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DEPARTMENT OF CHEMISTRY
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FOREWORD

‘Entropy', the departmental magazine of Chemistry will be 5 volumes old.

In this short span, it has established its credentials as a platform for serious discourse in the discipline.

'Chemistry in Food' is the theme of current publication. The sheer breadth of the issue has warranted two consecutive volumes i.e. volumes 5 and 6 to be published simultaneously.

The fledgling Honours Department must be commended for choosing to deliberate on an issue that is not only eminently relevant and topical to our times, but also because knowledge about the food we consume is so integral to our lives.

The salience and awareness of healthy, immunity boosting food has never been so crucial as in the present times. Having appropriate information on food and beverages that we consume on a daily basis enables a balanced diet that is of paramount importance in maintaining optimum physical and mental health.

I am sure that the two volumes will dwell on and address at length the huge knowledge bank on naturally obtained food, on the science governing colour, texture and flavour of foods, on the important role that chemical substances play in food production and preservation as also significant dimensions of food spoilage, microorganisms etc.

I look forward to these two volumes for the value it will add to the existing knowledge base and also for its contributions towards future research and academic enquiry.

My sincere congratulations and best wishes to the Editorial Team.

Dr Aditi Dey

Principal

FROM THE EDITORS DESK

It gives us immense pleasure to be able to present the 5th volume of "Entropy", the annual departmental journal of the department of chemistry. The year 2020 was a very different one for us in terms of a drastic change that was introduced into the teaching-learning process owing to the worldwide COVID 19 pandemic. The situation, unfortunately, has not changed in 2021. We are glad that despite the difficulties, the combined efforts of the students and teachers of the department has made it possible for us to publish the 2020-2021 issue of this journal.

The current issue is a continuation of the 5th volume of Entropy based on the theme 'Chemistry in Food, Volume 2'. Food is an essential part of our lives and its chemistry involves not only the molecular constitution of the food we consume but also knowledge about preservatives, food colours, additives, and so on. Detailed insight into the composition of our regular diet not only helps in maintaining a balanced eating habit but also makes us aware of the proper ways of treating and cooking various types of food ranging from our regular staples to different exotic varieties. We are happy that through the articles our students have tried to touch on every important aspect of food chemistry.

In the last section of the magazine a student project on heavy metals in cosmetics with the title ‘MAKEUP, A BEAUTY GIMMICK: BOON OR BANE?’ has been published. With the immense popularity of makeup products now, particularly amongst the youth of today, we thought the literature review would be an eye-opener for our students.

We express our sincere gratitude and thanks to our principal, Dr. Aditi Dey for her constant encouragement in this endeavour. The editorial team would also like to thank the college administration for their support. Lastly, a big thank you to all the students of the department without whose contributions this issue would not have come to life.

Dr. Agnita Kundu

Smt. Sohini Chakrabarti

Dr. Madhulika Ghose

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DEPARTMENTAL ACTIVITIES

This year has been one of a kind in all respects. The college has been closed due to COVID-19 pandemic since 16th March 2020 and all classes and activities have shifted to online mode. We have been successfully using the online platform IMPARTUS to carry on with our lessons. The department takes pride in the determination and resilience of the students who have taken part in various activities in this situation, even as all of us have struggled to adjust to the "NEW NORMAL".

The departmental practice of "Sharing of Research Experience" was continued with Dr. Madhulika Ghose, presenting a part of her doctoral research work for the benefit of our students on 12.06.2020. The department hosted an online student seminar on 'COVID-19: EFFECT OF LOCKDOWN FROM STUDENTS' PERSPECTIVE' in two parts on 19th and 29th of June, 2020. Here the 4th semester students gave power point presentations of 15 minutes each on various aspects of the lockdown. The topics chosen by the students are given below:

Name	Topic
Poushali Dey	COVID-19: The Pandemic Situation
Mrittika Sarkar and Sinchani Dutta	Mental Health in the Pandemic
Muskan Sharma and Soumyashree Mitra	Amphan: A Tale of Disaster
Pushpanjali Singh	Effect of lockdown due to COVID-19 on Education
Mitil Biswas and Srijoni Dey	The environmental impact of COVID-19
Shaheli Mondal	The impact of lockdown on Industries
Rittika Chakraborty	Medical situation of India

The department is extremely proud to have hosted a two-day International webinar on 'History of Science' in collaboration with Institute of Science, Education and Culture (ISEC) and Indian Chemical Society. It was attended by more than 180 registered participants including faculty, research scholars, PG and UG students. The book of abstracts was published with an ISBN No. 978-93-81042-00-7 by the collaborators ISEC. The submitted papers have been published after peer review in the September 2020, November 2020 and January 2021 issues of Indian Science Cruiser, the international

journal published by ISEC (ISSN No: 0970-4256). Both the days of the seminar were graced by experts on the subject, whose deliberations consisted of the first half, while faculty, research scholars and PG students presented their papers in the second half. The detailed schedule is given at the end.

We were pleasantly surprised by an online video presented to us by the students of the 4th semester on the occasion of Teachers' day on 5th September, 2020. The senior batches also arranged for an online freshers' welcome for the new entrants on 22nd December, 2020. The sharing of research experience continued with Dr. Subhadeep Ghosh presenting to the students a part of his research work on 30th January, 2021. The students also took part in various online events like essay writing, quiz, poster-making conducted by our college as well as by other colleges. Students of the 4th Semester have completed two student research projects under guidance of the departmental faculty. The first one by Apurba Roy, Arpita Das, Disha Ghatak, Soumata Sanyal and Tanaya Dey, titled 'MAKEUP, A BEAUTY GIMMICK: BOON OR BANE?' is a literature review of the heavy metals in cosmetics and has been published in this issue of 'ENTROPY'. The other project titled 'HEAVY METAL CONTAMINATION IN CROPS OF WEST BENGAL' by Aditi Maiti, Mousnita Palit, Sumedha Thakur, Samiya Islam, Sneha Paul and Eram Tahseen will be published in 'IMPACT', the journal of the Central Research Committee of Shri Shikshayatan College. The faculty has also taken part in various webinars and online workshops on relevant topics. The department of Chemistry is determined to continue with the tradition of students' upliftment through a variety of relevant activities, in suitable ways, even amidst this difficult time.

SCHEDULE of TWO DAY INTERNATIONAL WEBINAR on HISTORY OF SCIENCE

DAY 1: 27.07.2020

SESSION 1 - MORNING (10:30 AM-1:30 PM)

10:30 AM-11:00 AM - INAUGURAL SESSION

- Welcome Address by Dr. Aditi Dey, Principal , Shri Shikshayatan College
- Inaugural Speech by Padmashri (Prof.) G.D. Yadav , President, Indian Chemical Society, Emeritus Professor of Eminence and J C Bose National Fellow, Institute of Chemical Technology, Mumbai.
- Inaugural Speech by Prof. Anil Kumar Ghosh, President, Institute of Science, Education and Culture

11:00 AM - 1:30 PM - TECHNICAL SESSION 1

Session Chair: Dr. Dulal Chandra Mukherjee, Former Professor, Department of Chemistry, University of Calcutta, Formerly President and Honorary Secretary, Indian Chemical Society.

- Keynote Address: Prof. Syamal Chakrabarti, Professor, Department of Chemistry, University of Calcutta.
- Invited Lecture: Padmashri (Prof.) G.D. Yadav , President, Indian Chemical Society, Emeritus Professor of Eminence and J C Bose National Fellow, Institute of Chemical Technology, Mumbai.
- Vote of Thanks for the session - Smt. Sohini Chakrabarti, Department of Chemistry, Shri Shikshayatan College

1:30 PM - BREAK (30 mins)

DAY 1 : 27.07.2020

SESSION 2 - AFTERNOON (2:00 PM - 4:30 PM)

2:00 PM - 3:30 PM - TECHNICAL SESSION 2

Session Chair : Dr. Swapna Mukherjee, Vice President , Institute of Science , Education and Culture, Formerly Director, GSI, Government of India.

1. Invited Lecture - Dr. Kaushik Bharati , Advisor , Science Advisory Board, Arlington, Virginia, USA
2. Invited Lecture - Prof. Santanu Das , Professor , Department of Mechanical Engineering, Kalyani Government Engineering College

3:30 PM - 4:30 PM - TECHNICAL SESSION 3
Oral Presentations by registered participants (8+2) mins each

Session Chair: Dr. Swapna Mukherjee, Vice President , Institute of Science , Education and Culture, Formerly Director, GSI, Government of India.

1. Life Changing Discoveries In Science : Contribution Of India - Dr Sarbani Pal
2. Looking Back at Ayurveda In Ancient India and Reemergence of it in modern India-Dr. Agnita Kundu
3. Historical Background Behind The Innovation Of Science- Dr. Dola Chakraborty
4. The Development Of Modern Genetics : History Of Unfolding The Mystery Of Inheritance- Smt. Sohini Chakrabarti
5. Emergence Of Oligonucleotide Drugs-Dr. Jharna Barman Nandi
6. 'Lilavati's Daughters- The Women Scientists of India': A Book Review- Dr. Madhulika Ghose

- Vote of Thanks for the session: Dr. Agnita Kundu (Department of Chemistry , Shri Shikshayatan College

DAY 2 : 28.07.2020
SESSION 1 - MORNING (10:30 AM - 12:30 PM)

10:30 AM - 12:00 NOON - TECHNICAL SESSION 4

Session Chair: Prof. Syamal Chakrabarti, Professor, Department of Chemistry, University of Calcutta.

1. Invited Lecture - Dr. Supratim Ghosh , Associate Professor, Food and Bioproduct Sciences, College of Agriculture and Bioresources , University of Saskatchewan, Canada

2. Invited Lecture - Dr. Manas Pratim Das , Programme Producer , All India Radio , Akashbani Bhawan, Kolkata

12:00 NOON - 12:30 PM - TECHNICAL SESSION 5
Oral Presentations by registered participants (8+2) mins each

Session Chair: Prof. Syamal Chakrabarti, Professor, Department of Chemistry, University of Calcutta.

1. History of Plastic- A retrogressive Journey from being a promising invention to inevitable spoiler-Mrs. Aradhana Chaudhary
2. A Study On The History Of Medical Tourism- Doyel Aich
3. Ancient Drug Development In India With Special Reference To Indigenous Knowledge - Dr. Lovely Sarkar
4. Philosophy Of Genetics - A Study On Its Genesis Through The Ages-Arnab Ganguli

- Vote of Thanks for the session : Dr. Madhulika Ghose (Department of Chemistry, Shri Shikshayatan College)

12:30 PM- BREAK (30 mins)

DAY 2 : 28.07.2020

SESSION 2 - AFTERNOON (1:00 PM - 3:30 PM)

Oral presentations by registered participants - Parallel Sessions

PARALLEL SESSION 1

1:00 PM – 2:30 PM (Oral presentations by PG students and Research Scholars)

(6+2) mins each, COMPETITIVE SESSION

Session Chair and Judge: Dr. Saurabh Das, Associate Professor, Department of Chemistry, Jadavpur University

1. History of smallpox vaccination: a journey from culture to science- Sumouli Bhadra and Saurabh Chakraborti
2. The genesis of the IIT system: Were there global/national/local factors at play? Sunayana Maiti, Sujata Banerjee
3. Diversity, indigenous and sacred values of medicinal plants of Nagaland/North-easternIndia – A study correlating history of tribal medicine with recent commercially available drugs- Soching Luikham and Jhimli Bhattacharyya
4. A Comparative Statistical Study between Spanish Flu and COVID 19- Smritimayee Sarma and Dr Bandana Sharma
5. Yohimbine: A traditional plant based medicine – history, origin, application(s) and binding phenomenon - Vibeizonuo Rupre-o and Jhimli Bhattacharyya
6. Swami Vivekananda – The pioneer of technical science and education - Nirmalya Mondal
7. Physicochemical Insights into Mode of Action of Inhibitors on Protein Misfolding and Fibrillation/Aggregation-Ritutama Ghosh and Nand Kishore
8. The History Of Development Of Gas Metal Arc Welding Process -Tapas Bera
9. Science and its history - Shatadru Chaudhuri

2:30 PM- 3:30 PM (Oral Presentations by registered participants (8+2) mins each)

NON COMPETITIVE SESSION

1. Saga From The Prehistoric Graveyards: Ancient DNA Technology Is Rewriting The Population History Of The Indian Subcontinent - Pallab Sarkar
2. 'PATACHITRA in NATURAL COLOURS : Its journey with time' – Dr. Amrita Mondal
3. COVID-19 and Dissemination of Scientific Information: Analysis of New Social Equation amid Pandemic-Debolina Guha Thakurta and Mayukh Lahiri
4. History of Schiff bases, different kinds of Schiff bases and preparation of metal complexes with Schiff bases- Sri Manas Layek
5. A Report On The History And Development Of Soil Reinforcement -Anasuya Goswami And Dr. Shailen Deka

