loop-mediated isothermal PCR assay for detection of *Orientia tsutsugamushi* during acute Scrub Typhus infection. *PLoS Negl Trop Dis.* 2011;5:e1307.
58. Lee CH, Liu JW. Coinfection with leptospirosis and scrub typhus in Taiwanese patients. *Am J Trop Med Hyg.* 2007;77(3):525–527.
59. Phimda K, Hoontrakul S, Suttinont C, *et al.* Doxycycline versus azithromycin for treatment of leptospirosis and scrub typhus. *Antimicrob Agents Chemother.* 2007;51(9):3259–3263.
60. Kaushik RM, Kaushik R, Bhargava A. Multiple eschars in scrub typhus. *Trop Med Health.* 2014;42(2):65–66.
61. Rahi M, Gupte MD, Bhargava A, Varghese GM, Arora R. DHR-ICMR guidelines for diagnosis and management of rickettsial diseases in India. *Indian J Med Res.* 2015;141(4):417–422
62. Premaratna R, Rajapakse RP, Chandrasena TG, *et al.* Contribution of rickettsioses in Sri Lankan patients with fever who responded to empirical doxycycline treatment. *Trans R Soc Trop Med Hyg.* 2010;104(5): 368–370.
63. Cross R, Ling C, Day NP, McGready R, Paris DH. Revisiting doxycycline

- in pregnancy and early childhood: time to rebuild its reputation? *Expert Opin Drug Saf.* 2016;15(3):367–382. SCRUB RISK DIAG
64. Botelho-Nevers E, Rovey C, Richet H, Raoult D. Analysis of risk factors for malignant Mediterranean spotted fever indicates that fluoroquinolone treatment has a deleterious effect. *J Antimicrob Chemother.* 2011;66(8):1821–1830.
 65. Tantibhedhyangkul W, Angelakis E, Tongyoo N, *et al.* Intrinsic fluoroquinolone resistance in *Orientia tsutsugamushi*. *Int J Antimicrob Agents.* 2010;35(4):338–341.
 66. Kurup A, Issac A, Loh JP, *et al.* Scrub typhus with sepsis and acute respiratory distress syndrome. *J Clin Microbiol.* 2013;51(8):2787–2790.
 67. Watt G, Kantipong P, Jongsakul K, Watcharapichat P, Phulsuksombati D, Strickman D. Doxycycline and rifampicin for mild scrubtyphus infections in northern Thailand: a randomised trial. *Lancet.* 2000;356(9235):1057–1061.
 68. Strickman D, Sheer T, Salata K, *et al.* In vitro effectiveness of azithromycin against doxycycline-resistant and -susceptible strains of *Rickettsia tsutsugamushi*, etiologic agent of scrub typhus. *Antimicrob Agents Chemother.* 1995;39(11):2406–2410.
 69. Watt G, Chouriyagune C, Ruangweerayud R, *et al.* Scrub typhus infections poorly responsive to antibiotics in northern Thailand. *Lancet.* 1996;348(9020):86–89.
 70. Jang MO, Jang HC, Kim UJ, *et al.* Outcome of intravenous azithromycin therapy in patients with complicated scrub typhus compared with that of doxycycline therapy using propensity-matched analysis. *Antimicrob Agents Chemother.* 2014;58(3):1488–1493.
 71. Panpanich R, Garner P. Antibiotics for treating scrub typhus. *Cochrane Database Syst Rev.* 2002;(3):CD002150. 20-24 SCRUB RIFAMPICIN
 72. Watt G, Kantipong P, Jongsakul K, Watcharapichat P, Phulsuksombati D, Strickman D. Doxycycline and rifampicin for mild scrub-typhus infections in northern Thailand: a randomised trial. *Lancet* 2000; 356:1057–61.
 73. Pai H, Sohn S, Seong Y, Kee S, Chang WH, Choe KW. Central nervous system involvement in patients with scrub typhus. *Clin Infect Dis* 1997;
 74. Kim DM, Kim YS, Cho HY, Lee YB. Scrub typhus meningoencephalitis occurring during doxycycline therapy for

- Orientia tsutsugamushi*. *Diagn Microbiol Infect Dis* 2011; 69:271–4
75. Dotevall L, Hagberg L. Penetration of doxycycline into cerebrospinal fluid in patients treated for suspected Lyme neuroborreliosis. *Antimicrob Agents Chemother* 1989; 33:1078–80.
 76. Martínez E, Collazos J, Mayo J. Shock and cerebral infarct after rifampin re-exposure in a patient infected with human immunodeficiency virus. *Clin Infect Dis* 1998; 27:1329–30. Berman SJ, Kundim WD. Scrub Typhus in South Vietnam: A Study of 87 Cases. *Annals Internal Med.* July 1973. 79:26-30.MEDSC
 77. Jun Lee , Dong-Min Kim ,* Na Ra Yun , Yu Mi Byeon , Young Dae Kim , Chan Guk Park , Man Woo Kim , and Mi Ah Han: A Comparative Study of Hepatitis Caused by Scrub Typhus and
 78. Viral Hepatitis A in South Korea; *Am. J. Trop. Med. Hyg.*, 85(5), 2011, pp. 873–877 doi:10.4269/ajtmh.2011.09-0703
 79. Varghese GM, Mathew A, Kumar S, Abraham OC, Trowbridge P, Mathai E. Differential diagnosis of scrub typhus meningitis from bacterial meningitis using clinical and laboratory features. *Neurol India.* 2013;61:17–20. [PubMed] [Google Scholar]
 80. Kar A, Dhanaraj M, Dedeepiya D, Harikrishna K. Acute encephalitis syndrome following scrub typhus infection. *Indian J Crit Care Med.* 2014;18:453–5. [PMC free article] [PubMed] [Google Scholar]
 81. Viswanathan S, Muthu V, Iqbal N, Remalayam B, George T. Scrub typhus meningitis in South India – A retrospective study. *PLoS One.* 2013;8:e66595. [PMC free article] [PubMed] [Google Scholar]
 82. Kim JH, Lee SA, Ahn TB, Yoon SS, Park KC, Chang DI, *et al.* Polyneuropathy and cerebral infarction complicating scrub typhus. *J Clin Neurol.* 2008;4:36–9. [PMC free article] [PubMed] [Google Scholar]
 83. Pai H, Sohn S, Seong Y, Kee S, Chang WH, Choe KW. Central nervous system involvement in patients with scrub typhus. *Clin Infect Dis.* 1997;24:436–40. [PubMed] [Google Scholar]
 84. Drevets DA, Leenen PJ, Greenfield RA. Invasion of the central nervous system by intracellular bacteria. *Clin Microbiol Rev.* 2004;17:323–47. [PMC free article] [PubMed] [Google Scholar]

85. Kim DM, Chung JH, Yun NR, Kim SW, Lee JY, Han MA, *et al.* Scrub typhus meningitis or meningoencephalitis. *Am J Trop Med Hyg.* 2013;89:1206–11. [PMC free article] [PubMed] [Google Scholar]
86. Misra UK, Kalita J, Mani VE. Neurological manifestations of scrub typhus. *J Neurol Neurosurg Psychiatry.* 2015;86:761–6. [PubMed] [Google Scholar]
87. Chiou YH, Yang CJ, Lai TH. Scrub typhus associated with transient parkinsonism and myoclonus. *J Clin Neurosci.* 2013;20:182–3. [PubMed] [Google Scholar]
88. Kang JI, Kim DM, Lee J. Acute sensorineural hearing loss and severe otalgia due to scrub typhus. *BMC Infect Dis.* 2009;9:173. [PMC free article] [PubMed] [Google Scholar]
89. A. Jang MO, Jang HC, Kim UJ, Ahn JH, Kang SJ, Jung SI, *et al.* Outcome of intravenous azithromycin therapy in patients with complicated scrub typhus compared with that of doxycycline therapy using propensity-matched analysis. *Antimicrob Agents Chemother.* 2014;58:1488–93. [PMC free article] [PubMed] [Google Scholar]
90. Adams and Victor's Principles of Neurology;9th Edition,2009.pg-702
91. Pathak S, Chaudhary N, Dhakal P, Shakya D, Dhungel P, Neupane G, *et al.* (2019) Clinical profile, complications and outcome of scrub typhus in children: A hospital based observational study in central Nepal. *PLoS ONE* 14(8): e0220905. <https://doi.org/10.1371/journal.pone.0220905>
92. Raoult D (2009) *Orientia tsutsugamushi* (Scrub Typhus). In: Mandell GL, Bennett JE, Dolin R, editors. *Mandell: Mandell, Douglas, and Bennett's Principles and Practice of Infectious Diseases*. Seventh ed: Churchill Livingstone, An Imprint of Elsevier. pp. 2529–2530.
93. Reller ME, Dumler JS (2011) Scrub Typhus (*Orientia tsutsugamushi*). In: Kliegman RM, Stanton BF, GemeIII JWS, Schor NF, Behrman RE, editors. *Kliegman: Nelson Textbook of Pediatrics*. Nineteenth ed: Saunders, An Imprint of Elsevier. pp. 1045–1046.
94. Wu K-M, Wu Z-W, Peng G-Q, Wu JL, Lee S-Y (2009) Radiologic Pulmonary Findings, Clinical Manifestations and Serious Complications in Scrub Typhus: Experiences From A Teaching Hospital in Eastern Taiwan. *International Journal of Gerontology* 3: 223–232.
95. Tsay RW, Chang FY (1998) Serious complications in scrub typhus. *J*