PARALLEL SESSION 2

Session Chair: Dr. Bandana Barman, Faculty member, Department of Electronic and Communication Engineering, Kalyani Government engineering College

1. Indian Quantum Communication Enabled Space Security-Supriyo Banerjee
2. Time Series Analysis: A Brief History And Its Future Challenges-Koushik Ghosh,
3. The Journey of Statistics as a Subject- from the Past to Present- Somdutta Roy
4. The voyage of Solar Cells from Silicon to Perovskites- Dr. Romyani Goswami
5. Overview on progress of research in Plasma Physics for a promising future-S.Nasrin and M.Bose
6. Evolution of Dusty Plasma-Avik Kr. Basu and Mridul Bose
7. Chronological progress for finding the true nature of the strongest force in universe - S.H.Mondal, Dr.Md.A.Khan
8. Asian Influences on Renaissance Mathematics-Dr. Rupa Pal
9. Disability in India in 1990 and 2019 - Some Statistical Observations- Dr. Jumi Kalita,

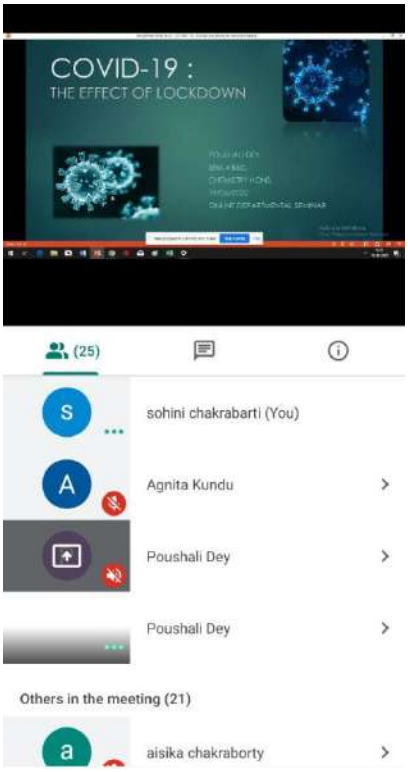
10. Convalescent Plasma Therapy: How We Survived Through The Centuries-Dr. Shakuntala Ghorai
11. History of the development of constitutive equations for strain-rate-metry from microstructures – Bhaskar Ghosh

PARALLEL SESSION 3

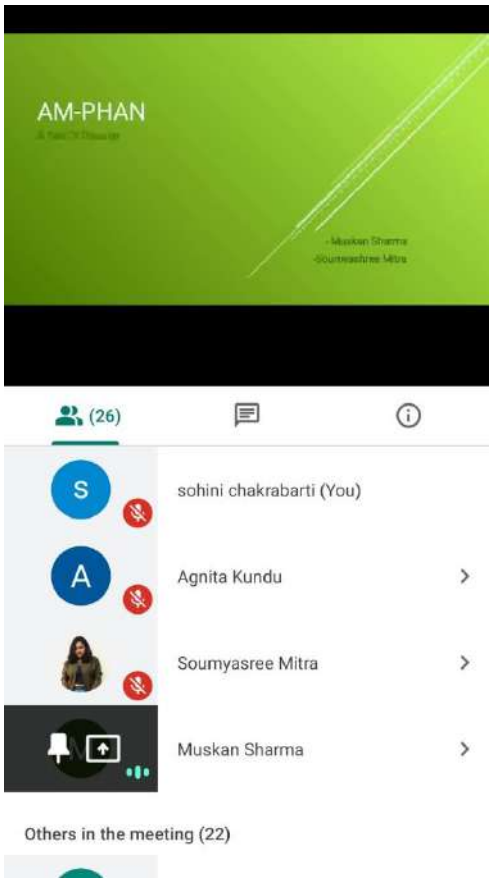
Session Chair: Dr. Kaushik Bharati, Advisor , Science Advisory Board, Arlington, Virginia, USA

1. History Of Development Of Some Popular Organic Pharmaceuticals -Dr. Santarupa Thakurta
2. The History Of Synthetic Organic Chemistry: A Journey From Urea To Taxol - Biswajit Gayen
3. Development Of Some Spectroscopic Instruments Used For Structure Determination In Research Purposes-Dr. Tanmay Mathur
4. Vegetable Oils As A Green Biolubricant- Mainul Hoque & Pranab Ghosh
5. Colour: The Fascinating World- Debarati Dey
6. Evolution Of Cancer Treatment- Dr. Moumita Gangopadhyay
7. Donor-Acceptor Cyclopropanes : Reactivity and Application in Organic Synthesis -Dr. Subhadeep Ghosh,
8. Bioprospecting Of Metals From Indian Chromite Mining Overburden – An Overview-Dr. Suchhanda Ghosh And Prof. A. K. Paul
9. Analysis Of Arsenic Content In Ground Water Over The Years Of Coastal Areas Of Purba Medinipur In West Bengal- Souvik Chakraborty And Subhasis Das
10. In Vitro Fertilization: A Boon Of Twentieth Century-Kantisree Goswami
11. A Historical Perspective on Impact of Diet as Major Environmental Source for AGEs in Humans -Koushik Chandra
12. Research Development Of DNA Damage Repair Mechanisms In Human Physiology - Mitrabrata Goswami

Sharing of research experience by Dr. Madhulika Ghose of the Department of Chemistry on 12/06/2020

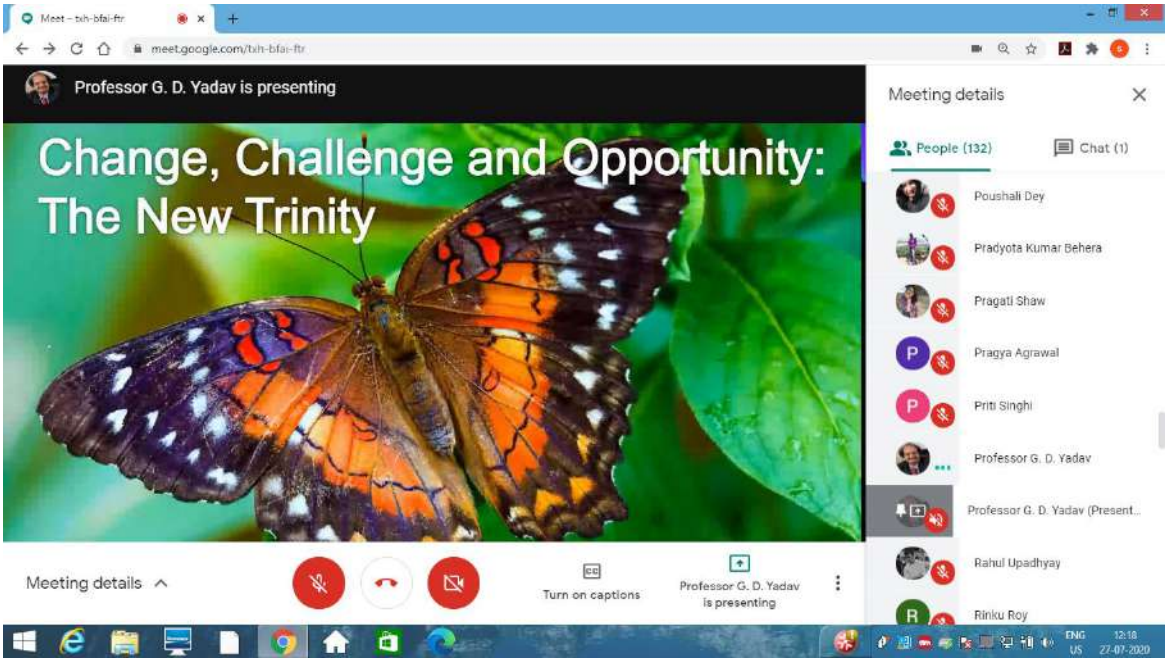


A presentation in the student webinar held on 19/06/2020



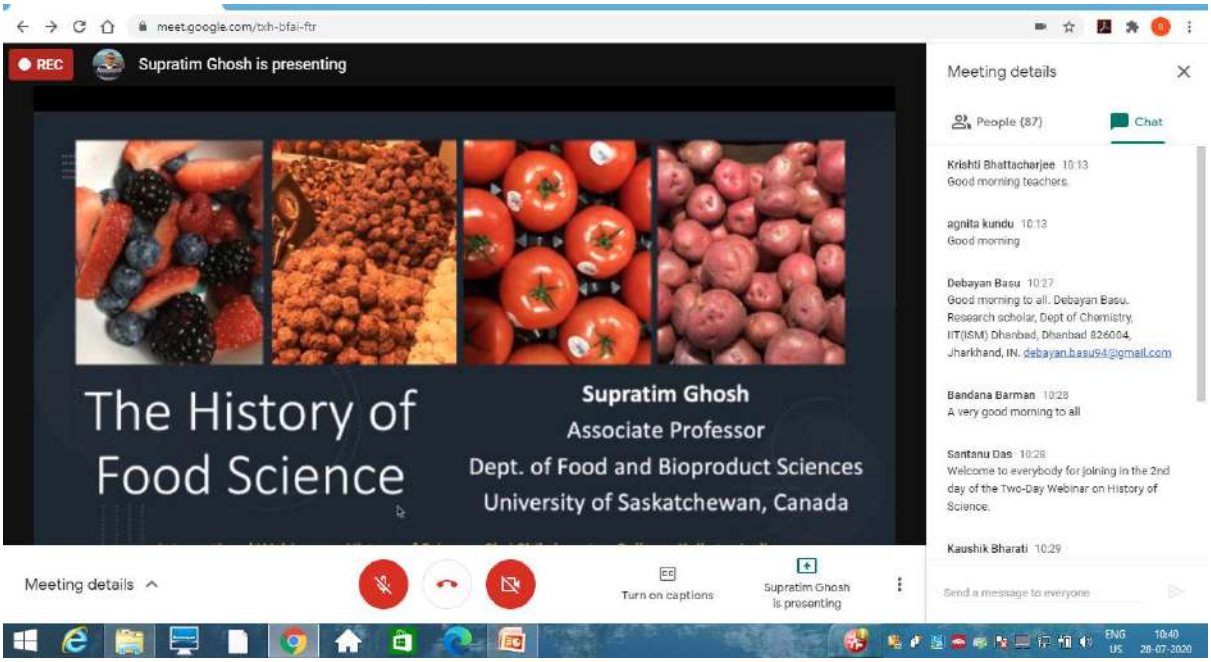
Presentations in the student webinar held on 29/06/2020

Two-day International webinar on History of Science held on 27/07/2020



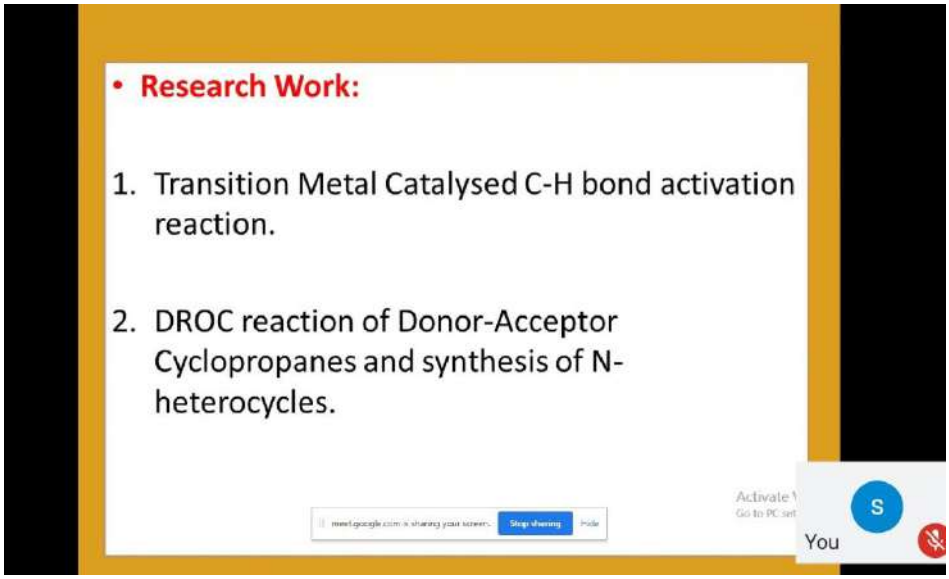
Talk by Prof. G. D. Yadav in the International Webinar on History of Science

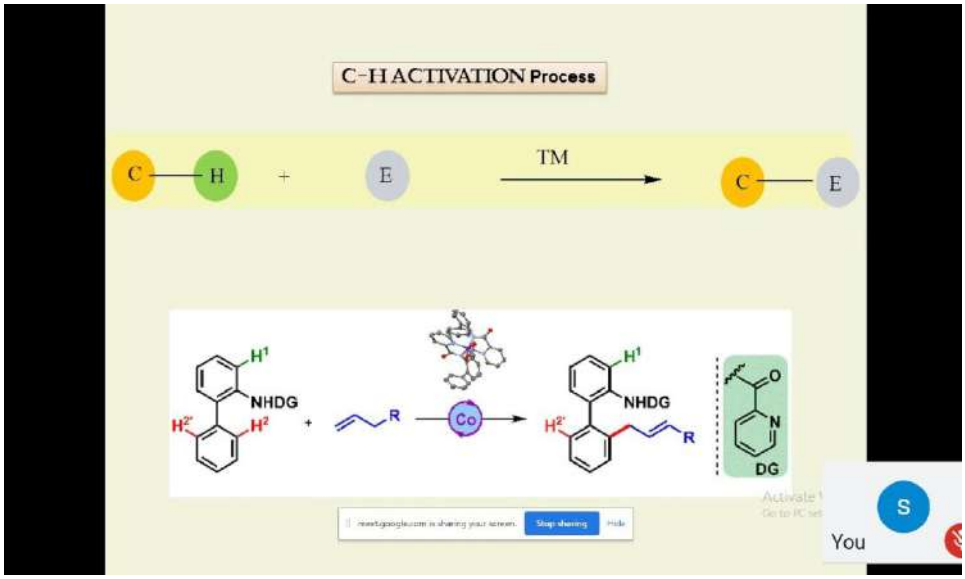
Talk by Prof Syamal Chakrabarti in the International Webinar on History of Science



Talk by Dr. Supratim Ghosh in the International Webinar on History of Science

Departmental Freshers Welcome held on 22/12/2020





Sharing of research experience by Dr. Subhadeep Ghosh on 30/01/2021

IMMUNITY BOOSTING FOODS TO FIGHT COVID-19

Upasana Chatterjee, Soumata Sanyal, Eram Tahseen

(4th Semester)

Chemistry Honours

Introduction

A coronavirus is a kind of common virus that causes an infection in your nose, sinuses, or upper throat. Most coronaviruses aren't dangerous. In early 2020, after a December 2019 outbreak in China, the World Health Organization identified SARS-CoV-2 as a new type of coronavirus. The outbreak quickly spread around the world. It spreads the same way other coronaviruses do, mainly through person-to-person contact. Infections range from mild to deadly.

Discussion

How immunity is needed to fight against COVID19

A strong immune system helps to keep a person healthy. Some specific foods boost the immune system. The immune system consists of organs, cells, tissues, and proteins. Together, these carry out bodily processes that fight off pathogens, which are the viruses, bacteria, and foreign bodies that cause infection or disease. When the immune system comes into contact with a pathogen, it triggers an immune response. The immune system releases antibodies, which attach to antigens on the pathogens and kill them.

Supplements and immunity boosting foods.

i) Vitamin C: This particular vitamin is a crucial participant in the army of immunity. It helps prevent the common cold. It acts as a powerful antioxidant and protects against damage induced by oxidative stress. For severe infections, including sepsis and acute respiratory distress syndrome (ARDS), high dose of intra intravenous vitamin C treatment has been shown to significantly improve symptoms in patients.

ii) Vitamin D: Vitamin D supplements have a mild protective effect against respiratory tract infections. Most people are deficient in Vitamin-D, so it's best to consult with a doctor about taking a Vitamin D supplement to boost immune response.

iii) Zinc: Zinc is a vital component to WBC (white blood corpuscles) which fights infections. Zinc deficiency often makes one more susceptible to flu, cold and other viral infections. It is advisable to take a zinc supplement, especially for older people.

iv) Elderberry: Elderberries are full of nutrients including minerals like phosphorus, potassium, iron, copper and vitamins, such as vitamin A, B, and C, proteins and dietary fibre. Elderberries have antibacterial and antiviral qualities which help fight cold and influenza.

v)Turmeric and Garlic: The bright yellow spice, Turmeric, contains a compound called Curcumin, which boosts the immune function. Garlic has powerful anti-inflammatory and antiviral properties which enhances body immunity.

vi) Yogurt: Yogurt is a natural probiotic and aids in the formation of good bacteria in our body. Remember, it has to be freshly made. If you have sore throat regardless of the cause, yogurt might worsen it but for better immunity, you need probiotics so you can resort to supplements.

Apart from maintaining a healthy lifestyle and taking supplements, the Indian health ministry is also suggesting few organic and natural ways to practise as preventive measures to fight COVID-19. The Ministry of AYUSH has recommended the following self-care guidelines as preventive measures and to boost immunity with special reference to respiratory health.

- Drink warm water throughout the day.
- Practice Meditation and Pranayama.
- Increase the intake of Turmeric, Cumin, Coriander and garlic.
- Drink herbal tea or decoction of Basil, Cinnamon, Black pepper, Dry Ginger and Raisin.
- Avoid sugar and replace it with Jaggery if needed.
- Apply Ghee (clarified butter), Sesame oil, or Coconut oil in both the nostrils to keep the nostrils clean.
- Inhale steam with Mint leaves and Caraway seeds.

Conclusion

A nutritious diet and an optimally functioning immune system can never go wrong. If you have a healthy immune system, your body can safeguard you from any disease, even the novel coronavirus or COVID-19. While as of now, there is neither any vaccine available nor proven home remedy to protect you from the COVID-19, there are some vitamins and foods which you can inculcate in your diet to have a strong immune system and in turn, fight the infectious disease. To ensure hand hygiene, experts and doctors recommend washing hands with soap or using an alcohol-based rub, regularly. While hand sanitizers do kick away germs, they take good bacteria essential in building immunity, as well. While the battle against the Covid-19 pandemic is fought by our health care workers, we can do our bit by limiting our exposure to the virus by staying indoors, social distancing, eating healthy, hydrating and following basic hygiene protocol.

CHEMICAL CONTAMINANTS IN FOOD AND THEIR HAZARDS

Arpita Das, Sumedha Thakur

(4th Semester)

Chemistry Honours

Introduction

The phrase chemical contamination is a clear indication of the presence of chemicals where they should not be or are present in an amount that is in a higher concentration than the amount that is attributed as safe. The chemical hazards are one of the main causes of food contamination that are associated with foodborne disease outbreaks. The origins of chemical contaminants are various from the field to the plate, namely soil, environment, disinfection by-products, personal care products, air, water, and packaging material. Chemical contaminants inhibit almost all the mass-produced everyday use products such as disinfectants, plastics, detergents, deodorants, pesticides, and so on. Even the food that is consumed and the water that is taken is not safe from the invasion of chemicals in unsafe concentrations. Food contamination, whether accidental or intentional, is an unfortunate act that brings in its wake numerous serious implications on the human health. Food contamination has been recorded in history for as early as 8,000 years ago; however, the growth in agribusiness and globalizations have aided the problem in spreading all over the planet. The US Centre for Disease Control and Prevention confirmed more than 11,000 foodborne infections in the year 2013, with several agents like viruses, bacteria, toxins, parasites, metals, and other chemicals causing food contamination. The symptoms of the foodborne illness due to chemical contamination range from mild gastroenteritis to obesity often breaks into the headlines as a result of its harmful consequences. A total of 1527 outbreaks of foodborne diseases were witnessed in the United States between 2009 and 2010, resulted in 29,444 illness cases and 23 deaths. Furthermore, food contamination has become more serious in recent years due to the development of industry and the consequent environmental pollution. Besides that, the ingestion of contaminated food with pesticides and heavy metals could cause gastrointestinal infections. For instance, an estimated 400 to 500 children died of acute lead poisoning due to ingestion of food contaminated with lead-contained soil and dust in Nigeria. Keeping such incidents in mind and the overall harmful health implications in the fore, this review examines the reasons and types

of chemical contaminants in food along with individual's exposure to such contaminated foods on a daily basis and further elaborates the health impacts of such food impurities.

Discusssions:

The reasons for food contamination:

Food is a crucial contributor to human health well-being and a major source of worry, pleasures, and stress, with one of the reasons behind the stress and worry, are the diseases caused as a result of contaminated food. There are multiple reasons for the contamination of food. Food preparation goes through a long chain of processing, where each stage is a potential source of chemical contaminants invasion of the food. Transportation of food can also lay the foundation for contamination of food, specifically under poor sanitary conditions. Likewise, some chemicals are mixed deliberately during the food preparation process to improve the shelf life of a food product. The contaminants may lead to impure food when cooked in the kitchen; nevertheless, the transmission is mainly dependent on the effectiveness of the kitchen hygiene though chemical contaminants enter the food chain naturally as well with pathogens that are present in the environment and show high bacterial numbers on some key raw foods such as poultry meat.

Types of food contaminants:

Food contaminants typically include environmental contaminants, food processing contaminants, unapproved adulterants and food additives, and contamination from packaging materials. Environmental contaminants are impurities that are either introduced by human or occurring naturally in water, air or soil. Food processing contaminants include those undesirable compounds, which are formed in the food during baking, roasting, canning, heating, fermentation, or hydrolysis. The direct food contact with packaging materials can lead to chemical contamination due to the migration of some harmful substances into foods. Further, use of unapproved or erroneous additives may result in food contamination.

Naturally occurring contaminants in food:

Several bacteria, viruses, and parasites inhabit the surfaces of the raw food naturally. Contamination of raw food can also occur due to the sewage, soil, external surfaces, live animals, the internal organs of meat animals. An additional source of contaminated food is the

food that originated from diseased animals although the health advancement has nearly eliminated this source of food contamination. Food contamination from the chemical sources includes the accidental mixing of chemical supplies in food or the chemicals in the animal feed or antibiotic injections given to poultry animals. Several parasites are also present in the food by symbiotic relations between the organism and the parasite. Numerous of these cause foodborne infections and outbreaks.

Contamination during the food production, processing, storage, and preparation phases:

Contaminants may be present in the food in their raw stages as a result of environmental sources of contaminants. During the transportation of food, common sources of contamination include the vehicle exhausts of diesel and petrol or cross-contamination in the vehicle being used for food transportation. Long-distance ships for transport are also often cross contaminated with chemicals used for disinfection or other sources. High barriers used for protection of food by wrapping it during long-distance transport are not always tested for their barrier properties, which makes it a cause of contamination. In the cleaning phase of food production and preparation, contaminants can invade due to the residues left from the disinfectants and cleaning agents on the surface of food handling equipment. Heating treatment in the production process is another source of contaminants. The use of high cooking temperature at homes and industries is the widely used method for food process. The use of high temperature for cooking paired with external factors potentially leads to the formation of toxic compounds that leave an impact on the food safety and quality. Toxic compounds such as nitrosamines chloropropanols, acrylamide, furanes, or PAHs are formed during the food processing methods like heating, roasting, grilling, baking, canning, fermentation, or hydrolysis. Frying is a leading source of generation of a range of toxic compounds in the food preparation processes. Additionally, microwave heating can also give birth to contaminants in food, as the common feature of microwave cooking is that the food is cooked in the container or wrapping film (packaging material) in the microwave oven. The microwavable packaging materials include paperboard, composites, and plastics and during the cooking components of these materials can transfer from the package to the food, resulting in a decline in food safety and quality. Food packing carries several advantages like physical protection and enhanced food protection; however, it still can pose a threat. Packaging processes make use of several additives like stabilizers, antioxidants, plasticizers, and slipping agents to improve the packaging material properties. Nevertheless, any direct or indirect contact with the food with the packaging material can result

in the transference of these substances from the packaging into the food. Such a phenomenon is termed as migration. When metallic cans are used in packaging, corrosion stands as a source of food contamination due to the migration of metallic ions to food. To avoid this, the inner side of cans are commonly coated with varnishes like epoxy resins to save from corrosion, but even the minor by-products from the epoxy resins manufacture like cyclo-di- BADGE, bisphenol A, or bisphenol A diglycidyl ether (BADGE) can migrate to food. Such compounds are known as endocrine disruptors. There is also the risk of non-intentionally added substances migrating from the packaging material to the food producing adverse effects.

Food storage is another step that can lead to toxins in food. Some of the contaminating factors include direct sunlight that speeds deterioration of food and packaging and adsorption of unwanted off-odours. Foods with longer shelf life contain flavours and colour that compromise with the nutritive value of food. Also, high fatty foods are prone to odour contamination.