96. Chrispal A, Boorugu H, Gopinath KG, Prakash JA, Chandy S, *et al.* (2010) Scrub typhus: an unrecognized threat in South India - clinical profile and predictors of mortality. *Trop Doct* 40: 129–133.
97. Basu G, Chrispal A, Boorugu H, Gopinath KG, Chandy S, *et al.* (2011) Acute kidney injury in tropical acute febrile illness in a tertiary care centre–RIFLE criteria validation. *Nephrol Dial Transplant* 26: 524–531.
98. Attur RP, Kuppasamy S, Bairy M, Nagaraju SP, Pammidi NR, *et al.* (2013) Acute kidney injury in scrub typhus. *Clin Exp Nephrol* 17 : 725–729.
99. Kumar M, Krishnamurthy S, Delhikumar CG, Narayanan P, Biswal N, *et al.* (2012) Scrub typhus in children at a tertiary hospital in southern India: clinical profile and complications. *J Infect Public Health* 5: 82–88.
100. Berman SJ, Kundin WD (1973) Scrub typhus in South Vietnam. A study of 87 cases. *Ann Intern Med* 79: 26–30.
101. Kim DM, Kang DW, Kim JO, Chung JH, Kim HL, *et al.* (2008) Acute renal failure due to acute tubular necrosis caused by direct invasion of *Orientia tsutsugamushi*. *Journal of clinical microbiology* 46: 1548–1550.
102. Kundin WD, Liu C, Harmon P, Rodina P. Pathogenesis of scrub typhus infection (*Rickettsia tsutsugamushi*) as studied by immunofluorescence. *J Immunol* 1964; 93:772–8155
103. Im JG, Lee WJ, Kim JH, Lee KS. Pulmonary manifestations of *tsutsugamushi* disease. *J Kor Radiol Soc* 1988; 24:750–55. .
104. Song SW, Kim KT, Ku YM, Park SH, Kim YS, Lee D-G, *et al.* Clinical role of interstitial pneumonia in patients with scrub typhus: a possible marker of disease severity. *J Korean Med Sci* 2004; 19: 668–73.
105. Wang CC, Liu SF, Liu JW, Chung YH, Su MC, Lin MC. Acute respiratory distress syndrome in scrub typhus. *Am J Trop Med Hyg.* 2007;76:1148-52.
106. Rungta N. Scrub typhus: Emerging cause of multiorgan dysfunction. *Indian J Crit Care Med.* 2014;18:489-9.
107. Yu XJ, Liang MF, Zhang SY, Liu Y, Li JD, Sun YL, *et al.* Fever with thrombocytopenia associated with a novel bunyavirus in China. *N Engl J Med.* 2011;364:1523–32. <http://dx.doi.org/10.1056/NEJMoa1010095>
108. Liu Q, He B, Huang SY, Wei F, Zhu XQ. Severe fever with

- thrombocytopenia syndrome, an emerging tick-borne zoonosis. *Lancet Infect Dis*. 2014;14:763–72. [http://dx.doi.org/10.1016/S1473-3099\(14\)70718-2](http://dx.doi.org/10.1016/S1473-3099(14)70718-2). 1,5,14,2,4 SCRUB THROMBO IDSA
109. Liu Q, He B, Huang SY, Wei F, Zhu XQ. Severe fever with thrombocytopenia syndrome, an emerging tick-borne zoonosis. *Lancet Infect Dis* 2014; 14:763–72.
 110. Choi SJ, Park SW, Bae IG, *et al*. Severe fever with thrombocytopenia syndrome in South Korea, 2013–2015. *PLoS Negl Trop Dis* 2016; 10:e0005264.
 111. Oh WS, Yoo JR, Kwon KT, *et al*. Effect of early plasma exchange on survival in patients with severe fever with thrombocytopenia syndrome: a multicenter study. *Yonsei Med J* 2017; 58:867–71.
 112. Watt G, Parola P. Scrub typhus and tropical rickettsioses. *Curr Opin Infect Dis* 2003; 16:429–36.
 113. Korea Center for Disease Control and Prevention. Annual surveillance of infectious diseases, 2016. Available at: http://cdc.go.kr/CDC/info/CdcKrInfo0302jsp?menuIds=HOME001-MNU1132-MNU1138-MNU0038&fid=32&q_type=&q_value=&cid=75290&pageNum=. Accessed 1 December 2017.
 114. Harrison CN, Bareford D, Butt N, Campbell P, Conneally E, Drummond M, Guideline for investigation and management of adults and children presenting with a thrombocytosis *Br J Haematol* 2010 149:352-75.10.1111/j.1365-2141.2010.08122.x20331456 [Google Scholar] [CrossRef] [PubMed] JCDR
 115. Carratala J, Roson B, Fernandez-Sabe N, Shaw E, del Rio O, Rivera A: Factors associated with complications and mortality in adult patients hospitalized for infectious cellulitis. *Eur J Clin Microbiol Infect Dis* 2003, 22:151-157.
 116. Jang KM, Kang MH, Yang YS, Hwang HG, Lee KP, Lee JS: The twenty cases of serologically confirmed tsutsugamushi disease. *J Korean Med Assoc* 1987, 30:638-646.
 117. Song SW, Kim KT, Ku YM, Park SH, Kim YS, Lee DG, Yoon SA, Kim YO: Clinical role of interstitial pneumonia in patients with scrub typhus: A possible marker of disease severity. *J Korean Med Sci* 2004, 19:668-673.(SCR HYPOALB)
 118. K Park;Park's Textbook of Preventive and Social Medicine.24th

119. Card WI, Walker JM (1947) Scrub-typhus vaccine; field trial in South-east Asia. *Lancet* 1: 481–483. PMID: 20294827
120. Berge TO, Gauld RL, Kitaoka M (1949) a field trial of a vaccine prepared from the Volner strain of *Rickettsia tsutsugamushi*. *Am J Hyg* 50: 337– 342. PMID: 15391985
121. Smadel JE, Ley HL Jr., Diercks FH, Traub R, Tipton VJ, *et al.* (1951) Immunization against scrub typhus. Combined living vaccine and chemoprophylaxis in volunteers. *Am J Hyg* 53: 317–325. PMID: 14829443
122. Eisenberg GH Jr., Osterman JV (1977) Experimental scrub typhus immunogens: gamma-irradiated and formalinized rickettsiae. *Infect Immun* 15: 124–131. PMID: 401770
123. Seong SY, Huh MS, Jang WJ, Park SG, Kim JG, *et al.* (1997) Induction of homologous immune response to *Rickettsia tsutsugamushi* Boryong with a partial 56-kilodalton recombinant antigen fused with the maltose-binding protein MBP-Bor56. *Infect Immun* 65: 1541–1545. PMID: 9119501
124. Chattopadhyay S, Jiang J, Chan TC, Manetz TS, Chao CC, *et al.* (2005) Scrub typhus vaccine candidate Kp r56 induces humoral and cellular immune responses in cynomolgus monkeys. *Infect Immun* 73: 5039–5047. PMID: 16041019
125. Ni YS, Chan TC, Chao CC, Richards AL, Dasch GA, *et al.* (2005) Protection against scrub typhus by a plasmid vaccine encoding the 56-KD outer membrane protein antigen gene. *Am J Trop Med Hyg* 73: 936–941. PMID: 16282307, 18, 31, 33, 32, 36, 23, 39, 70, 71, 72 scr vac
126. Kelly DJ, Fuerst PA, Ching WM, Richards AL (2009) Scrub typhus: the geographic distribution of phenotypic and genotypic variants of *Orientia tsutsugamushi*. *Clin Infect Dis* 48 Suppl 3: S203–230. doi: 10.1086/596576 PMID: 19220144
127. Valbuena G, Walker DH (2012) Approaches to vaccines against *Orientia tsutsugamushi*. *Front Cell Infect Microbiol* 2: 170. doi: 10.3389/fcimb.2012.00170 PMID: 23316486
128. Nakayama K, Yamashita A, Kurokawa K, Morimoto T, Ogawa M, *et al.* (2008) The Whole-genome sequencing of the obligate intracellular bacterium *Orientia tsutsugamushi* revealed massive gene amplification

- during reductive genome evolution. *DNA Res* 15: 185–199. doi: 10.1093/dnares/dsn011 PMID: 18508905
129. Ha NY, Kim Y, Choi JH, Choi MS, Kim IS, *et al.* (2012) Detection of Antibodies against *Orientia tsutsugamushi* Sca Proteins in Scrub Typhus Patients and Genetic Variation of sca Genes of Different Strains. *Clinical and Vaccine Immunology* 19: 1442–1451. doi: 10.1128/CVI.00285-12 PMID: 22787193
130. Ha NY, Cho NH, Kim YS, Choi MS, Kim IS (2011) An autotransporter protein from *Orientia tsutsugamushi* mediates adherence to nonphagocytic host cells. *Infect Immun* 79: 1718–1727. doi: 10.1128/IAI.01239-10 PMID: 21282412
131. Chan YGY, Riley SP, Chen E, Martinez JJ (2011) Molecular Basis of Immunity to Rickettsial Infection Conferred through Outer Membrane Protein B. *Infection and Immunity* 79: 2303–2313. doi: 10.1128/IAI.01324-10 PMID: 21444665.
132. Seong SY, Huh MS, Jang WJ, Park SG, Kim JG, *et al.* (1997) Induction of homologous immune response to *Rickettsia tsutsugamushi* Boryong with a partial 56-kilodalton recombinant antigen fused with the maltose-binding protein MBP-Bor56. *Infect Immun* 65: 1541–1545. PMID: 9119501
133. Ko Y, Choi JH, Ha NY, Kim IS, Cho NH, *et al.* (2013) Active escape of *Orientia tsutsugamushi* from cellular autophagy. *Infect Immun* 81: 552–559. doi: 10.1128/IAI.00861-12 PMID: 23230293
134. Min CK, Kwon YJ, Ha NY, Cho BA, Kim JM, *et al.* (2014) Multiple *Orientia tsutsugamushi* ankyrin repeat proteins interact with SCF1 ubiquitin ligase complex and eukaryotic elongation factor 1 alpha. *PLoS One* 9: e105652. doi: 10.1371/journal.pone.0105652 PMID: 25166298
135. Choi JH, Cheong TC, Ha NY, Ko Y, Cho CH, *et al.* (2013) *Orientia tsutsugamushi* subverts dendritic cell functions by escaping from autophagy and impairing their migration. *PLoS Negl Trop Dis* 7: e1981. doi: 10.1371/journal.pntd.0001981 PMID: 23301113
136. Cho BA, Ko Y, Kim YS, Kim S, Choi MS, *et al.* (2012) Phenotypic characterization of peripheral T cells and their dynamics in scrub typhus patients. *PLoS Negl Trop Dis* 6: e1789. doi: 10.1371/journal.pntd.0001789 PMID: 22905277 Protective Immunity against Scrub Typhus by ScaA Immunization PLOS.

137. Arthi P, Bagyalakshmi R, Krishna M, Krishna M, NitinM, Madhavan HN, *et al.* First case series of emerging Rickettsial neonatal sepsis identified by PCR based DNA sequencing. *Indian J Med Microbiol.* 2013;31:343-8.
138. Rathi N, Rathi A, Goodman MH, Aghai ZH. Rickettsial diseases in Central India: proposed clinical scoring system for early detection of spotted fever. *Indian Pediatr.* 2011;48:867-72.
139. Kulkarni A, Vaidya S, Kulkarni P, Bidri LH, Padwal S. Rickettsial disease-an experience. *Pediatr Infect Dis.* 2009;1:118-24.
140. Volovitz B, Shkap R, Amir J, Calderon S, Varsano I, Nussinovitch M. Absence of tooth staining with doxycycline treatment in young children. *Clin Pediatr (Phila).* 2007;46:121-6.
141. Todd SR, Dahlgren FS, Traeger MS, Beltrán-Aguilar ED, Marianos DW, Hamilton C, *et al.* No visible dental staining in children treated with doxycycline for suspected Rocky Mountain spotted fever. *J Pediatr.* 2015;166: 1246-51.
142. Biggs HM, Behravesh CB, Bradley KK, Dahlgren FS, Drexler NA, Dumler JS, *et al.* Diagnosis and Management of Tickborne Rickettsial Diseases, CDC. *MMWR Recomm Rep* 2016;65:1-44.