Contamination due to environmental influences:

The biosensor assay format helps to determine the numerous environmental pollutants that cause food contamination. Several metals, primarily toxic heavy metals cadmium, mercury, lead, and polychlorinated biphenyl (PCB) enter through the industrial environment to contaminate food. A case in point is the industrial area of Huludao in Northeast China, which is seriously contaminated by heavy metals such as mercury, lead, cadmium, zinc, and copper due to the heavy metals smelting in the area. Plants form the base of the food chain, and they can easily absorb toxic substances from the soil, contaminating not only fruits and vegetables but also the seafood. The soil environment is another source of food contamination. Heavy metals from industrial areas can seep into the soil and enter into the food chain to infect the raw sources of food. Pesticides used as plant protection agents also enter into the food chain and human exposure to these chemicals shows a wide array of health problems like immune suppression, diminished intelligence, hormone disruption, cancer, and reproductive abnormalities. Approximately 3 billion kg of pesticides is applied every year around the world, which poses a serious threat, as the chemicals contaminate the raw sources of food. In the case of pesticides, however, the maximum residue level (MRL) is an important determinant of the risk it poses to human health. The pesticide residue levels in food are regulated by legislation to minimize its exposure to the consumer. However, in numerous underdeveloped countries, such legislation is not in place or is poorly enacted. Similar to pesticides are the residues of veterinary drugs in the farm animals that may remain in the meat and threaten the individual

through the exposure to these drug residues, transference of antibiotic resistance, and risk of allergies

Chemical contaminants in drinking water:

The issue of food consumption has evolved from a short trading chain between producer and consumer to a complex chain of various parties. Similar to food, drinking water is also at a risk of contaminants with serious health implications not only for the human life but also for the marine life and other organisms that consume the impure water. The sources of these contaminants are multiple including industrial and municipal discharges, natural geological formations, urban and rural run-off, drinking water treatment process, and water distribution materials. Human activities such as hydraulic fracturing and horizontal drilling have increased energy production, however, also increased the incidence of drinking water contamination. Drinking water sourced from groundwater can also be contaminated with heavy metals (e.g., nickel, mercury, copper, and chromium) which could resulted in increased cases of health defects of carcinogenic and noncarcinogenic nature, including faecal contamination . Such a source of contamination of the drinking water is particularly prevalent in low and middle-income countries. By-products of pharmaceuticals are also toxic and another identified source of water contamination by chemicals. Drinking water contaminants include several chemicals such as arsenic, aluminum, lead, fluoride, disinfection by-products, radon, and pesticides. Their health effects range from cancer, cardiovascular diseases, adverse reproductive outcomes, and neurological diseases. Analysis have also identified that the consumption of chemically contaminated water by mothers, specifically those who are less educated, show significant effects on the gestation of infants and birth weight of the baby.

The preventative measures to control food contamination:

There is legislation in place to regulate the levels of several chemicals in the food. Unhealthy additives and adulterants are legally not allowed for use. However, effective surveillance and response systems are required to prevent chemical hazards from entering the food supply and posing harm to the public. The FDA prescribes the minimum levels of chemicals that are allowed in food, such as pesticide concentration should not go higher than the limit assigned. However, errors may still occur in following the determined concentration and guidelines. Particularly in the case of developing and underdeveloped countries, the legislation enforcement is still weak about administrating the concentration of harmful contaminants in

the food. Some countries are highly dependent on agriculture, resulting in high levels of pesticides seeping into the ground water, contaminating both food and water. Non-regulated chemicals are of specific concern and more research needs to focus on contaminants that escape human detection. Also, individual consumer concerns are essential as they can play a fundamental role in managing their health. Moreover, the popularity and widespread use of internet also allow consumers to seek information online and reduce the health risks associated with food contamination incidents. The news media and journalists have an important role in reporting on the outbreaks, threat and its cause, including expert commentary regarding the chemical food contaminants. Furthermore, the public need to keep a healthy degree of scepticism about the contaminated food products reported on the news and avoid consuming the accused food products until scientific evidence justifies immediate action. Most importantly, the food industries must accept the need to be more honest and upfront in producing safe commercial food products as well as protecting the public from food contamination.

Conclusion

The chemical contamination of food has emerged as a serious concern with potential health hazards in their wake. Majority of the food contamination occurs through naturally occurring toxins and environmental pollutants or during the processing, packaging, preparing, storage, and transportation of food. As the technology advances, the detection of such contaminants becomes easier. However, there are several contaminants that are still unknown and research continues in this regard. Although the government has taken adequate steps to minimize the individual exposure to food contaminants, there are still measures that need to be taken to reduce the health risks and diseases that come with the chemical food contamination.

BEVERAGES

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(4th Semester)

Chemistry Honours

A **beverage** is a liquid intended for human consumption. In addition to their basic function of satisfying thirst, beverages play important roles in human culture. Common types of drinks or beverages include plain drinking water, milk, coffee, tea, hot chocolate, juice and soft drinks. In addition, alcoholic beverages like wine, beer and different kinds of liquors which contain ethanol, have been known to be a part of human culture for more than 8,000 years.

Figure 1: Depiction of hot drink (Tea)

History and Origin of Beverages

Drinks and Beverages in the Ancient World:

Water or Adam's ale as it is sometimes called is probably the first drinkable liquid known to mankind. However with the advent of farming people started inventing other drinks. Interestingly it is believed that beer was invented before writing and there are evidences to support the fact that in Ancient Egypt it was a common drink. In northern Europe the Celts also drank beer. After the Romans conquered Britain brewing continued. It is known that in the Ancient Middle East, as early as 4000 BC. There are various instances where alcoholic beverages have been an integral part of social customs. For instance "Toasting" a method of

honoring a person or wishing good will by taking a drink or the tradition of the" loving cup" at weddings or other celebrations such as a sports victory.

Drinking has been a large part of socializing throughout the centuries. In Ancient Greece, a social gathering for the purpose of drinking was known as a symposium, where watered down wine would be drunk. The purpose of these gatherings could be anything from serious discussions to direct indulgence. In Ancient Rome, a similar concept of a *convivium* took place regularly. Many early societies also considered alcohol a gift from the gods, leading to the creation of gods such as Dionysus.

Figure 2: Depiction of ancient drinking custom

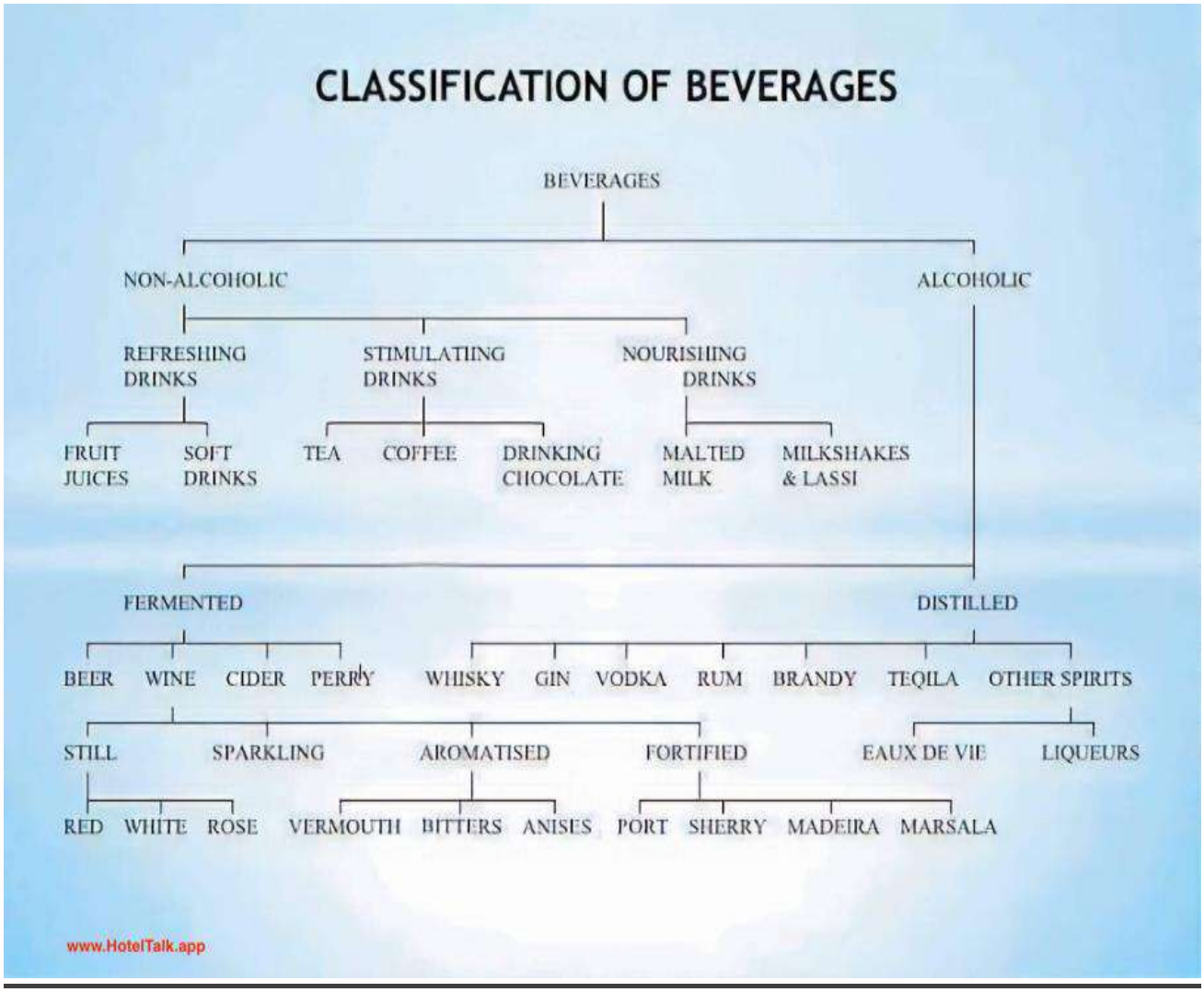

Figure 3: Classification of Beverages

Classification of Beverages

Technically a beverage is a product that has been packaged in a quantitative manner either for direct drinking or preparing a drinkable liquid by brewing in a certain proportion of water. Its role is to quench thirst, provide nutrition or refreshment. There are 3 major types of beverages, they are non-alcoholic beverages, hot drinks and alcoholic beverages.

Non-alcoholic drinks - first type of beverages

A non-alcoholic drink is one that contains little or no alcohol. This category includes low-alcohol beer, non-alcoholic wine, and apple cider if they contain a sufficiently low concentration of alcohol by volume (ABV). The exact definition of what is "non-alcoholic" and what is not depends on local laws: in the United Kingdom, "alcohol-free beer" is under

0.05% ABV, "de-alcoholised beer" is under 0.5%, while "low-alcohol beer" can contain no more than 1.2% ABV. The term "soft drink" specifies the absence of alcohol in contrast to "hard drink" and "drink". The term "drink" is theoretically neutral, but often is used in a way that suggests alcoholic content. Drinks such as soda pop, sparkling water, iced tea, lemonade, root beer, fruit punch, milk, hot chocolate, tea, coffee, milkshakes, and energy drinks are all soft drinks. Other examples include carbonated drinks, fruit and vegetable juice drinks, tea-based drinks, etc.

Figure 4: Different types of soft drinks

Hot drink - second type of beverage

Hot drinks refer to beverages like coffee, tea, hot chocolate etc. **Tea** is an aromatic beverage commonly prepared by pouring hot or boiling water over cured or fresh leaves of the *Camellia sinensis*, an evergreen shrub (bush) native to East Asia. Tea originated in the region encompassing today's Northeast India, North Myanmar, Southwest China and Tibet, where it was used as a medicinal drink by various ethnic groups in the region. The stimulating effect in tea may be attributed to chemicals like theobromine and caffeine. The tannins and polyphenols present in tea are also known have various health benefits

Figure 5: Tea and Tea leaves

Coffee is a brewed drink prepared from roasted coffee beans, the seeds of berries from certain *Coffea* species. When coffee berries turn from green to bright red in color – indicating ripeness – they are picked, processed, and dried. Dried coffee seeds (referred to as "beans") are roasted to varying degrees, depending on the desired flavor. Roasted beans are ground and then brewed with near-boiling water to produce the beverage known as coffee. Coffee is darkly colored, bitter, and slightly acidic. It has a stimulating effect in humans, primarily due to its higher caffeine content. It is incidentally one of the most popular drinks in the world and the most commonly consumed beverage.

Figure 6: Coffee and coffee beans

Alcoholic beverages – Third type of drink

Alcoholic beverages are beverages that are intended for human consumption and have an ethanol content above 0.5% vol. Internationally, it is generally divided into three categories according to the production process: Distilled spirits produced by direct fermentation of raw materials and with high alcohol content, Wines produced by fermentation of grapes and other fruits and Beers produced by the saccharification of starch and fermentation of the resulting sugars. Wines in general have lower alcohol content compared to distilled spirits and beers have the lowest alcohol content of all three categories.