Acknowledgement:- Dedicated to my parents, my wife and daughter along with my patients and the Management of JIMSH.

Chapter - 10

Recent Progress in Pharmaceutical Sciences

Amartya De

BCDA College of Pharmacy & Technology

Abstract

Even while there are cures for many conditions, new diseases or disorders require more specialised care. Contrary to popular belief, pharmacy is now a multidisciplinary field with core research domains in pharmacognosy, pharmaceutical biotechnology, pharmaceutical analysis, pharmaceutical chemistry, pharmacology, and pharmaceuticals. Traditionally, the word "pharmacy" conjures up images of a medical supply store. These topics' primary goal is to offer robust support for both fundamental and translational research. Here, we provide a summary of how different areas of pharmaceutical research contribute to the creation of medications. The general public's understanding of drugs has recently changed as a result of COVID-19. Despite the fact that a number of medications have been unintentionally found, research has moved on to the next stage of drug development. Drug usage is unavoidable, and in the modern world, they have taken on a life-saving role. The primary role of pharmacy must be kept in mind, despite the fact that research from various scientific backgrounds has assisted translational research of drug creation. Here, we've outlined the significance of a few key topics in pharmacy education that have built various paths for medication development.

Introduction

There has been significant progress in pharmaceutical sciences in recent years. This progress has been driven by advances in technology and our understanding of disease. One area of progress has been in the development of new drugs. In particular, there have been significant advances in our ability to target specific diseases with new therapies. This has led to more effective treatments for many diseases. Another area of progress has been in the development of new delivery systems for drugs. This has led to more effective and efficient delivery of drugs to patients. Finally, there has been progress in our understanding of the mechanisms of disease. This has led to

the development of new treatments that are more effective and have fewer side effects.

Keyword: Pharmaceutical Sciences, New methodologies, progress, mechanism

Advancements in Pharmacology

Antifungal and Antibacterial Activity: Since the late 1990s and the beginning of the 2000s, significant research has been done on the benzimidazole moiety's antibacterial potential (Zkay *et al.*, 2011). The following section concentrates on the most recent information on antibacterial and antifungal activities, while antiviral, antiulcer, antiprotozoal, and antitubercular properties are covered in separate sections. This is due to the vast amount of research that has been done on the antimicrobial property of benzimidazole derivatives since 2012. Several substances with benzimidazole bases that have antibacterial and antifungal properties [3].

A wide range of compounds known as potassium (K) channel openers are able to open K channels in excitable cells. The smooth muscle system is where these drugs' efficacy is highest, but cardiac muscle, neurones, and secretory cells are also affected by their effects on K channels. The identification of such a chemical has wide-ranging ramifications, and researchers are currently looking into how it affects cardiovascular regulation [1].

According to two recent research, oral health and cancer are related because germs in the mouth are linked to cancers in other parts of the body. These studies show how bacteria infiltrate tumours and may be assisting in the progression and spread of tumours. The two articles centre on *Fusobacterium nucleatum*, an oral bacterium that has been connected to colorectal cancer.

The team discovered that a variety of bacterial species were present within oral and colorectal cancers, but they weren't distributed uniformly. They did this by adapting spatial transcriptomics, a cutting-edge technique that enables researchers to detect where genes are turned on and off in slices of tumour tissue [38910111213].

In the interim, the possible antidepressant potential of a number of novel pharmacological principles is being studied. The hypothalamic-pituitary-adrenal system is one of these, as are 5-HT_{1A} receptor agonists, tachykinin receptor antagonists, and several other therapies. While there is evidence that

these new treatments have antidepressant properties in animal studies, case series, open studies, and to some extent, placebo controlled studies, no conclusive evidence for the antidepressant efficacy of these new pharmacological strategies in accordance with the standards for evaluating antidepressant drugs has yet been provided. However, it is critical to monitor the new pharmacological approaches in order to develop even better clinical management strategies for depression, which has a significant socioeconomic impact^[4].

Positive effects of bee venom (BV), such as anti-tumor, neuroprotective, anti-inflammatory, analgesic, and anti-infectivity properties, have been demonstrated. Akt, mTOR, JNK, Wnt-5, HIF-1, NF-B, JAK2, Nrf2, BDNF, Smad2/3, AMPK, and other proteins are among the linked target proteins of BV and its primary components against the illnesses. The Kyoto Encyclopedia of Genes and Genomes pathway was used to bioinformatically forecast potential impacts and mechanisms^[5].

Key elements of treatment regimens for people with seizure clusters include rescue treatments. Although adults and adolescents may feel awkward using diazepam rectal gel, it is a successful rescue therapy for seizure clusters. Due to their ease of use, social acceptability, and quick start, intranasal delivery of midazolam or diazepam is a viable alternative to rectal administration. The bioavailability and tolerance of benzodiazepines used off-label, such as lorazepam that dissolves in the mouth and intravenous injections of an intravenous formulation using a nasal atomizer, are less well understood.

Ailments caused by diseases alter patterns, and new ailments appear as a result of shifting environmental conditions. The resources already available for pharmaceuticals are already at capacity due to the rapid increase in global population. Due to the rising demands of the global population, pharma producers are constantly searching for new sources to provide efficient and secure medications. Water covers 75% of the earth's surface, but little is known about the pharmacology of marine creatures, and much of it is still unknown. The marine ecosystem offers a limitless and diversified source for developing new medications to treat serious illnesses like cancer or malaria. Additionally, it provides an ecological resource made up of many water plants and animals. Antibacterial, immunomodulation, anti-fungal, anti-inflammatory, anticancer, antimicrobial, neuroprotective, analgesic, and antimalarial properties are checked on these aquatic species^[6].

New Pharmaceuticals Developments

The pharmaceutical industry has been compelled by the surge in the

number of poorly soluble medications over the past few years to develop formulation methodologies for enhancing the solubility and bioavailability of these drugs. Although solid dispersion technology and other traditional formulation methods (such as complexation with cyclodextrins; the use of salts, cosolvents, surfactants, and prodrugs) were introduced decades ago, there are still a significant number of potential drugs with demonstrated pharmacological activity that do not reach the market as a result of undesirable physicochemical and biopharmaceutical properties.

The marketability of these formulations is hampered by a number of issues, including inherent preparation technique limitations (the use of organic solvents or high temperatures), poor flowability and compressibility behaviour of the obtained product, stability problems caused by drug recrystallization from amorphous form or polymorphic transitions, as well as high formulation bulk due to the high weight percentage of excipient required to ensure formulation stability.⁷

The methods for in vitro drug release testing have seen a great deal of development and can be broadly divided into three categories: sample and separate, dialysis membrane, and continuous flow (flow-through cell) methods. Testing for medication release in vitro is crucial for getting a sense of how well a product works in vivo. Drug product development can be sped up and costs reduced by using in vitro release tests with in vivo relevance. In order to produce particle formulations, it is increasingly important to investigate the in vitro-in vivo correlation (IVIVC).

As well as advancements in adjacent domains including pharmaceutical sciences, material sciences, and biological sciences, substantial progress in the study of drug delivery systems was made over the period 2015–2018. Through its concentration on distribution methods, construction methodologies, and specific instances, this review offers a succinct summary of recent developments in this field of study.

Contemporary Pharmacognosy Advancements

The pharmaceutical sciences' oldest subfield is pharmacognosy. It is the investigation and study of plants and other natural substances as potential medications and therapies. It has to do with the physical, biochemical, biological, and chemical properties of drug entities or prospective therapeutics.

Since the beginning, pharmacognosy has been a translational or interdisciplinary science, and as the field's focus has expanded, phytochemistry and phytochemical analysis have been integrated into the

discipline. Through the selection and application of suitable screening assays targeted toward physiologically relevant molecular targets, molecular biology has become crucial to the discovery of medicinal plant drugs. Modern pharmacognosy also incorporates all these pertinent new fields into a unique interdisciplinary science.

From concentrating on the discovery of medications, including the isolation of active principles, and more recently, the examination of biological activity, the emphasis and focus of research in pharmacognosy have shifted substantially. Pharmacognosy has also benefited from research in ethnobotany, ethnomedicine, and ethnopharmacology.

A multimodal strategy combining botanical, computational, phytochemical, biological, and molecular approaches is currently being used in drug development from therapeutic plants. It is clear that the development of novel and significant leads for drugs against a variety of pharmacological targets, such as cancer, HIV/AIDS, Alzheimer's, malaria, and pain, comes from the study of medicinal plants. A number of natural product medications with plant origins have either just recently been released or are undergoing late-phase clinical studies.

Although the term "pharmacognosy" may not be as prominent in pharmacy curriculum in the UK and the USA, several of its concepts are still covered there under various titles and forms, such as "drug discovery from natural products/medicinal plants," "herbal therapy," and "phytotherapy." Despite all odds, pharmacognosy is becoming more and more popular and is being used more and more in nations like Brazil, China, and India, emerging giant economies where pharmacognosy research has gained new momentum due to its demonstrated potential to boost those nations' economies by billions of dollars. Natural substances derived from medicinal plants and their derivatives have historically produced a large number of clinically valuable medicines.

It has evolved and evolved over the years to adapt to the changing environment. The importance of pharmacognosy in pharmacy cannot be overstated. Pharmacognosy will continue to be an important and essential contribution to the knowledge and understanding of medicines and therapies and should therefore be an integral part of all significant university pharmacy programs worldwide.

The Modernization of Medicinal Chemistry

It is crucial to introduce new approaches, theories, and technologies that shorten the drug research and development cycle in academia as well as the

fiercely competitive pharmaceutical sector. In this perspective, recent strategic developments in medicinal chemistry and drug discovery are intended to be presented in a "big-picture" manner.

The idea of an activity cliff has a lot of use in medicinal chemistry. Recent studies that have improved our comprehension of activity cliffs and offered various methods of utilizing activity cliff data are presented. The introduction of computational methods to predict activity cliffs, alternative approaches to define and categories activity cliffs in two and three dimensions, data mining investigations to systematically detect all potential activity cliffs, and studies intended to examine activity cliff progression in medicinal chemistry are a few examples. New findings that show the frequency of activity cliff creation when various molecular representations are used and the distribution of activity cliffs across various targets are added to the discussion of these studies. When seen collectively, the findings have a variety of ramifications for the field of medicinal chemistry.⁷

The phenotypic analysis of mutations in three human genes that cause hereditary, early forms of Alzheimer's disease (AD) and information from preclinical investigations point to the involvement of Abeta in the onset and progression of AD. Gamma-secretase inhibitors are presently being researched as prospective AD therapies to lessen Abeta generation in light of this information. This article discusses current developments in the medicinal chemistry of peptide isosteres, azepines, and sulfonamides, three main groups of gamma-secretase inhibitors. For proving that presenilin is the catalytic subunit of gamma-secretase and for examining the active site, peptide isosteres have proved helpful. However, the peptidic nature of these inhibitors has limited their usefulness for in vivo research. Instead, azepines and sulfonamides have been the focus of the pharmaceutical industry's optimization efforts.

New Technology in Zoology

Largely as a result of a plethora of inventive new technological developments, zoology has made enormous strides during the 20th century. These include electron microscopes, oscilloscopes, radioisotopes, radiotelemetry, digital and satellite imagery, PCR and DNA sequencing, global positioning systems (GPS), quick and inexpensive travel, unimaginable computing power, faxes, and email. Zoologists are now able to examine things that were previously unattainable because to all this new technology. Instinct and animal behaviour, speciation, hybrids, parthenoforms, a new, previously undiscovered Kingdom of chemosynthetic

organisms, restriction enzymes, cloning, genetic engineering, genetic control of development, and an understanding of metabolic pathways were all discovered in the century after Mendelian genetics was rediscovery.

Exploration of all phenomena within the context of Darwinian natural selection has been one of biology's most recurring topics this century. Nothing in biology "makes sense except in the light of evolution," according to Dobzhansky (1971). All zoology is conceptually based on evolution.

The first things that come to mind when you think about the last century are new methods and technological developments. We can observe and research phenomena at the microscopic level thanks to electron micrographs. We now have "macrographs" thanks to satellite imagery that let us see and analyse very big occurrences like El Nio. Since 1972, satellite imagery has been widely available, allowing chronosequences to be used to track cyclical processes like fire succession in grasslands.

Let's now look at some more significant advances in zoology over the past century. Of course, the discovery of Mendelian genetics at the start of the century set the stage for genetics' prominence throughout the 1900s. X-rays are known to trigger mutations, according to Herman Mueller. The genetic code itself, the mechanism of genetics, transcription, translation, etc. were all discovered in the middle of the 20th century. Animal instincts and behaviour, as well as speciation, hybridization, and parthenogenesis, came to the fore [8].

Recent development in Hospital Pharmacy

The traditional healthcare system is centred mostly on the delivery of medical services through networks of hospitals and outpatient clinics. The qualifications of medical staff, hospital infrastructure, and the availability of modern equipment are only a few of the numerous variables that affect how well a health service is provided. Countries may use different models. The fundamental ideas, though, are the same. The "patient-oriented" strategy and supporting infrastructure that ensure the best possible access to the healthcare service are the first thing that come to mind. Due to the rapid advancement of technology and the public's demand for high-quality medical care, such a traditional platform has recently been confronted with new difficulties. Additionally, cutting-edge digital technologies provide the opportunity for an accelerated increase of the potential of different diagnostic and therapeutic methods.

In 1980, the English Regional Pharmaceutical officers developed the standards for the Hospital Pharmacy services which was revised in 1989 and

all together contain 28 areas of Pharmaceutical care/ practice including Ensuring the appropriate purchase of medicines, Quality assurance of medicines provided to the patients, Establishing safe systems for storage and supply of medicines ,Preparation of Hospital Formularies, etc.

The use of artificial intelligence (AI) in biomedicine, healthcare, and medical education is another promising and quickly expanding field. AI has the potential to greatly enhance the functionality and performance of diagnostic tools. Additionally, it might aid in treatment process optimization, raising therapeutic effectiveness, improving patient happiness, and reducing expenses. Clinical trials and scientific research can both be made easier by AI. AI will also be crucial in industries that require heavy manual labour and automation. Despite recent advancements, AI cannot yet completely replace people in the fields of healthcare and biomedical research.

References

1. Brishty, S. R., Hossain, Md. J., Khandaker, M. U., Iqbal Faruque, M. R., Osman, H., and Abdur Rahman, S. M. (2001, January 1) A Comprehensive Account on Recent Progress in Pharmacological Activities of Benzimidazole Derivatives. *Frontiers*.
2. (2002, November 15) Recent progress in potassium channel opener pharmacology. *Recent progress in potassium channel opener pharmacology - ScienceDirect*.
3. Jorge Luis Galeano Niño, Hanrui Wu, Kaitlyn D. LaCourse, Andrew G. Kempchinsky, Alexander Baryames, Brittany Barber, Neal Futran, Jeffrey Houlton, Cassie Sather, Ewa Sicinska, Alison Taylor, Samuel S. Minot, Christopher D. Johnston, Susan Bullman. Effect of the intratumoral microbiota on spatial and cellular heterogeneity in cancer. *Nature*, 2022;
4. Recent Progress in Pharmacological and Non-Pharmacological Treatm...: Ingenta Connect. *Recent Progress in Pharmacological and Non-Pharmacological Treatm...: Ingenta Connect*.
5. (2022, September 27) Pharmacological effects and mechanisms of bee venom and its main components: Recent progress and perspective - PubMed. PubMed.
6. Malve, H. Exploring the ocean for new drug developments: Marine pharmacology. *PubMed Central (PMC)*.
7. Kinghorn, A. D. (2001, February 1) Pharmacognosy in the 21st century. *OUP Academic*.

8. Pharmaceutics. *Pharmaceutics | Special Issue: Recent Progress in Formulation Approaches for Improving the Solubility and Bioavailability of Poorly Soluble Drugs*.
9. Kim, Y., Park, E. J., Kim, T. W., and Na, D. H. (2021, August 23) Recent Progress in Drug Release Testing Methods of Biopolymeric Particulate System. *MDPI*.

Chapter - 11

Impact of COVID 19 on Higher Education through Online Education Platform

Rawal Singh Aulakh,

Assistant Professor, Department of Architecture,
Guru Nanak Dev University,
Amritsar, Punjab, India

Sakshi Sahni,

Assistant Professor,
Guru Ram Das School of Planning,
Guru Nanak Dev University,
Amritsar, Punjab, India

Abstract

Although COVID 19 had disrupted the global economy, it has impacted higher education as well to quite a considerable extent. Many online platforms took a front seat after the closure of schools and higher education institutions worldwide. The research article tries to present and understand both adverse as well as positive impacts of the online education platform. The paper is an exploratory research article with secondary data collection from various databases like Scopus, Web of Science, Google Scholar etc.

Keywords: Online education, MOOC, Positive, Negative, Psychology, Google meet.

Introduction

Globally as we became more and more interrelated as well as interconnected, so the risk as well as danger (Schleicher2020). The COVID 19 pandemic is not still at the countrywide borders and it has affected people adversely irrespective of race, nationality, level of education, income or sex (Schleicher 2020). COVID 19 has obstructed, hindered as well as stuckdifferent aspects of society with advanced education and university students as no exclusion. This pandemic has had a severe impact on higher education as campuses of colleges or universities closed their premises and nationsclosed their boundaries in response to lockdown norms (Schleicher 2020). Coronavirus had affected the globe tremendously and it also affected the world education system as well. Various schools, colleges, universities

had to be shut down due to COVID19. According to UNESCO, on 1 April, 2020 schools and higher education institutions were closed in 185 countries affecting 15424,12,000, which constitute 89.4% of total enrolled students (Marinoni *et al.* 2020). According to Tadesse *et al.*, 2020 citing UNESCO states that

At least 9 out of 10 pupils globally had their face-to-face classes stopped by the epidemic.

Almost 1.5 billion children in pre-primary through higher education are affected by the closure of all schools in 195 nations worldwide.

Around 43% of pupils (706 million), or 50% (826 million), do not have access to a computer or the internet at home.

Also, because they are not serviced by mobile networks, 56 million students cannot use mobile phones.

Over 89% (216 million), 82% (199 million), and 11% (26 million) of students in Sub-Saharan Africa countries do not have access to a computer, a home internet connection, or a mobile network, respectively. Moreover, there are 56 million pupils in Sub-Saharan Africa. In countries, The percentage of pupils who lack a computer is around 89% (216 million), 82% (199 million), and 11% (26 million), respectively (Tadesse *et al.*, 2020). Tadesse cites UNESCO in saying that the COVID 19 school closures had an impact on 87% of the world's student population.. With traditional classroom teaching taking a back seat, new platforms which are online have taken place. Although it has certain advantages as well as disadvantages that will be explored and investigated in this paper.

Objectives

- To understand the positive impacts of online education platform
- To examine the negative impacts of online education platform

Research Methodology

The paper is an exploratory research method with focus on systematic literature review. The systematic literature review involves reviewing secondary data and coming with pros and cons of online teaching for students. The papers were retrieved from online platforms like web of science, Elsevier, Google Scholar, Scopus. They were reviewed and evaluated on the basis of positive and negative impacts.

Literature Review

According to Mustafa (2020), the coronavirus pandemic has

tremendously affected globally the educational systems with total shutting of schools, universities as well as colleges. Mustafa 2020 states that at the middle of April 2020, approximately 1.723 billion learners have been affected due to school closures in response to pandemic. Mustafa (2020) states that remote learning over a video call or conferencing during COVID 19 has become quite acquainted as well as familiar and popular among students and teachers. These platforms include Zoom, Google Meet, WebEx etc to name a few which has been extensively used worldwide.

Adverse Impacts

Psychological disorders among students have risen to a great extent where many students have faced rise in anxiety levels and needs a psychologist to monitor their mental health.

Due to school closure, there is a high level of anxiety, depression and stress disorders among students due to school closures (Tadesse *et al*, 2020). Mustafa (2020) also states that there is lack of access to technology or fast, reliable internet access can prevent students from disadvantaged families say for example in case of India where 70 % people are below poverty line and have no access to basic needs like food, water and sanitation. In that case, availability of online distances education a dream to them. Affordability is another factor to limit access to eLearning with students (Rashid, Yadav 2020) from lower income groups where 70% of population in India is below the poverty line. In remote as well as rural areas there is lack of ICT infrastructure, computers, radio, T.V. to provide distance learning (Tadesse *et al*, 2020). The screen time has increased to a considerable extent thereby affecting the overall health and well-being of the students. The students face problems in understanding the digital content as compared to face to face teaching (Rashid, Yadav 2020) which is more favourable to learn and asking for supervision and direction (Rashid, Yadav 2020). The unexpected shift to familiarize and implement online learning has led to over work, stress among the teaching faculty as well. The instructors need to re- imagine styles of prospectus planning, development of e- content, valuation as well as reporting (Rashid and Yadav 2020).