Figure 7: Alcoholic beverages

Packaging of beverages

The packaging of beverages both carbonated and non-carbonated, is a complex technological branch in the Food Processing /Packaging industry. The traditional returnable glass bottle has given way to newer plastic containers as well as cartons. The current trend is to improve the conventional containers, extend their share in the large market, extend the shelf-life of the products, provide greater consumer convenience and ultimately to produce economic packages. The changing Indian scenario, with implementation of various technologies and market promotion activities, has changed the scope for this industry exponentially.

The packaging requirements for all types of beverages are:

• Absolutely leak-proof and prevent contamination

• Protect the contents against chemical deterioration

• Protection from permeating of external flavours

• Maintenance of hygiene and safety.

• Retainment carbonation in the case of carbonated beverages

The different packaging materials used are:

***Glass Containers*:** The use of glass bottles for the packaging of fruit beverages was widespread although the hot-fill/hold/cool process had to be applied with care to avoid breakage of the containers. Glass is still the preferred packaging medium for high quality fruit beverages.

Metal Containers: Tinplate cans made of low carbon mild steel of 99.75% purity, coated with tin with easy open ends are used. They are lacquered internally to prevent corrosion.

Plastic Containers: Fruit juices contain organic substances, which are sensitive to bacterial contamination. Packaging of such products is done through hot filling, to achieve extended shelf-life, PET bottles are usually used for hot filling applications. The package is heat-set in order to improve the temperature resistance of the containers. PET resins with a higher T_g (glass transition) temperature and/or a faster rate of crystallisation are used. Generally, lower levels of PET co-polymer are preferred and intrinsic viscosities of about 80 are acceptable. Flexible plastic packages even though are more economic over conventional glass and metal containers

but they are permeable to oxygen which needs to be kept in mind while selecting these materials.

Aseptic Packages: Ready to serve fruit beverages and fruit pulps / concentrates, packed in aseptic packages provide excellent protection for fruit juices / pulps. These aseptic packages are made by combining thermoplastic with paperboard and aluminium foil. Their multi-layered construction enables the carton to protect the contents from various factors responsible for spoilage. The aluminium foil layer is a strong barrier for O_2 and light. The inner plastic layer made of polyethylene makes it possible to seal through the liquid. The outer paper layer provides stiffness making it possible for the cartons in a brick shape, thus, enabling maximum utilization available storage and transportation space.

Bag-in-Box System: It consists of a collapsible bag within a rigid container, a filling machine to introduce the liquid product into the bag and a dispenser to draw the product out. Bag: The outer container can be a box, a crate or a drum. The bag actually consists of two bags. An inner bag contains the liquid and an outer bag provides the barrier properties. Both are heat-sealed at the edges.

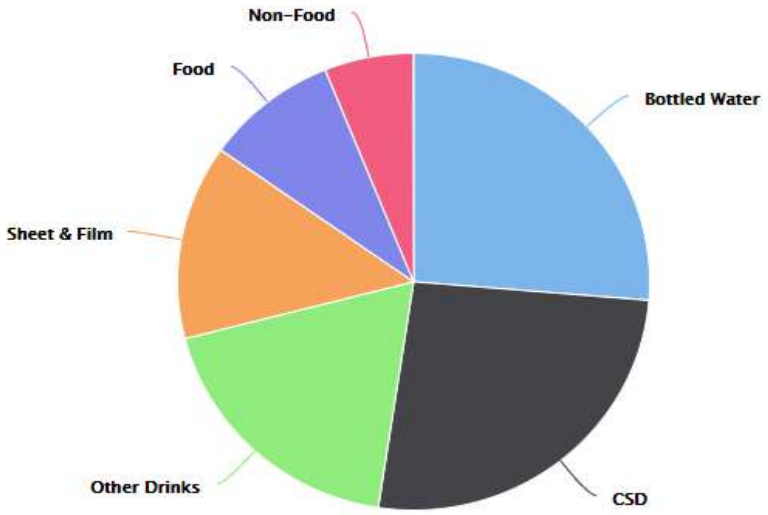

Figure 8: Global PET consumption in 2016

Plants and herbs used for the production of beverages

Herbs and spices play a significant part in the production of beverages and have been used for many centuries. Some of them were already in use in ancient times (cinnamon, hops, marjoram, etc.). At present hundreds of plants are used in the production of beverages for flavoring and coloring purposes. Herbs and spices can be applied separately or in groups for achieving the desired effect. The plants are normally used in the form of abstracts or extracts.

Table : Groups of herbs and spices based on agents (drugs)

Flavor		**Typical representative**
Strongly flavored drugs without any special bitter taste		Cumin seed
	Sweet	Anise seed
Flavored drug	Vanilla	Vanilla
	Bitter almond flavor	"Bitter" almond
	Sharply hot flavor	Cinnamon
	Bitter	Orange peel
Slightly flavored drugs	Without any special bitter taste	Coffee bean
Most bitter drugs		Cassia
Spices		Allspice

Common plants used in the preparation of beverages:

Allspice (Pimenta officinalis) - This popular spice is used both whole and ground. It is used in the kitchen for flavoring foods, beverages, etc. It is employed by food manufacturers in the preparation of many meats, sauces, etc. Whole allspice fruits are an ingredient of whole Mixed Pickling Spice, and ground allspice is a constituent of a number of spice mixtures including curry powder, pastry spice, etc.

Anise (Pimpinella anisum) - Anise seed, like most herbs and spices can be used in several dishes. The leaves may be used as a garnish or in salads and for flavoring soups and meat dishes

Cassia (Cinnamomum cassia) - Ground cassia cinnamon (i.e. the bark) is employed to flavor foods, and cracked cassia cinnamon is an ingredient of whole mixed pickling spice. The bark contains chemical substances (quasiin), which give it a bitter aroma and taste. For this reason it is used in the beverage industry for flavoring liqueurs and bitters.

Cinnamon (Cinnamonum sp.) - Cinnamon is one of the oldest spices. It is used in the kitchen for flavoring foods, sauces, beverages, etc. Ground cinnamon bark is employed by manufacturers in the preparation of many foods, sauces, cream soups, beverages, etc. Extracts of cinnamon are also used in the pharmaceutical trade.

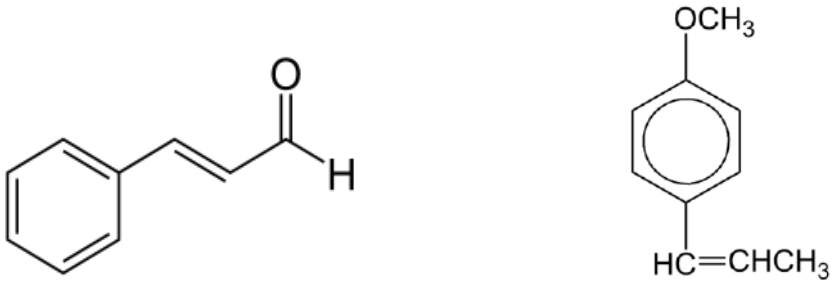

Figure 9: Cinnamaldehyde and Anethol (present in Cinnamon and Anise)

Safety Issues in Beverage Production

Metabolites of microbial origin in beverages with harmful effect on human health

Beverages are very complex systems consisting of a variety of compounds. In addition to many essential nutritional components and biologically active molecules, beverages could contain some harmful substances. Among undesirable compounds, metabolites of microbial origin such as **biogenic amines and mycotoxins** represent one of the greatest concerns, owning to their harmful effect on human health and their frequent occurrence in beverages.

Ochratoxin A(OTA***)*** is produced by *Aspergillus* spp. and *Penicillium* spp. and derives from 3,4-dihydrocumarin linked to an amide bond with an amino group of L-β-phenylalanine. It can be recovered in a variety of foods, including cereals, grapes, cocoa, coffee, and spices; its presence in alcoholic beverages is mainly in red wine followed by rosé and white wines. Ochratoxin A is a great threat for humans, because it accumulates in several tissues in the body and is classified as a possible human carcinogen. Kidney is its main target, and hereby causes Balkan endemic nephropathy (BEN), chronic interstitial nephritis, and karyomegalic interstitial nephritis.

The presence of OTA in the grape can be shifted from grain grapes to wine during fermentation. OTA levels depend on different factors such as vineyard location (latitude), weather (rain, temperature, and relative humidity in the vineyards), period of harvest, pesticide treatments and wine fermentation with a strong impact of the duration of grape maceration. The European Union allows a maximum limit for OTA in wine of 2 ng/g. Chemical removal relies upon the use of some fining agents, like activated carbon, bentonite, chitin and chitosan, egg albumin, gelatin etc.

The control of biogenic amines (BA) in wine is mainly based on the adoption of strategies to prevent their formation rather than their elimination from the beverage. Amino acids are key precursors and contribute to aroma and organoleptic profile of wines. Therefore, it seems to be more advisable to intervene controlling the microflora responsible for the vinification in order to avoid potential BA-producers. Common practices in wine-making are the addition of sulphite and the inoculation of starter cultures in order to inhibit the growth of unknown and uncharacterized indigenous microorganisms.

Although the biological degradation of BA and the removal of OTA offer interesting perspectives for wine industry, prevention is the most important strategy to control the threat of these toxic compounds. Nowadays, advances in molecular approaches ensure considerable advantages to select safe microbial starter cultures. At the same time, progresses in analytical tools can provide an early detection of BA and OTA encouraging their monitoring during winemaking and storage. However, it is presumable that the risk of these compounds in wine is still underestimated, due to a poor awareness of the consumer and discrepant surveillance strategies across the world. In this regard, it is crucial to emphasize the effort of regulatory agencies like EFSA (European Food Safety Authority) for proposing and introducing a standardized framework for BA and OTA risk assessment and detection in beverages of concern.

BIOCHEMISTRY OF SPICES: CUMIN AND CORIANDER

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(6th Semester)

Botany Honours

Abstract

A comprehensive study was carried out to assess the microbiological, nutritional, biochemical and essential oil characteristics of 2 spices namely cumin (Cuminum cyminum) and coriander (Coriandum sativum). Analysis of essential minerals in seed spices indicated that they are rich in K, Ca, Na, Fe and Zn.

Introduction

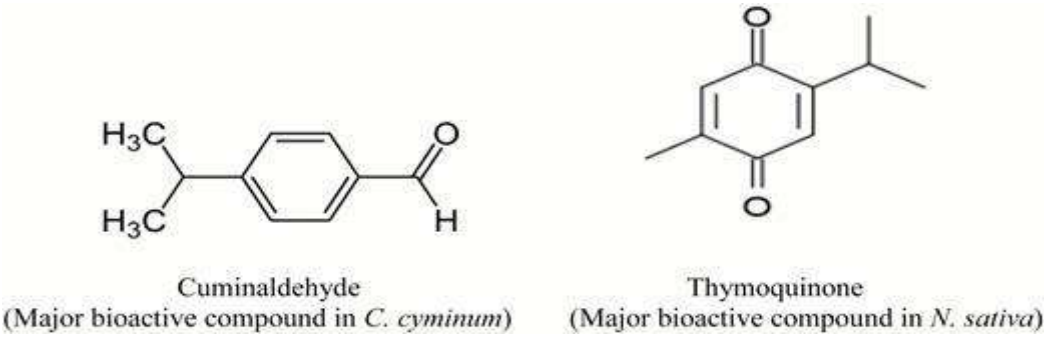
Cumin and coriander are both seeds with the intense, concentrated flavor that comes with this part of the plant. They are dried to preserve shelf life and deepen flavors, and both of these seeds can be used either whole or ground. In their whole form they can be somewhat overwhelming but, when ground, they integrate nicely with other elements of a dish. Toasting the whole seeds before grinding them adds an extra layer of savoriness. Cumin and coriander are typically used in curries, although the flavor of cumin is distinctive enough to be predominant. The two spices are frequently paired and both are readily available in both whole and ground options at typical supermarkets. In addition to the familiar curry powders, where they often appear side by side, cumin and coriander also make strong partners in the Egyptian spice mix dukkah, which uses both along with a combination of ground nuts and seeds, as well as thyme and ground chili.

Cumin (Cuminum cyminum)

Chemical constituents

Cumin seeds are nutritionally rich; they provide high amounts of fat (especially monounsaturated fat), protein, and dietary fibre. Vitamins B and E and several dietary minerals, especially iron, are also considerable in cumin seeds. Cuminaldehyde (Figure 2), cymene, and terpenoids are the major volatile components of cumin (Bettaieb et al., 2011). Cumin has a distinctive strong flavour. Its warm aroma is due to its essential oil content. Its main constituent of aroma compounds are cuminaldehyde and cuminic alcohol. Other important aroma

compounds of roasted cumin are the substituted pyrazines, 2-ethoxy-3-isopropylpyrazine, 2-methoxy-3-sec-butylpyrazine, and 2-methoxy-3-methylpyrazine. Other components include γ-terpinene, safranal, p-cymene, and β-pinene (Li and Jiang, 2004).



Cuminaldehyde
(Major bioactive compound in *C. cyminum*)

Thymoquinone
(Major bioactive compound in *N. sativa*)

Anti-inflammatory effects

Cumin essential oil was investigated for the anti-inflammatory effects in lipopolysaccharide (LPS)-stimulated RAW 264.7 cells and the underlying mechanism

Cardio-protective influence through hypolipidemic and hypotensive effects

Cuminum cyminum is traditionally used for the treatment of indigestion and hypertension. The anti-hypertensive potential of aqueous extract of cumin seed and its role in arterial–endothelial nitric oxide synthase expression, inflammation, and oxidative stress have been evaluated in renal hypertensive rats.

Paraoxanase-1 plays a protective role against the oxidative modification of plasma lipoproteins and hydrolyzes lipid peroxides in human atherosclerotic lesions. Flavonoids present in cumin seeds are recognized to have antioxidant activity and improve the antioxidant system.

Chemo-preventive effects

Cancer chemo-preventive potentials of dietary 2.5 and 5.0 per cent cumin were evaluated against benzo(α)pyrene-induced tumorigenesis in forestomach and 3-methylcholanthrene (MCA)-induced tumorigenesis in uterine cervix in mice. The effect of cumin (C. cyminum; dietary 1.25% for 32 weeks) was studied on colon cancer induced in rats by 1,2-dimethylhydrazine (DMH) s.c. 20 mg/kg of body weight (15 doses, at weekly intervals).

Miscellaneous nutraceutical effects

Cumin seeds are traditionally used for the treatment of diarrhoea. The aqueous extract of cumin seeds (100, 250, and 500 mg/kg) has been examined against diarrhoea in albino rats induced with castor oil.

Health effects of N. sativa

Black cumin (N. sativa) has been in use in traditional systems of medicine for various medical disorders. Nigella sativa is used in Moroccan folk medicine for the treatment of diabetes mellitus. Many pre-clinical and clinical trials have investigated its efficacy, using the seed oil, essential oil, and its isolated main constituent TQ (Ali and Blunden, 2003). These investigations provide preliminary support for its use in asthma, allergic rhinitis, and atopic dermatitis (Yarnell and Abascal, 2011). Black cumin might help in dyspepsia, respiratory problems, diabetes mellitus, and metabolic syndrome (Yarnell and Abascal, 2011).

Antidiabetic effects

Nigella sativa seeds are traditionally used in the management of diabetes mellitus in indigenous systems of medicine and folk remedies. Defatted extract of N. sativa seed is reported to increase glucose-induced insulin release from isolated rat pancreatic islets in vitro (Rchid et al., 2004) (Table 4). The effect of N. sativa extracts (defatted fractions either containing acidic and neutral compounds or containing basic compounds) have been investigated on insulin secretion in vitro in rat pancreatic islets in the presence of glucose (8.3 mmol/l).

Ameliorative effects of N. sativa on dyslipidemia

Dyslipidemia is an established risk factor for ischemic heart disease. Nigella sativa has been used for the treatment and prevention of hyperlipidemia (Asgary et al., 2015). Different preparations of N. sativa including seed powder (100 mg–20 g daily), seed oil (20–800 mg daily), TQ (3.5–20 mg daily), and methanolic extract reduced plasma levels of total cholesterol, low-density lipoprotein cholesterol, and triglycerides. In clinical trials, N. sativa was found to be effective when added as an adjunct to conventional hypolipidemic and antidiabetic medications.

Anti-inflammatory property and analgesic activity

The antinociceptive and anti-inflammatory effects of TQ (Table 6), supporting the common perception of N.sativa. as a potent analgesic and anti-inflammatory agent, have been recently reviewed (Amin and Hosseinzadeh, 2016). Many protective properties are attributed to radical scavenging activity as well as an interaction with molecular targets involved in inflammation (proinflammatory enzymes and cytokines).

Immunomodulatory action

The immunomodulatory properties of N. sativa and its major active ingredient, TQ in terms of their experimentally documented ability to modulate cellular and humoral adaptive immune responses (Table 6) have comprehensively been reviewed (Majdalawieh and Fayyad, 2015). The molecular and cellular mechanisms underlying such immunomodulatory effects of N. sativa and TQ are highlighted, and the signal transduction pathways implicated in the immunoregulatory functions are suggested.

Antioxidant and antimicrobial activity

The bioactive compounds of N. sativa essential oil identified using GC and GC-MS included p-cymene, TQ, α-thujene, longifolene, β-pinene, α-pinene, and carvacrol. Nigella sativa essential oil exhibited different biological activities including antifungal, antibacterial, and antioxidant potentials. Nigella sativa essential oil completely inhibited different Gram-negative and Gram-positive bacteria (Morsi, 2000). Nigella sativa oil also exhibited stronger radical scavenging activity against DPPḢ radical in comparison with synthetic antioxidants.

Anti-cancer properties

The anti-cancer effect of N. sativa has extensively been studied in different in vitro and in vivo models (Table 5). Nigella sativa is able to exert antioxidant, anti-mutagenic, cytotoxic, pro-apoptotic, anti-proliferative, and anti-metastatic effects in various primary cancer cells and cancer cell lines (Majdalawieh and Fayyad, 2016). The available studies strongly suggest that N. sativa could serve as an effective agent to control tumour initiation, growth, and metastasis independently or in combination with conventional chemotherapeutic drugs.

Gastroprotective, hepatoprotective, nephroprotective, and pulmonary-protective effects of black cumin (Nigella sativa) seeds.

Gastroprotective effect:

Rats: N. sativa (2.5 and 5.0 ml/kg)/TQ administration (10, 20, 50, and 100 mg/kg) exerted gastro-protection when subjected to ischemia/reperfusion insult (El-Abhar et al., 2003 and Magdy et al., 2012)

Rats:Anti-ulcer potential of N. sativa aqueous suspension on experimentally induced gastric ulcers (with various necrotizing chemicals) has been evidenced (Al Mofleh et al., 2008)

Hypothyroidal rats: N.sativa and TQ protect gastric mucosa against the ulcerating effect of alcohol(Khaled, 2009)

Newborn Sprague-Dawley rats: N. sativa oil (2 ml/kg daily; i.p.) showed beneficial effect in rats with necrotizing enterocolitis (Tayman et al., 2012)

Mice: Treatment with TQ (5–25 mg/kg) ameliorated colonic inflammation in experimental inflammatory bowel disease (C57BL/6 murine colitis induced with dextran sodium sulfate)(Lei et al., 2012)

Nephroprotective effect

Rabbits: Nephro-protective effect of N. sativa oil was observed against gentamicin-associated nephrotoxicity(Saleem et al., 2012)

Rats: Protective effect of N. sativa oil against methotrexate-induced nephrotoxicity (Yaman and Balikci, 2010)

Rats: Protective effects of N. sativa oil in the prevention of chronic cyclosporine A-induced nephrotoxicity by attenuation of the oxidative stress(Uz et al., 2008)

Rats: TQ supplementation prevented the development of gentamycin-induced degenerative changes in kidney tissues. (Sayed-Ahmed and Nagi, 2007)

Hepatoprotective effect

Rats: N. sativa (0.2 ml/kg) relieves the deleterious effects of ischemia-reperfusion injury on the liver (Yildiz et al., 2008)

Mice: Pre-treatment with TQ (10 µmol/l) showed a significant protection on the hepatotoxicity of Cd++ particularly by relieving the depletion of non-enzymatic and enzymatic antioxidants (Zafeer et al., 2012)

Pulmonary protective effect

Wistar rats: N,sativa treatment showed beneficial effects on experimental lung injury; inhibited the inflammatory pulmonary responses(Kanter, 2009)

Rats: N. sativa oil significantly reduced the severity of lung damage due to hyperoxia(Tayman et al., 2012)

Patients with asthma: N. sativa (15 ml/kg of 0.1 g% boiled extract for 3 months) significantly alleviated symptoms and frequency of asthma symptoms, chest wheezing, and pulmonary function tests (Boskabady et al., 2007.)

Coriander (Coriandrum sativum L.)

Nutritional aspects

Coriander nutrition is basically due to its green leaves and dried fruits. Like all other green leafy vegetables, its leaves are a rich source of vitamins, minerals and iron. Its leaves contain high amount of vitamin A (β-carotene) and vitamin C. The green herbs contain vitamin C upto 160 mg/100 g and vitamin A upto 12 mg/100 g (Girenko, 1982). It is very low in saturated fat and cholesterol and a very good source of thiamine, zinc and dietary fiber. Green coriander contains 84% water.

Functional aspects

The functional properties of coriander cannot be under estimated. Besides nutritional benefits, it is well known for its health or medicinal benefits as well as for additional benefits like it acts as antimicrobial agent. The type of meat and temperature did not influence the antimicrobial activity of the oil; indicating the potential of coriander oil to serve as a natural antimicrobial compound against Campylobacter jejuni in food (Rattanachaikunsopon and Phumkhachorn, 2010). The most important and well characterized functional aspect involves antioxidant activity.

Adverse side effects of Coriander leaves consumption

Alright, so we've gone through the top benefits of coriander leaves, but what about the potential side effects? Herbs are known as powerful agents of healing and rejuvenation. However, since they're so incredibly potent, they can also cause some unwanted reactions in certain people.

1. Allergic Reactions: A lot of plant foods can potentially cause allergic reactions, and coriander is no different.

2. Lower Blood Pressure: Eating a lot of coriander has been known to cause lower blood pressure. This is partly because of the potassium found in the plant, which can reduce the effects of sodium in your body. That's great for overall heart health, since excess sodium is correlated with heart disease.

3.Repulsive Taste Of Soap: This one isn't really harmful for your physical health. Still, it's potentially a big issue with coriander, as well as a few other plants. While most of the world enjoys the exotic flavor of the herb, there's a small percentage that absolutely can't stand it.

Health Benefits Of Coriander Leaves

1.Nourish Your Eyes-Coriander leaves are full of vitamin C — 1 ounce (28 grams) will give you 7.6 mg, which is 13% of the recommended daily value. Vitamin C helps your body form and preserve connective tissue — such as the collagen in your cornea. Also, it keeps your blood vessels strong and flexible, including the more delicate ones found in your eyes

2. Cleanse Your Body Of Heavy Metals-Today, many countries have regulations in place to deal with the most serious forms of pollution. Still, the situation is far from ideal. Contaminants can be found all over the place — air, soil, water, food, and various consumer products. Coriander could be of great help when it comes to detoxing your body from heavy metals. It loosens them from tissue, wraps them together and helps eliminate them from your system.

3. Defend Against Food Poisoning-Coriander is not only effective at treating infections — it can also prevent them from spreading in the first place. Foodborne illnesses caused by salmonella, listeria and cholera are still major health issues in the modern world.

4. Prevent Heart Disease-Heart disease is no laughing matter. It's the number one killer in the world. Every year, it claims around 610 000 lives in the U.S. alone. That's 1 out of 4 total deaths!

5. Helps with Irregular Menstruation-Coriander, both the seeds and leaves, have long been used as a home remedy for menstrual issues. This is because it helps regulate the function of your endocrine glands, as well as the hormones involved in your period. Due to this, the herb is known an emmenagogue.

6. Protect Your Brain & Nerve System-As we covered earlier, coriander can be of great help when it comes to removing dangerous toxins from your body — especially heavy metals. While this has a number of benefits to your health, the most important one has to do with your brain

and nerve system. Buildup of toxic metals in the body is strongly correlated with scary neurological disorders like Alzheimer's, Parkinson's and multiple sclerosis. A study published in the Journal of Molecular Neurobiology found that coriander (along with other herbs and spices) fights inflammation and protects your nerve system in the long-term.

Major chemical constituents

Coriander seeds contain upto 1.8% volatile oil according to origin. The distilled oil (coriander oil BP) contains 65 to 70% of (+)-linalool (coriandrol), depending on the source (Anju et al., 2011)

Antioxidant activity

Coriander is a good source of polyphenols and phyto-chemicals due to its high antioxidant activity. Reactive species of oxygen can cause oxidative stress and consequently, the damage of tissues and biomolecules(Barros et al., 2012). Both leaves and seeds of coriander contain antioxidants but leaves contain more amounts of antioxidants than seeds (Wangensteen et al., 2004). Its Antioxidant content is attributed to its high content of pigments particularly carotenoids. The carotenoids of its extract were found to show higher hydroxyl radicals scavenging potential thereby protecting cells from oxidative damage.