There were lot of differences in the education system of various countries due to impact of COVID 19 pandemic. The academic years start and end date varies with the lack of homogeneity along with school holiday timings. There were different timings and less restrictions were there along with online classes and reduction in face to face teachings (Gonzalez *et al*, 2020 cites study.eu.com).

It has been observed in developing countries there has been an increase in social inequality in schools (Tadesse *et al*, 2020). The students from rich class and higher status have access to better infrastructure facilities and skills (Tadesse *et al*, 2020). The school of rich class are mostly private and are better equipped with digital technology and resources for conducting online classes while as Lower Income Groups or disadvantaged group of students are at school where very little ICT facilities and resources are available (Tadesse *et al*, 2020). It is very unfortunate that schools in rural areas have no resources or appropriate infrastructure required for teaching (Tadesse *et al*, 2020). Hence, a huge gap in technology of private and public schools can be seen. The web platforms like googlemeet, zoom are challenging in government schools due to lack of finance, skill as well as infrastructure related to ICT. There are certain courses that are difficult to teach online like lab test, practical test, experiments, performance tests are impossible to conduct online. Students with no connectivity will suffer in assignment (Tadesse *et al*, 2020). There is huge difficulty to do the evaluation and monitor the online exam. The assessment of practical skill is really difficult (Tadesse *et al*, 2020).

In the rural areas of developing countries, rural population and their families force the girl students to help them in farming as well as rearing the cattle herds (Tadesse *et al*, 2020). There are also higher chances of higher sexual abuse, forced labour as well as early marriage which result in the chances of fear, stress, anxiety, depression, fear of relatives and makes the rural children more helpless through online platforms (Tadesse *et al*, 2020).

Positive Impacts

The impact on higher education has been histrionic and transformative and a common trend in education systems around the world (Rashid and Yadav, 2020)The online learning environment has many advantages, such as ranging the spatial and demographic barriers, elasticity, interactivity as well as interoperability(Miliszezwska 2007 cites Curran, 2002, Huang & Hu, 2000;Khalifa and Lam 2002, Kinushkand Yang, 2003). Management in digital learning tools include Google classroom, MOoodle, Masive Open Online Courselike Alison, Coursera are there which help students (Tadesse *et al*, 2020).. Self Directing Platforms like Khan Academy and One course are designed for one's speed and can be done at convenient time by students (Tadesse *et al*, 2020). Many online platforms have played an important role in imparting education and ICT has become a new normal for students. MOOC courses, as well as GOI initiatives like SWAYAM portal, NPTEL have gained recognition during these difficult times. UDEMY, EDX are the

new platforms from which students can take courses at their own pace. Digital Libraries of internet have taken the front seat and have become popular online platforms. The students are using various platforms for e learning and lectures like Zoom App, Team Link, You Tube Live, Skype, Google meets, Google classroom, Whatsapp etc (Kapasias 2020)

Various nations used a variety of resources to provide students learning while they were unable to come to institutes, including instructional packages (textbooks, worksheets and printouts) radio education, educational television and online instructional resources (Schleicher 2020). Certain online platforms like Blackboard, Googlemeet, Zoom, We Chat Group, Tron Class, Classin, Tron Class etc. (Tadesse *et al*, 2020). Online tools extended from instructive content which pupils could discover as well as reconnect at their own choice and formalised new knowledge as well as learning programmes directed at their individual step and pace, to real time lessons by their educators using computer-generated or virtual assembly rooms (Schleicher 2020).

The online videos taught by the teachers can be repeated by the weaker students and home learning of concepts can be done at its own pace and time (Mohammed, Joshi, 2021). There is no discrimination in online teaching and it provides equal opportunity to everyone (Mohammed, Joshi, 2021). The contents can be accessed at any point of the day due to availability of content at any point of time (Mohammed, Joshi, 2021). There are no back benches in the online classes and all students get equal opportunity to self study (Mohammed, Joshi, 2021). The analysis by the students of what is being taught is done effectively through self study and online platform (Mohammed, Joshi, 2021). There is lot of learning of computer skill and students get to learn a lot of softwares like Google meet, zoom etc. and also the assignments are to be submitted online hence they get access to all basic softwares.

One benefit is that the reading and study material of the online classroom are shared after the class immediately by the teachers on web or social platforms like whatsapp, facebook and emails therefore the students have access to it immediately (Mohammed, Joshi, 2021). Students are able to learn as well as manage their time effectively during COVID 19 pandemic (Mohammed, Joshi, 2021). Many students can learn online without worrying about the strength (Mohammed, Joshi, 2021).

Conclusion

Although virtual education is filling the gap to adapt to new normal

norms of social distancing but it is not possible in the long run to continue with this virtual education due to adverse effects which it is carrying whether it may be counted in terms of screen time, anxiety among students, poor internet connectivity or affordability issues among students especially in case of developing countries. It is very important to take into consideration the above-mentioned factors and challenges in developing economies. The positive affects vary from range of new platform options mentioned above to instruct students and learn at their own pace.

References

1. Cao, Wenjun *et al.* "The psychological impact of the COVID-19 epidemic on college students in China." *Psychiatry research* vol. 287 (2020): 112934. doi: 10.1016/j.psychres.2020.112934
2. Fernandes AJ. Impact of COVID-19: University Students' Perspective. *Int J NutrPharmacolNeurol Dis* [serial online] 2020 [cited 2020 Nov 5];10:168-9. Available from: <https://www.ijnpnd.com/text.asp?2020/10/3/168/292689>
3. Mustafa Nasir (2020) Impact of the 2019-2020 Coronavirus pandemic on education. *International Journal of Health Preferences Research*
4. Miliszewska, I. (2007). Is it fully 'on' or partly 'off'? The case of fully-online provision of transnational education, *Journal of Information Technology Education*, 6, 499–514.
5. Rashid Shazia, tadav S.S (2020). Impact of Covid 19 Pandemic on Higher Education and research. *Indian journal of Human development*. Sage Publications.
6. Schleicher Andreas (2020). The impact of COVID 19 on education insights from education at a glance 2020. OECD
7. Marinoni Giorgio, Van't land Hiilgje, Trine Jensen. (2020).The Impact of COVID 19 on Higher Education around the world .IAU Global Survey Report. UNESCO House, France
8. González-Calvo, G., Barba-Martín, R., Bores-García, D., & Gallego-Lema, V. (2020). Learning to be a teacher without being in the classroom: COVID-19 as a threat to the professional development of future teachers. *International and Multidisciplinary Journal of Social Sciences*, 9(2), 152-177. doi:<http://dx.doi.org/10.17583/rimcis.2020.5783>
9. Yaseen Saima Firdaus Mohammed, Joshi Shubhada Ramesh. (2021). Positive Impact of COVID 19 on Education. *International Research*

10. Gonzalez T, de la Rubia MA, Hincz KP, Comas-Lopez M, Subirats L, Fort S, *et al.* (2020) Influence of COVID-19 confinement on students'performance in higher education. PLoS ONE 15(10): e0239490. <https://doi.org/10.1371/journal.pone.0239490>
11. Tadesse, S., & Muluye, W. (2020). The Impact of COVID-19 Pandemic on Education System in Developing Countries: A Review. Open Journal of Social Sciences, 8, 159-170. <https://doi.org/10.4236/jss.2020.810011>

Chapter - 12

‘The Medicinal and Pharmacological Study of Some Plants Used In Dibites Cure

Mr. Sandipan Babasaheb Jige

Assistant professor and Head Department of Botany, Sant Ramdas College Ghansawangi
Dist- Jalna, Maharashtra, India

Abstract

India has a rich and unique collection of flora, with an estimated 45,000 plant species, among which are numerous species of medicinal plants spread over many different geographical and climatic zones. Chemical compounds obtained from plant source are termed as secondary plant products. Alkaloids and glycosides are the two major compounds present. In 4000 plant species, more than 3000 alkaloids have been identified. The difference between a toxic and medicinal effect of many alkaloids depends upon the dosage. When a sugar molecule gets attached to component which is active, it is called as glycoside which is categorized by the nature of the active component. Today man has known 4,50,000 species of plants about 2000 species come under 60 plant families has conations essential oils. Over 7,000 species of differently ecosystem occurred used as medicine in our country. In the essential oil production our country share 16-17% total production of world is 1, 00,000 to 1, 10,000 tons. Brazil was top most country of essential oil production it produces only citrus oil 40,000 tones. About 219 plants from 83 families were found to have antiviral activity. The World Health Organization (WHO) has listed 21,000 plants, which are used for medicinal purposes around the world. Among these 2500 species are in India, out of which 150 species are used commercially on a fairly large scale. India is the largest producer of medicinal herbs and is called as botanical garden of the world.

Diabetes is a disease that occurs when your blood glucose, also called blood sugar, is too high. Blood glucose is your main source of energy and comes from the food you eat. Insulin, a hormone made by the pancreas, helps glucose from food get into your cells to be used for energy. Sometimes your body doesn't make enough or any insulin or doesn't use insulin well.

Glucose then stays in your blood and doesn't reach your cells. Diabetes is a chronic disease that occurs either when the pancreas does not produce enough insulin or when the body cannot effectively use the insulin it produces. Insulin is a hormone that regulates blood sugar. A list of medicinal plants with proven anti diabetic and related beneficial effects and of herbal drugs used in treatment of diabetes is compiled. These include *Allium sativum*, *Eugenia jambolana*, *Momordica charantia*, *Ocimum sanctum*, *Phyllanthus amarus*, *Pterocarpus marsupium*, *Tinospora cordifolia*, *Trigonella foenum graecum* and *Withania somnifera* etc.

Keywords- Diabetes, Pancreas, Insulin and WHO etc.