Antifungal activity of Coriandrum sativum

The increasing incidence of drug-resistant pathogens and toxicity of existing antifungal compounds has drawn attention towards the antimicrobial activity of natural products. The aim of the present study was to evaluate the antifungal activity of coriander essential oil according to classical bacteriological techniques, as well as with flow cytometry. The effect of the essential oil upon germ tube formation, seen as an important virulence factor, and potential synergism with amphotericin B were also studied. Coriander essential oil has a fungicidal activity against the Candida strains tested with MLC values equal to the MIC value and ranging from 0.05 to 0.4% (v/v). Flow cytometric evaluation of BOX, PI and DRAQ5 staining indicates that the fungicidal effect is a result of cytoplasmic membrane damage and subsequent leakage of intracellular components such as DNA. Also, concentrations bellow the MIC value caused a marked reduction in the percentage of germ tube formation for C. albicans strains. A synergetic effect between coriander oil and amphotericin B was also obtained for C. albicans strains, while for C. tropicalis strain only an additive effect was observed. This study describes

the antifungal activity of coriander essential oil on Candida spp., which could be useful in designing new formulations for candidosis treatment.

Effect on rats:

(a) Study on effects of Arsenic on rats through hematological parameters Determination of erythrocytes, lymphocytes and platelets were done using a Neubauer chamber after proper dilution of the blood into R.B.C counting fluid, W.B.C fluid and platelets counting fluid. The no of cells and platelets were counted under a compound microscope. Blood taken from the sacrificed rats were taken in heparinized tubes for the hematological determination and parallel into anticoagulant ones. Cyanmethahemoglobin method were used for the determination of hemoglobin levels.

(b) Effect of Arsenic induced toxicity on liver and kidney of rats Liver function test (LFT) and Kidney function test (KFT) were performed to check the toxicity in Liver and Kidney respectively after administration of Arsenic for a particular time period of 60 days. All the test was performed using the serum as sample with the commercial kits manufactured by CORAL, India.

Effect of coriander and cumin extracts on human platelets:

(i)(a) Aqueous extracts of coriander and cumin were tested on human platelets for their inhibitory effect at different concentrations with a variety of agonists like ADP, epinephrine, collagen, calcium ionophore A 23187 and ristocetin to obtain the IC50 at one-minute incubation.

(b) The effect of increase in the duration of incubation from one minute to 2, 4 and 8 min were determined at the IC50.

(c) After aggregation the products like malondialdehyde (MDA) and serotonin released were assayed for all the spice extracts.

(ii) Raw extracts of coriander and cumin were tested on human platelets for their inhibitory effect and steps (i) a – c were carried out.

(iii) Heat treatment of coriander and cumin: The stability of the inhibitory activity of coriander and cumin were tested by subjecting them to heat treatment (boiling and roasting) as they may be susceptible to changes due to their chemical nature. These extracts were used on human platelets and steps 1a – 1c were carried out. (iii) Combination of coriander and cumin. -Spices

are generally used in combinations. In order to determine their synergistic effect, these two spices were taken in the ratio of 1:1. Raw and heat-treated extracts were used on human platelets and steps 1a – 1c were carried out.

(iv) Processed coriander dhal extract was tested on human platelets and steps 1a – 1c were carried out.

(v) The pure isolated and selected components of coriander and cumin available commercially were tested on human platelets to assess their inhibitory effect and steps 1a – 1c were carried out.

(vi) Effect of extracts of coriander and cumin at IC50 were used to study their effect on washed platelets with agonists like ADP, collagen and A 23187.

Conclusion

Regarding cumin, present study suggested that apart from environmental factors, there is sufficient genetic variation existed essential oil & its constituents in cumin and coriander. Quality of aroma and fatty oils can be improved for desired characters selecting grinding technology. Cryogenic grinding of spices in general, cumin and coriander in particular produces better quality ground powder in terms of more pleasant flavour, desirable fatty acids and enhanced antioxidant properties. Major constituents of essential oil, cumineldehyde and thymol showed significant increase in cryo ground seed powder of both the genotypes. Some constituents only recovered in cryo ground samples. This grinding technology can significantly increase the recovery of essential oil with superior quality, thus has tremendous commercial application. Cumin and coriander both seed spices showed considerable medicinal activities which further enhanced due to cryogenic grinding. Hence, the technology not only improves the quality of ground product in terms of flavor but also in medicinal qualities.

ENZYME DIGESTION

Mousnita Palit, Aditi Maiti and Apurba Roy

(4th Semester)

Chemistry Honours

Introduction:

Digestive enzymes are a group of enzymes that break down polymeric macromolecules into their smallest building blocks for facilitating their absorption by the body. They are found in the digestive tracts of animals and even in the tracts of carnivorous plants, where they aid in the digestion of food as well as inside the cells where they function to maintain the cellular survival. Digestive enzymes are found in the saliva, secreted by the salivary gland, in the pancreas, stomach, small intestine.

Classification of Enzymes:

Based on their target substrates digestive enzymes can be classified into four types:

a) LIPASE: Lipases split the fatty acids into the fats and oils.
b) PROTESES AND PEPTIDASES: They split the proteins into small peptides and amino acids.
c) AMYLASES: Amylases split carbohydrates such as starch and sugars into simple sugars such as glucose.
d) NUCLEASES: Nucleases split nucleic acids into the nucleotides.

Secretion sites of digestive enzymes in the human body:

1) MOUTH: In the oral cavity, salivary glands secrets and array of enzymes and substances that aid in the digestion and also disinfection. They include:
   (a) Lingual Lipase: Lipid digestion initiates in the mouth. Lingual lipase starts the digestion of lipid and fats.
   (b) Salivary Amylase: Amylase produced by the salivary glands, breaks complex carbohydrates to smaller change, or even simple sugars. It is referred to as ptyalin.
   (c) Lysozyme: Some bacteria and viruses which are not a part of the essential nutrients also offers a limited and non-specific, yet beneficial antiseptic function in digestion.

2) STOMACH: The enzymes secreted in the stomach are known as gastric enzymes. The enzymes produced by the stomach are:

   (a) Pepsin: It is the main gastric enzyme. It is produced by the stomach cells in its inactive form, pepsinogen which is a zymogen. Pepsinogen is then activated by the stomach into its active form pepsin.

   (b) Gastric Lipase: It is an acidic lipase. It has a pH of 3 to 6. Acidic lipases make up 30% of lipid hydrolysis occurring during digestion in the human adult, with gastric lipase contributing the most of the two acidic lipases.

3) PANCREAS: Pancreatic juice composed of the secretions of both ductal and acinar cells of the pancreatic parenchyma contains the following digestive enzymes:

   (a) Trypsinogen: It is an inactive enzyme that is activated in the duodenum into trypsin that breaks down proteins to the basic amino acids.

   (b) Chymotrypsinogen: It is also an inactive enzyme activated, in the duodenum into chymotrypsin and breaks proteins into amino acids.

   (c) Carboxyteptidase: It is a protease that takes of the terminal amino acid group from a protein.

   (d) Pancreatic Amylase: Pancreatic Amylase breaks down starch and glycogen which are alpha-linked glucose polymers. Humans lack the cellulases to digest the carbohydrate cellulose which is a beta-linked glucose polymer. The significant pancreatic bio-feedback mechanisms that are essential to maintain the pancreatic balance are Secretin, Cholecystokinin (CCK), Gastric Inhibitory Peptide (GIP), Somatostanin.

4) SMALL INTESTINE: The following enzymes are produced in the duodenum:

(a) Secretin: This is an endocrine enzyme produced by the duodenal S cells in response to the acidity of the gastric chyme.

(b) Motilin: this substance increases gastrointestinal motility via specialised receptors called “motilin receptors”.

(c) Somatostatin: This enzyme is produced by the duodenal, mucosa and also by the delta cells of the pancreas. Its main function is to inhibit a variety of secretory mechanism.

Throughout the lining of the small intestine there are numerous brush border enzymes whose function is to further break down the chime released from the stomach into absorbable particles.

These enzymes are absorbed while peristalsis occurs. Some of these enzymes include Erepsin, Maltase, Lactase, Sucrase etc.

Digestive enzymes in plants:

In carnivorous plants digestive break down in sects. In some plants the leaf collapses on the prey to increase contact. Then the digestion fluids are used to digest the prey to get nitrates and phosphorus. Some carnivorous plants contain digestive enzymes such as esterase, protease, nuclease, phosphatase, glucanase and chitinase.

Conclusion:

Thus, digestive enzymes are a key player in effectively supporting the optimal breakdown of the food ate every day. When the food is not properly digested one can experience a variety of consequences. So, digestive enzymes play a very crucial role in our daily life.

CHOCOLATES

Sneha Paul and Samiya Islam

(4th Semester)

Chemistry Honours

Introduction

The word "chocolate is derived from the classical word xocoātl. Chocolate word comes from the word "cacao" which is the plant. This plant contains the high level of minerals and antioxidants. Chocolate is the most beloved food that have usually creamy texture, sweet taste and brown color. It is prepared by roasted and ground cacao seeds which can be made in the form of liquid or paste. The seeds of cacao have bitter taste and used as a flavoring ingredient in many other foods. The making of chocolate is the result of long discovery and innovation.

Chemicals in chocolate

Chocolate contains more than 300-500 known chemicals in which some chemicals react with human brain and alter their mood. Chocolate includes chemicals- phenylethylamine (PEA), anandamide, theobromine, caffeine, histamine, phenolics, xanthenes, serotonin etc and components like cocoa butter, sugar, milk powder in which cocoa is the rich source of fatty acids that helps to balance the cholesterol in the human body. All the chemical components present in chocolate have an effect on human brain and also having a physiological effect on human body.

- Phenylethylamine(pea):

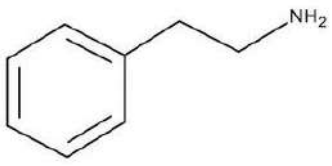


Figure 1: Structure of PEA

Phenylethylamine is an organic compound having molecular formula $C_8H_{11}N$. PEA is a kind of amphetamines that is found in brain and acts as a natural stimulant. It encourages the production of dopamine and promotes well-being.

- Theobromine:

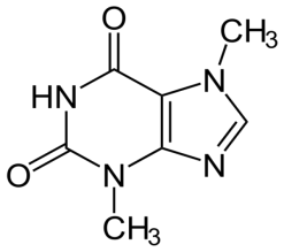


Figure 2: Structure of Theobromine

Theobromine is a stimulant frequently confused with caffeine. It is the bitter alkaloid of cocoa plant which naturally occurs in chocolates. Theobromine is mildly diuretic (increases urine production), is a mild stimulant, and relaxes the smooth muscles of the bronchi in the lungs. Theobromine has very different effects on the human body from caffeine; it is a mild, lasting stimulant with a mood improving effect, whereas caffeine has a strong, immediate effect and increases stress. A normal portion of chocolate exhibits psychopharmacological activities.

- Caffeine

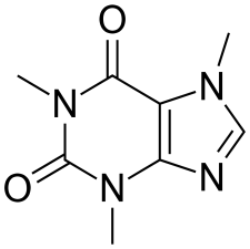


Figure 3: Structure of Caffeine

It is very beneficial for the human health and safe upto a particular limit (300 mg or less per day). It increases the secretion of an impotant neurotransmitter serototin. It decreases fatigue , lifts the spirit and enhances alertness of mind and mood, respiration and cardiovascular function.

- Anandamide:

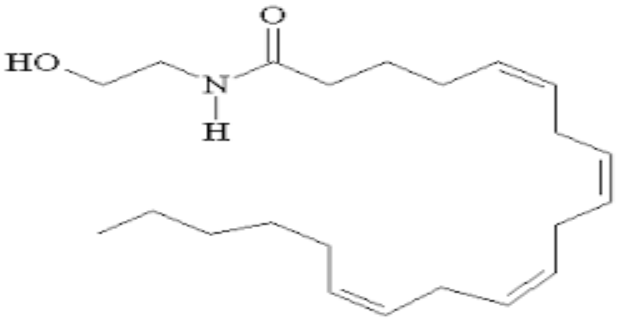


Figure 4: Structure of Anadamide

Chocolate contains small quantities of anandamide. It is a polysaturated fatty acid having chemical formula $C_{22}H_{37}NO_2$. It is the neurotransmitter that naturally produces in the brain to bind cannabinoid receptors. It exhibits both properties – anti anxiety and anti-depressant. It is responsible for the feeling of happiness that we feel.

- Serotonin:

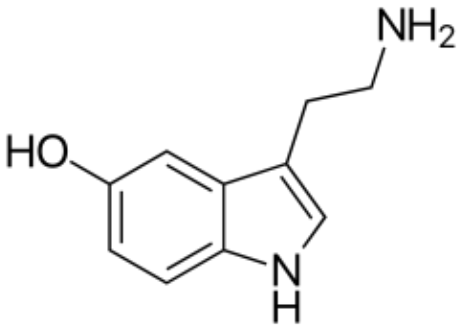


Figure 5: Structure of Serotonin

Serotonin is present both in the cocoa powder and in the dark chocolate. The levels serotonin in chocolate samples containing 70–100% cocoa ranged from 1.30 to 2.93 mg/kg. The majority of the body's serotonin, between 80-90%, can be found in the gastrointestinal tract.