Introduction-

In 2014 number of trees in per km² in the world Sweden has at the top having 69161 trees, Brazil at second number having 35288 trees but in India it is 11109 trees. In the number of trees per capita New Zealand has top in the world with 2543 trees per capita and Brazil having at second position with 1494 trees per capita and India has 28 trees per capita the average of world is 422 trees per capita. In the forest area Europe has shared about 25.07% area, South America has shared about 20.08% area, Africa has shared about 15.68% area and the Asia having has shared about 15.34% area. On the earth about 29% share has land it is about 14.9 billion hectares and 71% land has covered by ocean about 36.1 billion hectares. In the 29% land about 71% land has habitable land it is 10.6 billion hectares, the barren land is 19% cover 2.8 billion hectares land and the 10% land cover by glaciers is about 1.5 billion hectares. About five thousands year before the forest has consist 57% area it is about 6 billion hectares in which 42% land covered by grassland and shrubs it is about 4.6 billion hectares and one percentage lakes and freshwater. But today in 2018 the forest has consist 38% area only four billion hectares area. The crops has covered 15% area it has been 1.6 hectares land, the grazing area is 31 % about 3.2 billion hectares the wild grassland and shrubs cover 14% about 1.74 billion hectares but in which 01% land has urban and build up land it includes settlements and infrastructure 150m hectares. The world has lost one third forests till today and almost half habitable land is used for agriculture. In this land today man has known 4,50,000 species of plants about 2000 species come under 60 plant families has contains essential oils. Over 7,000 species of differently ecosystem occurred used as medicine in our country. In the essential oil production our country share 16-17% total production of world is 1, 00,000 to 1, 10,000 tons. Brazil was top most country of essential oil production it produces only citrus oil 40,000 tones. About 219 plants from 83 families were found to

have antiviral activity. The World Health Organization (WHO) has listed 21,000 plants, which are used for medicinal purposes around the world. Among these 2500 species are in India, out of which 150 species are used commercially on a fairly large scale. India is the largest producer of medicinal herbs and is called as botanical garden of the world.

In Ayurveda, diabetes is described as madhumeha, a condition where a person passes sweet honey like urine. It is considered one of 20 urinary disorders (prameha). Depending on your body constitution, Ayurveda might recommend different treatments for this condition Jamun seeds have been found to be more potent than the fruit pulp. It has also been observed that jamun seeds have higher phenolic compounds in comparison to the pulp. Since phenolic compounds have anti diabetic effects this could explain why the seeds are more potent. One study observed that jamun varieties with smaller fruits exhibited greater antidiabetic properties than those with larger fruits.

The diabetes has chronic condition it results in abnormally in high blood sugar level it has two type of diabetes. Type 1 diabetes and type 2 diabetes the sugar level controlled by the hormone known as insulin. In the Type 1 diabetes the immunity system destroy cells which produce insulin and in Type 2 diabetes people condition is either more insulin not produced by body or body not responds properly for insulin. The artificial insulin discover by Sir Frederick G. Banting, Charles H. Best and JJR Macleod in May1921.

Objectives-

- To study the history of diabetes mellitus
- To study the role of different plants in cure of diabetes mellitus
- To focus on development pharmacological research
- To aware young generation about to save medicinal plants for future life

Analysis and Result-

In India Sushruta identified the diabetes and known as Madhumeha the word madhu means honey and the term means sweet urine. The word diabetes first coined by Araetus of Cappodocia and mellitus added by Thomas Willis in 1675. The symptoms of diabetes firstly mentioned by Egyptian physician Hesy-Ra in 1552 B.C., it noticed that ants are attracted to the urine of people. The Greek physician Arateus describe the melting down of flesh and limbs into urine are diabetes. The word mellitus means honey

add with diabetes in 1675. The test for this disease developed in 1800 for detection of sugar in urine. The German scientist Georg Zuezer discovered that injecting of pancreatic extract into patients help to control diabetes. In 1920 the Canadian physician Frederick Banting given idea to use insulin for diabetes treatment it has given it successfully in 1922 to patient and it awarded by Nobel Prize of medicine. The word diabetes mellitus is derived from Greek word diabetes it means siphon to pass through and Latin word mellitus means sweet or honey. All types of diabetes causes by high blood sugar level and the body trouble in producing insulin.

The diabetes has main type it is type 1 and type 2 with these type there is another types of diabetes like Maturity onset diabetes of the young (MODY), Neonatal diabetes, Wolfram syndrome, Alstrom syndrome, Latent Autoimmune diabetes in adults (LADA), Type 3 C diabetes Steroid-induced diabetes and cystic fibrosis diabetes.

Maturity onset diabetes of the young (MODY)- It has a rare form of diabetes it is different from type 1 and type 2, diabetes, it runs strongly in families. The gene change by mutation caused this type of diabetes. The parent having show gene mutation the child also 50% chances of inheriting it from them. If it not happens or child not inherits the mutation it is generally develop the maturity onset diabetes of young before 25 ages.

Neonatal diabetes- It is type of diabetes it diagnosed under age of six months; it is common type of diabetes¹. The body has destroyed its insulin producing cell.

Wolfram Syndrome- It is also rare type of genetic order it is also known as diabetes insioidus diabetes mellitus optic atrophy and deafness (DIDMOAD).

Alstrom Syndrome- It is also genetically inherited syndrome it has number of common feature occurs in patients.

Latent Autoimmune diabetes in adults (LADA)- It is type 1 and type 2 diabetes, the bits of it more like type 1 diabetes and other bits like more to the type 2 diabetes. It is separate type of diabetes at the moment.

Type 3 C diabetes- When the diseases damage to the pancreas it develops this type of diabetes. It is related to type 3 C are the pancreases cancer, pancreatitis, and cystic fibrosis of haemochromatosis. In this Type 3 C diabetes pancreases removal is necessary due to its damage.

Steroid-induced diabetes- The people is having type 2 shows the risk of this type of diabetes.

Cystic fibrosis diabetes- It is common type of diabetes in people with cystic fibrosis it also feature of both type 1 and type 2 diabetes, it is different condition.

Type 1 diabetes- It is also known as insulin dependent diabetes, it characterized by deficient insulin production and require daily administration of insulin. Its symptoms show excessive excretion of urine, thirst, constant of hunger, weight loss, vision changes and fatigue.

Type 2 diabetes- It is known as non insulin dependent diabetes, it results from body's ineffective use of insulin. This type diabetes occurs in more people, it results excess body weight and physical inactivity. The symptoms of this type are similar to type 1 diabetes it occurs generally in adults but now occurring increasingly frequently in children.

Gestational diabetes- It is hyper glycaemia with blood glucose value above the normal but below those diagnostic of diabetes. This type of diabetes occurs in pregnancy of women with gestational diabetes. It increase risk of complications during pregnancy and at delivery, the children also show risk of type 2 diabetes in future.

The scientist Anton H. Clemens has developed blood glucose meter and glucose self monitoring system the Ames reflectance meter (ARM) to detect reflected light from dextrostix in 1970. This meter used in 1970 the dextrometer is show the digital display. The glucose meter is small and portable it measures the glucose in the blood.

The risk and food for diabetes-

In the diabetes type 2 high fat foods like meat, fatty cuts of pork, lamb, poultry skin and dark meat chicken avoid. The dairy fat food like milk, butter cheese and sour cream also avoid. The sweets like candy, cookies, baked goods, ice cream and desserts also avoids. The sugar sweetened beverages, juice, sods, sweet tea and sports drinks also avoid. In the risk family history of type 1 diabetes includes injury of pancreas like infection, tumor and surgery. The presence of auto antibodies attack mistakenly attack body tissue or organ the physical stress, exposure to illness caused by viruses. In the risk family history of type 2 diabetes includes family history of pre diabetes, overweight, high blood pressure. Low cholesterol HDL and high triglyceride level, physically inactive, polycystic ovary syndrome and heart disease show risk.

1) Jamun (Eugenia jambolana) -

The plant is not only powerful antioxidant but also helps to improve

immunity of body it is specially used in treatment of diabetes. The fruit of plant shows acidic nature but test is sweet and also act as astringent. In ripen fruit glucose and fructose is major sugar, it also contains minerals provide fewer calories. In unani and ayurvedic system it used in digestive disorder the leaves, bark and seeds are used in various treatments. The seed contains anti-diabetic properties in which jamboline is main constituent is found. The leaves and bark extract also helps in decrease of blood sugar and glycuria, it is known as hypoglycemic due to alkaloids present in it. The consumption of fruit daily by diabetic patients helps to enhance the insulin activity and sensitivity. The power of seed used in type 2 diabetes insulin and non insulin type as adjuvant. The fruit is containing vitamin A and C it also helpful in skin and eye health. The leaves of plant have shows anti-bacterial and antioxidant properties it helps to prevent cancer like diseases. The leaves also help convert starch into energy and keep blood sugar level in control. The jamun also helps to low glycemic index and reduce symptoms like frequent urination and thirsting. The type 2 diabetes peoples shows low level of insulin the seed of jamun ensure greater availability of insulin by increasing its secretion or by preventing it from degrading fast. The chemical substance jambosine and jamboline helps in this process. The jamun to increase vata and balance the kapha and pitta dosha according by ayurveda medicinal system. It also contains phenolic compounds it block break down of starch and enhance insulin secretion helping keeping blood sugar in normal. The fruit contains chromium it is good for the pancreas it help manage blood sugar level.

The jamun plants leaves extracted with methanol and water it anal sized different photochemical. It founds alkaloids, flavonoids, glycosides, steroids, phenols, tannins, saponins and cardiac glycosides in the extracts. The stem bark with ethanol shows the presence of terpenoids, alkaloids, catechins, phenols, quinones, saponins and tannins; whereas, the methanol extract of such was found to additionally contain flavonoids. The ethyl acetate and methanol extracts of Jamun seeds were found to contain flavonoids, alkaloids, glycosides, triterpenoids, steroids, saponins, and tannins. leaves of Jamun were found to contain betulinic acid, crategolic acid, n-dotricontanol, n-hentriacontane, n-hepatcosane, mycaminose, myricetin, myricitrin, myricetin 3-O-(4"-acetyl)- α -L-rhamnopyranosides, n-nonacosane, quercetin, β -sitosterol, noctacosanol, n-triacontanol, triterpenoids, tannins, eicosane, octacosane and octadecane. octadecane The flowers of Jamun have shown the presence of various phytochemicals, including kaempferol, quercetin, myricetin, isoquercetin (quercetin-3-glucoside), myricetin-3-L-arabinoside, quercetin-3-D-galactoside, dihydromyricetin, oleanolic acid, acetyl oleanolic

acid, eugenol-triterpenoid A and eugenol-triterpenoid B. The fruit of Jamun consists of different anthocyanins (including delphinidin 3,5-diglucoside, cyanidin 3,5-diglucoside, petunidin 3,5-diglucoside, peonidin 3,5-diglucoside, delphinidin 3-glucoside, malvidin 3,5-diglucoside, delphinidin acetyl-diglucoside, peonidin-3 and 5-diglucoside).

2) Bitter gourd or Karela (*Momordica charantia*)–

The bitter gourd is also one of helpful plant to reduce sugar level in type 1 and type 2 diabetes. The juice of fruit or leaves consumption is very effective to diabetes patients. This juice consumption reduces their dose of medicine it also helps to manage of gestational diabetes. The contains of bitter gourd is linked to lowering blood sugar its consumption help cells use glucose and move into liver, muscles and fat. The plants nutrient comes in body blocks conversion to glucose that end up in blood stream. The plant contains lectin it reduce blood glucose concentration by acting on peripheral tissues and suppressing appetite similar to effect of insulin in brain. Momordicin is the functional components of bitter gourd. Momordicin was found at fruit, leaves, and roots. A further component of charantin is reported to be highly effective for controlling the blood glucose in relation to insulin resistance. Plant-based medicine has been used cost-effectively worldwide to treat diabetes. In fact, in many parts of the world, especially poor countries, this may be the only form of therapy available to treat diabetic patients. The fruits contain high amounts of vitamin C, vitamin A, vitamin E, vitamins B1, B2 and B3, as well as vitamin B9 (folate). The fruit is also rich in minerals including potassium, calcium, zinc, magnesium, phosphorus and iron, and is a good source of dietary fiber. The medicinal value of bitter melon has been attributed to its high antioxidant properties due in part to phenols, flavonoids, isoflavones, terpenes, anthroquinones, and glucosinolates, all of which confer a bitter taste. The main constituents of bitter melon which are responsible for the antidiabetic effects are triterpene, proteid, steroid, alkaloid, inorganic, lipid, and phenolic compounds. Several glycosides have been isolated from the *M. charantia* stem and fruit and are grouped under the genera of cucurbitane-type triterpenoids.

3) fenugreek seeds- (*Trigonella foenum graecum*)

It contains high soluble fibers it helps for lowering blood sugar by slowing digestion and absorption of carbohydrates it has shows anti- diabetes properties. The seed and leaves of plant are good sources of vitamins, minerals and antioxidant it protect body's cell from damage caused by free radicals. It also used for nourishing mother for stimulation of production of

breast milk during pregnancy and after childbirth. It has shows anti- diabetes and antiviral properties so used as herbal remedy in cold and sore throats. These properties arise from three main chemical constituents: steroidal sapogenins, isoleucine, and galactomannans. The Steroidal sapogenins are applicable in hypercholesterolemia or in diabetes. The plant contains active constituents, such as alkaloids (trigonelline, choline, carpaine), flavonoids (naringenin, lilyn, kaempferol, vecenin-1, tricin 7-O-D glucopyranoside, saponaretin, isovitexin, isoorientin. orientin, vitexin, luteolin, quercetin), coumarins (methyl coumarin, trigocoumarin, trimethyl coumarin), steroids, saponins (fenugrin, foenugracin, glycoside, yamogenin, trigonoessides, smilagenin, gitogenin, sarsasapogenin, yuccagenin, hederagin, diosgenin, tigoninenin, neotigogenin) and other antioxidants. It contains a major class of phenolics like gallic acid, protocatechuic acid, catechin, gentisic acid, chlorogenic acid, vanillic acid, and syringic acid. Fenugreek is better known for the benefits obtained from its external use.

4) Insulin plant (*Costus igneus*)-

The plant generally known as insulin plant because consumption of leaves of plant believed that it lowers the blood glucose levels. The chemical present in leaves reduce the spiked sugar level in blood. The leaves contains protein, antioxidants, flavonoids, terpenoids, iron, ascorbic acid, iron, carotene and corsoic acid. The plant used as traditional medicine in treatment of diabetes in many countries in the world. In India, it is popularly known as insulin plant due to the consumption of leaves of *Costus igneus* helps to prevent diabetes mellitus by decreasing the blood glucose level compounds such as tannins, phlobatannins, saponin, flavonoids, terpenoids and Cardiac glycosides. Quantitative phytochemical analysis revealed that Saponin and Flavonoids were in leaf. Flavonoid and sapogenin were studied to responsible for antidiabetic activity in Costu. The phytochemicals of this plant include saponins, flavanoids, glycosides, xyloglucan, taraxerol, carotenoids and cryptoxanthin

5) Apple (*Malus domestica*)-

The fruit of apple is hypo glycaemic contains many fibers it is impeccable ingredient for the diabetes. The fruit also contains chemical pectin it has capability to reduce blood sugar level and the requirement of insulin for body mostly 50%. The fruit also contains antioxidants it so lower the risk of diabetes. In apple fruit sugar is mostly fructose it contains polyphenols it help to down the suger level. The phenols a compound mostly presents in skin of apple fruit it stimulate pancreas to release insulin. The

antioxidant prevents the diabetes. The main structural classes of apple constituents include polyphenols, polysaccharides (pectin), phytosterols, and pentacyclic triterpenes. Also, vitamins and trace elements complete the nutritional features of apple fruit. There is now considerable scientific evidence that these bioactive substances present in apple and peel have the potential to improve human health, Quercetin and quercetin glycosides peel Anthocyanins peel, phytosterol peel, triterpenoids peel Pectin peel, pulp, root, stem, leaf Carbohydrate seed, pulp, leaf Amino acid, peptide and protein ingredients seed, pulp Oil composition seed, pulp Endogenous hormone Plant The research on apple bioactive substances is mainly concentrated in the pulp and peel of an apple. Overall, a large number of bioactive substances including polyphenols, polysaccharides, plant sterols, pentacyclic triterpenes, and organic acids have been found in apples, and it has been shown that their presence significantly differs in pulp and skin. From the human health point of view, polyphenols, polysaccharides, plant sterols, and triterpenes especially jointly contribute to the majority of positive effects on human health, such as antioxidants, anti-cancer, and anti-inflammatory. The apple contains bioactive substances including polyphenols, hydroxycinnamic acid, glycosylated flavonoids, flavan-3-ols, proanthocyanidins, polysaccharides (pectin), phytosterols, pentacyclic triterpenes, triterpene acids, dihydrochalcones, and vitamin. Also, many types of antioxidant compounds present in apple and apple peels have been reported such as catechin, chlorogenic acid, epicatechin, cyanidin-3-galactoside, procyanidin, coumaric acid, gallic acid, phloridzin, quercetin-3 galactoside and quercetin-3-rhamnoside. In the apple flesh, there are some compounds found in a lesser amount, i.e., epicatechin, catechin, phloridzin, and procyanidin than in the peels. In apple, concentrations of compounds have been reported as quercetin glycosides, 13.2 mg/100 g fruit; phloretin glycosides, 5.59 mg/100 g fruit; procyanidin B, 9.35 mg/100 g fruit; chlorogenic acid, 9.02 mg/100 g fruit; vitamin C, 12.8 mg/100 g fruit; epicatechin, 8.65 mg/100 g fruit. However, chlorogenic acid is found higher in the flesh than in the peel.

6) Berries (*Vaccinium corymbosum*)-

The berries like blue or black barriers are help to break glucose in energy and it reduce the increased blood sugar or glucose by considerable amount. The berries are helpful to increase the release of insulin in common type. The blue berries also reduces the body fats, cholesterol and fasting the glucose level. The color of berries fruit also contains the phyto chemical that is having power. The blueberries contain 3.5% cellulose and 0.7% soluble pectin. More than 10% of fresh weight of the berry is composed of total

sugars. Glucose and fructose constitutes the predominant reducing sugars in blueberries. The acid content of ripe blueberries ranges from 1% to 2% and citric acid forms the primary organic acid (1.2%) in blueberries. Blueberries contain high levels of the amino acid arginine. Blueberries contain 22.1 mg of vitamin C per 100 g. Blueberry anthocyanins also play a key role against neurodegeneration in regard to inflammation. The major compounds detected were delphinidin 3-glucoside and delphinidin 3-galactoside and peonidin 3-arabinoside. The *Vaccinium corymbosum* leaf extract was found to be rich in polyphenolic compounds: two phenolic acids chlorogenic and caffeic acids and two quercetin glycosides.

7) Guava (*Psidium guava*)-

The guava fruit is rich in dietary fiber that helps ease constipation it is common diabetic complains. It also helpful lowers the chance of developing type 2 diabetic. The fruit also contains high amount of vitamin A and vitamin C it help to boost heart health in number of ways. The fruit contains higher potassium level and soluble fibers it is show good effect on heart health. The plants leaves contain high level of antioxidants and vitamins so it protects heart damage by free radicals. The guava fruit provides 12% of recommended of daily fiber intake. The leaves of plant are very effective in managing diabetes and controlling cholesterol level. Its skin contains a lot of phytochemicals in intuit fruit which is rich in vitamins (A & C), iron, phosphorus and calcium and minerals. The phenolic compounds in guava help to cure cancerous cells and prevent skin aging before time. The leaves contain many fungistatic and bacteriostatic agents and important oxidants. They contain 82.47% moisture, 3.64% ash, 0.62% fat, 18.53% protein, 12.74% carbohydrates, 103 mg ascorbic acid, and 1717 mg gallic acid equivalents total phenolic compounds. The fruits are often included among super fruits, being rich in dietary fiber, vitamins A and C, folic acid and dietary minerals such as potassium, copper and manganese. Generally broad, low-calorie profile of essential nutrients occurs in a single common guava. Guava leaves contains 9.73% protein on a dry weight basis. The proteins are large bimolecular composed of amino acids and act as building blocks of cells. Proteins play a major role in growth and maintenance, enzyme regulation, and cell signaling, and also as biocatalysts. Guava leaves are the rich source of minerals, such as calcium, potassium, sulfur, sodium, iron, boron, magnesium, manganese, and vitamins C and B. The higher concentrations of Mg, Na, S, Mn, and B. The major constituent of GL essential oil includes 1, 8-cineole and trans-caryophyllene. They contain 82.47% moisture, 3.64% ash, 0.62% fat, 18.53% protein, 12.74%

carbohydrates, 103 mg ascorbic acid, and 1717 mg gallic acid equivalents total phenolic compounds. The presence of terpenes, caryophyllene oxide and p-selinene produces relaxation effects. Guava leaves contain many compounds which act as fungistatic and bacteriostatic agents. Guava contains a higher content of vitamin C and vitamin A. Guava is also a very good source of the pectin which is an important dietary fiber. It has high content of flavonoids. The fruit contains saponin, oleanolic acid, lyxopyranoside, arabopyranoside, guaijavarin, quercetin and flavonoids. Essential oil is present in leaves which contain α -pinene, limonene, β -pinene, isopropyl alcohol, menthol, terpenyl acetate, caryophyllene, longicyclene and β -bisabolene. Oleanolic acid is also found in the guava leaves. Leaves have high content of limonene about 42.1% and caryophyllene about 21.3%. Leaves of guava have a lot of volatile compounds. The bark includes 12–30% of tannin and one source declares that it includes tannin 27.4%, or polyphenols, resin and the crystals of calcium oxalate. The tannin is also present in roots of plants.

8) Papaya (*Carica papaya*)-

The papaya plant has very effective in diabetes it is natural antioxidants. When the diabetic has prone to many ailments like heart damage or nerve damage caused by irregular blood sugar levels, the diet of papaya can obstruct future cell damage for better and longer life spans. The consuming of papaya fruit reduced risk of diabetes and cancer by improving blood glucose control in people with diabetes and lowering blood pressure. The small piece of papaya provides three gram fiber it is equivalent to seventeen gram of carbohydrates. It help to lower blood glucose level also improve blood sugar lipid and insulin level. The leaves of papaya also used as folk medicine for diabetes. The papaya fruits contain flavonoids and antioxidants it helps to keep sugar level in control. Papaya content vitamins A, B and C, proteolytic enzymes like papain and chymopapain which have Antiviral, Antifungal and Antibacterial properties, Papaya is used for treatment of a several diseases like corns, sinuses, eczema, cutaneous tubercles, glandular tumors, blood pressure, dyspepsia, constipation, amenorrhea, general debility, expel worms and stimulate reproductive organs. Papaya content vitamins A, B and C, proteolytic enzymes like papain and chymopapain which have Antiviral, Antifungal and Antibacterial properties, Papaya is used for treatment of a several diseases like corns, sinuses, eczema, cutaneous tubercles, glandular tumors, blood pressure, dyspepsia, constipation, amenorrhea, general debility, expel worms and stimulate reproductive organs. the leaf of papaya contain many active components, including enzymes

(Papain, Chymopapain, Caricain, Glycyl endopeptides), alkaloids (Carpaine, Pseudocarpaine, Dehydrocarpaine I and II, Nicotine, Choline, Bispiperidine, Carpinine), Flavonoids (Myricetin, Kaemferol, Quercetin), Phenolic compounds, (Caffeic acid, Pcoumaric acid, Chlorogenic acid), Glycoside (Carposide), Cardiac glycoside (Cardenolids), Glucoside, (Cyanogenic glucoside, Benzylglucosinolate), Carotenoids (β -carotene, Lycopene, Lutein, Cryptoxanthin, Violoxanthin, Zeaxanthin), Vitamins (Thiamine, Riboflavin, Niacin, Ascorbic acid and tocopherol), Amino acids (Tryptophan, Methionine, Lysine), Electrolytes and Minerals (Ca, P, K, Mg, Zn, Mn, Fe) and other compounds Cystatin, Saponins, Tannins.

9) Gurmar (*Gymnea sylvestre*)-

The plant gurmar leaves contain triterpenoid saponins, flavonols and gurmardin it is help in diabetes. Its effect shows against high blood sugar level. It is also used as cardiovascular stimulant. It has effective against diabetes type-2 due to its anti-inflammatory and antioxidant property. It prevent pancreatic cell against damage caused by free radicals and increase insulin secretion so lowers the blood sugar. The sylvestre has good prospects in the treatment of diabetes as it shows positive effects on blood sugar homeostasis, controls sugar cravings, and promotes regeneration of pancreas. Several plant species being a major source of terpenoids, flavonoids, phenolics, coumarins, and other bioactive constituents have shown reduction in blood glucose levels Other phytoconstituents include anthraquinones, flavones, hentriacontane, pentatriacontane, phytin, resins, tartaric acid, formic acid, butyric acid, lupeol, β -amyrin related glycosides, stigmasterol, and calcium oxalate. The presence of alkaloids had been detected in plant extracts. Leaves of *G. sylvestre* have acidic glycosides and anthraquinones and the derivatives.

10) Pimple (*Ficus religiosa*)-

It is evergreen plant considered as sacred plant; it emits more oxygen so it is medicinally important plant. Peoples root, bark, leaves and fruits used to manage high blood sugar level and other issues like asthma and constipation. It has show anti diabetic properties containing sitosterol- D-glucoside and phytosterolin. This contains prevents the damage of pancreatic cell caused by free radicals and insulin secretion. It is help to lowering blood sugar level. The leaves are rich in amino and fatty acids, as well as terpenoids. The latex of *F. religiosa* contains serine protease named Religiosin B and C. Chemical analysis showed that *Ficus religiosa* contained tannins, phenols, saponins, sugars, alkaloids, methionine, terpenoids, flavonoids, glycosides, proteins,

separated amino acids, essential and volatile oils and steroids. The barks of *Ficus religiosa* contained bergapten, bergaptol, lanosterol, β -sitosterol, stigmasterol, lupen-3-one, β -sitosterol-d-glucoside (phytosterolin), vitamin k1, tannin, wax, saponin, leucoanthocyanidin, leucoanthocyanin, and α -amyrin acetate. Fruits contained protein 4.9%, amino acids, isoleucine, phenylalanine, asparagine, tyrosine, flavonols (kaempferol, quercetin, and myricetin), undecane, tridecane, tetradecane, (e)- β -ocimene, α -thujene, α -pinene, β -pinene, α -terpinene, limonene, dendrolasine, dendrolasine α -ylangene, α -copaene, β -bourbonene, β -caryophyllene, α -trans bergamotene, aromadendrene, α -humulene, alloaromadendrene, germacrene, bicyclogermacrene, γ -cadinene and δ -cadinene [65, 67, 70-71]. The major components of *Ficus religiosa* leaf oil were identified to be Eugenol (27.0%), Itaconic anhydride (15.4%), 3-Methylcyclopentanone-1,2-dione (10.8%), 2-Phenylethyl alcohol (8.0%), and Benzyl alcohol (4.2%). However, the leaf contained 44 compounds including (%): (3Z)-Hexenol 1.1, (2Z)-Hexenol 0.7, n-Hexanol 0.7, Phenol 0.7, Adipoin 0.6, 3-Methylcyclopentanone-1,2-dione 10.8, Itaconic anhydride 15.4, Benzyl alcohol 4.2, Salicylaldehyde 1.5, Phenylacetaldehyde 0.6, Allyl caproate 3.5 and Linalool 0.3.

In India Kerala state is capital of diabetes, its prevalence is high up to 20% double to the national average the national average is 8%. In the adult age of 20 years the average in India is 5.5% in 1990 but it increase 7.7% in 2016. In world China is country shows highest number of diabetes it having 141 million people suffer from diabetes up to 2025 it increases about 175 million. The diabetes is ninth leading cause of the death in the world it has estimated 1.5 million deaths in 2019. In which the highest death occur in Western Pacific region over 717,000 people died in 2021. In 2025 three quarters of world's 300 million adults occur with diabetes. In India the prevalence ranges 10.9% and in rural area 14.2% among it 20 years population shows higher prevalence. In India per capacity calories taken from non vegetarian food is lowest in Northern states like Rajasthan and Haryana here the percentage of adult population living with diabetes is lowest. The International Diabetes Federation states that 8.8% people in world lives with diabetes. It expected in 2040 up to 642 million. In world the highest diabetes peoples occur in Marshall Islands is 30.5%, in the Kiribati it is 22.5% the Tuvalu shows the 22.1% as same to Sudan. In the Mauritius 22% people lives with diabetes, the New Caledonia has shows 21.8% the Pakistan is 19.9%, French Polynesia 19.5%, Solomon Islands 19% and Guam 18.7%. In 1980 the number of diabetic people was 108 million it increase 422 million in 2014. The diabetes causes blindness, kidney failure,

heart attack, stroke and lower limb amputation. The healthy diet, physical regular activity, maintains normal body weight and avoiding tobacco use prevent type 2 diabetic. In 2014 adult aged 8.5% diabetes people occurs, in 2019 the people causes 1.5 million and 48% all deaths occurs. Today 1.2 million children and adolescents live with type 1 diabetes, 541 million adults increased risk of type 2 diabetes. In India in 1990 only 26 million peoples cause by diabetes it grows in 2016 up to 65 million.

Conclusion-

Plant provides us with food, fiber, shelter, fuel and medicine. Life on earth only depends on plants. Plant is real wealth of every nation; it used from the early civilization as source of medicine of all types diseases. Plants occupy important place in modern and traditional medicine in all over the world. A history of medicine in India traced to past form Rig Veda. In the world first written record of medicinal plants appeared from Sumerian and Babylonian physicians around 3000 BC. The diabetes is ninth leading cause of the death in the world it has estimated 1.5 million deaths in 2019. It is mainly occur by changing of lifestyle it increase blood glucose; it also called blood sugar is too high. It is source of energy comes from the food; the insulin is made by hormone by pancreas it helps glucose from food get into cell. The glucose of blood not reaches to cell. Diabetes is chronic disorder of carbohydrate, fat and protein metabolism characterized by fasting increase and post parandial blood sugar level. The global prevalence of diabetes is occur 4% in 1995 and it increase up to 5.4% in 2025. In India about 33 millions adults affected by diabetes it also increase 57 million up to the 2025. The diabetes mellitus is a complex metabolic disorder resulting from either insulin insufficiency or insulin dysfunction. The World Health Organization (WHO) has listed 21,000 plants, which are used for medicinal purposes around the world. Among these 2500 species are in India, out of which 150 species are used commercially on a fairly large scale. India is the largest producer of medicinal herbs and is called as botanical garden of the world. The use of different plants in diabetes is occurring in India by the using of this wealth the prevention of diabetes is necessary for healthy life.

References-

1. Ali M.(1998), 'Text book of Pharmacogeny' New Delhi CBS publication
2. Chopra R.N. (1982) 'Indigenous drugs of India' Calcutta Acadmic press publisher
3. Das Kundal (2009) 'Medicinal Plants' New Delhi Kalyani publication

4. Kamlakar Tripathi and Anju Maheshwari (2015) 'Fundamentals of Diabetes' New Delhi Jaypee Brothers Medical Publisher Publication.
5. Pandey B.P. (2014) 'Economic botany' New Delhi S. Chand And Company publication
6. Pandey B.P. (1982) 'Taxonomy of Angiosperms' New Delhi S. Chand And Company publication
7. Ralph A De Fronzo (2015) 'Text book of Diabetes Mellitus' Canada, Johan Wiley Publication
8. Shubhrata R. and Mishtra (2014) 'Cultivation technology of house plants' New Delhi Discovery publishing house publicatuon
9. Sing Sadhana (2014) 'Economic botany' New Delhi Blank printer publication
10. Shukla V.K. and Shenai S.K. (2013) 'Economic botany' New Delhi Campus books international publication
11. Wee, Y. C. (2003) Tropical trees and shrubs: A selection for urban planting. Singapore: Sun Tree publishing, publication
12. Zingare A. (2014) 'Medicinal and poisonous plants' New Delhi Sonali publication