Health benefits of chocolates

Recent studies have shown that cocoa or dark chocolate has potent health benefits for people. Dark chocolate is full of the flavonoids and epicatechin and gallic acid which are antioxidants that help do the following:

- Protect blood vessels
- Cardiac health and
- Prevent cancer

It has also been effectively demonstrated to counteract mild hypertension.

PROTEINS

Aisika Chakraborty, Shaheli Mondal and Payal Das

(6th Semester)

Chemistry Honours

Proteins were first recognised as a distinct class of biological molecules in 18th century by Antoine Fourcoy and others, distinguished by the molecules ability to coagulate under treatment with heat or acid. One of the first few proteins extracted was albumin from egg white.

Proteins are large biomolecules, or macromolecules consisting of one or more long chains of amino acid residues called polypeptides. The sequence of amino acid residue in a protein is defined by the sequence of a gene which is encoded in the genetic code. Once formed, proteins exist for a certain period and are then degraded and recycled by the cell machinery through the process of protein turn over. They can exist for minutes or years with an average lifespan of 1-2 days in mammalian cells.

Proteins are assembled from the amino acids using information encoded in genes. Each protein has its own amino acid sequence that is specified by the nucleotide sequence of the gene encoding this protein. The rate of protein synthesis is higher in prokaryotes than eukaryotes and can reached up to 20 amino acid per second. Genes encoded in DNA are first transcripted into pre-messengers RNA (m-RNA), which is then used as template for proteins synthesis and the process is known as translation.

There as two general classes of proteins:

- Globular – compact, soluble, spherical in shape
- Fibrous- elongated, insoluble

Structure of protein:

- ***Primary structure***- It describes the unique order in which amino acids are linked together to form a protein. Proteins are constructive form a set of 20 amino acid
- ***Secondary structure***- It refers to the coiling or folding of a polypeptide chain that gives the protein its 3D shape.

- ***Tertiary structure***- It refers to comprehensive 3D structure of a polypeptide chain of a protein. The protein molecule will bend and twist in such way as to achieve maximum stability or lowest energy state
- ***Quaternary structure***- It refers to the structure of a protein macromolecule formed by interaction between multiple polypeptide chains. Each polypeptide chain is referred to as a sub unit. Protein with quaternary structure may consist more than one of the same type of protein subunit.

Proteins can be synthesized in the laboratory outside the cell, that is called cell free protein synthesis or as commonly known by in vitro-protein synthesis or CFPs. It is the production of protein using biological machinery in a cell-free system. It is not constrained by a cell wall or homeostasis condition necessary to maintain cell viability. Thus CPFs enables direct access and control of the translation environment which is advantageous for a number of applications including co- translation solubilisation of membrane proteins, optimisation of protein production etc. Due to open nature of the system, different expression conditions such as PH, redox potentials, temperature can be screened. Since there is no need to maintain cell viability, toxic, proteins can be produced. Common cell extracts in use for CFPS today are made using E. coli (ECE), wheat germ (WGE) and insects cell (ICE). All these extracts are commercially available.

Proteins have critical physiological functions. They can act as basic building units and also as a source of energy. Most common functions are:

1. Acts as antibodies that bind to specific foreign particles to help protect the body. (Ex- immunoglobulin G).
2. Enzymes, that carry out thousands of chemical reactions that take place in cells. They assist with formation of new molecules. Example- phenylalanine hydroxylase.
3. The proteins provide structure and support for cells. On a larger scale, they also allow the body to move. Example- actin.
4. Some proteins bind and carry atoms and small molecules within cells and throughout the body.

Briefly going over the role proteins plays in the body shows humans cannot live without it. All humans need proteins to survive, and that’s the reason why it is described as the “building block of life”.

STUDENT PROJECT REPORT

MAKEUP, A BEAUTY GIMMICK: BOON OR BANE?

Apurba Roy, Arpita Das, Disha Ghatak, Soumata Sanyal and Tanaya Dey

(4th Semester)

Chemistry Honours

Introduction

Cosmetics are a category of health and beauty products that are used to care for the face and body, or used to accentuate or change a person's appearance. In the United States, the Food and Drug Administration (FDA), which regulates cosmetics, defines cosmetics as products "intended to be applied to the human body for cleansing, beautifying, promoting attractiveness, or altering the appearance without affecting the body's structure or functions". This broad definition includes any material intended to be used as an ingredient of a cosmetic product. Cosmetics are constituted from a mixture of chemical compounds derived from either natural sources or synthetically created ones. The persistence of metals in the environment and their natural occurrence in rocks, soil and water cause them to be present in the manufacture of pigments and other raw materials used in the cosmetic industry. Heavy metals like lead, arsenic, mercury, aluminum, zinc, chromium and iron are found in a wide variety of personal care products including lipstick, whitening toothpaste, eyeliner and nail color. Some metals are intentionally added as ingredients, while others are contaminants. [1] Exposure to metals has been linked to health concerns including reproductive, immune and nervous system toxicity. Among such heavy metals, lead is a proven neurotoxin and although it may not cause cancer, but it is still an element that is dangerous to humans. Thus, every effort counts to distance mankind from it. Metals present in cosmetic products tend to accumulate in specific parts of the body as they get absorbed by the epidermal layer of the skin. Lead accumulates in the bones, mercury and cadmium accumulate in kidney and liver, and the form of mercury known as methyl mercury accumulates evenly throughout the body. So, in order to enlighten ourselves and educate ourselves, such an assessment needs to be carried out.

Discussions

Necessity of putting heavy metals in cosmetic products: Heavy metals like lead, iron, arsenic, cadmium, chromium, etc are readily incorporated into cosmetic products, these days. Some metals are intentionally added as ingredients while others are just contaminants. They mainly serve as colorants or are contaminants of the chemical combining processes. For example,

lead acetate is sometimes used as a color additive in “progressive” hair dye products. These products are applied over a period of time to achieve a gradual coloring effect. In 1980, lead acetate was permanently listed as a color additive for the safe use in cosmetics for hair coloring. The high levels of iron may be attributed to the aesthetic purpose it serves in cosmetics. Human beings require varying amounts of heavy metals. Iron, cobalt, copper, manganese, molybdenum, zinc, etc are required by us. But all metals are toxic at higher concentrations or when consumed beyond permissible limits. Certain colorants used in lipstick do contain tiny amounts of lead because it is virtually impossible to eliminate all contaminants. As the regulation states, it is illegal for cosmetic products or its ingredients to contain lead and its compounds as ingredient. While very small(trace) amounts may be found in colour cosmetics, this is regulated to be below 10ppm as impurity (10 parts per million; or less than 0.001%w/w) in the US, Canadian, UK, Asian, African and New Zealand markets.

Historical background of cosmetics*:* The usage of cosmetics dates back to over 10 thousand years ago, when the ancient Egyptians discovered the healing properties of some scented or essential oils and black eye makeup. In China, people were executed if they were found wearing nail polish, whereas in Japan, noble women were debarred from walking in public without undergoing entire body cosmetic treatment. Few traditional cosmetic products applied by ancient people prevalent today are Kohl and henna. From the copper and lead ore that the ancient Egyptians used to create the world's first cosmetics to the scientifically advanced products of today that can do everything from hide pores, smooth complexions, and turn the pale green of your eyes a vivid shade of emerald, makeup has been an integral part of humankind for thousands of years. Over the centuries, women used burnt matches to darken their eyes, berries to stain their lips and young boys' urine to fade their freckles. They even swallowed ox blood in some misguided attempt to improve their complexions. In the eighteenth century, women mixed lead with vinegar to make ceruse, which helped them achieve that extremely pale look popular at the time. It also visually smoothed out the face — there was no such thing as sunscreen back then and smallpox was rampant, so women often had a lot to hide. Italian women, who called it belladonna, used deadly nightshade as an eye drop to dilate their pupils, which supposedly made them more attractive, or at least, made them look like anime characters. It can cause visual distortion and sensitivity to light, and if taken systemically, can kill people pretty quickly. Scientists discovered X-rays in the early twentieth century and promptly put them to use removing excess body hair. According to one report, some patients had to be exposed to the X-ray for up to twenty hours. Sure, their hair fell out, but they also

had skin thickening, atrophy, ulcerations, and later on, cancer. Ancient cosmetics were prepared using lead palmate ($C_{32}H_{62}O_4Pb$). Women throughout history put their health at risk with many of their homemade cosmetics. In some cultures, for example, women used arsenic, lead, mercury, and even leeches to give themselves the pale appearance deemed beautiful in the old days. Thankfully, we've come a long way from the days of using toxic and deadly mixtures to enhance our looks. Today's multibillion dollar cosmetic industry must meet strict government regulations about what it can and cannot include in products and must follow safe manufacturing guidelines. Today, the most serious injury a person is likely to receive from cosmetics is an irritation from a product that is too harsh for that particular person's skin, or an allergic rash from a fragrance or a preservative in the product. Yet, despite decades of safety testing and a safety record unparalleled in many industries, there are many myths circulating about the dangers of cosmetic ingredients.

Organic cosmetics and its benefits: Organic cosmetics produced from plants and flowers and are free from hazardous synthetic compounds. In absence of harsh chemicals, organic cosmetics are less likely to cause allergic reactions, inflammations and skin irritations. Plants which are grown organically which are free of herbicides or pesticides and are hence safe for skin. Using natural, organic skincare products, ensure that one gets the real nutritional benefits from its ingredients. Natural organic ingredients such as coconut oil, honey, aloe vera, and shea butter, for example, are known to soothe, nourish, moisturize and promote smooth skin. Even though the results may be slower, organic skincare products are gentle on skin and won't harm in the long run. Consumer demand for organic cosmetics has grown at double-digit rates in recent years. Natural and organic cosmetics contain organic vegetable oils, organic essential oils. Vegetable oil, rich in active substances ingredients (essential fatty acids, vitamins), have natural feel texture and moisturizing effect which soothes the skin. This is one of the reason for advocating organic cosmetics is that they're gentler on the skin. Organic cosmetics do not contaminate the environment and pollution. Conventional beauty products utilize petroleum-based ingredients and usually rely on a host of other chemicals for their production process. These compounds are typically harsh substances, like petroleum, aluminium, and lead, all of which require extensive mining. Much of this is done in some of the world's most beautiful and sensitive areas, like the amazon rainforest, and miles of land are destroyed and stripped of vital wildlife every year. In this manner organic cosmetic products are way more eco-friendly.

Societal pressure on women to apply cosmetics: Society has constructed the idea that using makeup is an activity that women do because it's inherently a product of being female. Women

who don't wear makeup tend to be scrutinized and are expected to wear makeup because they are supposed to look like society's version of a woman. Even though no one is born wearing makeup, but due to immense societal pressure women tend to hide their natural skin under the veil of cosmetics. Women are always under pressure to look good whether that is their workplace or even when she is casually roaming on streets to satisfy some unjustified norms of society. There is also a tendency to criticize women who show natural signs of ageing. Wrinkles, pimples, scars, which are due to a natural process of ageing often, need to be hidden as they tend to make her less presentable. Cosmetics make us look good temporarily but they can cause permanent damages to skin. In an era where social media is all about creating the perfect image of ourselves, the idea that one can look perfect without makeup has become laughable. Some people have an extreme dependency on cosmetics and avoid social interaction if they are not fully made up. This dependency can lead to psychological problems like lowering of the self-esteem of a person. Models and actors face more skin damage as compared to other people. In the present business environment, marketers are using different kinds of strategies to achieve the organizational goals. Celebrities often credit their glowing, flawless skin to habits that every living creature on earth must do to survive, like drink a lot of water and not burn in the sun. And, of course, whatever product they're getting paid to endorse. Most of the celebrities and models use makeup more widely as compared to any normal consumer. Many celebrities and models in the past have come out in the open and talked about the adverse effects they have faced because of using makeup products on a daily basis. Actors in the television industry have been seen complaining about how, on using makeup products on a daily basis, their skin broke out. Breakouts don't happen in one day. Days and days of applying makeup products leads to clogged pores which is caused mainly due to the hard metals present in the items used. For example, Cr^{+6} on skin may include ulcerations, dermatitis and allergic skin reactions.

Some Heavy metals being used in the Makeup Industry:

Lead:

Lead is a heavy bluish-grey metal that is present in trace amounts in the environment and is present in numerous foods. It is found in rocks, water and soil but its concentration is usually below the critical limit that which can cause health concerns. People are most likely to be exposed to lead through air pollution and the consumption of food and drinking water. Lead exposure has been associated with hormonal changes, miscarriage, reduced fertility in men and women and delay in the onset of puberty in girls. Lead compounds have been classified as

suspected carcinogens to humans. The following table depicts the comparison of lead content in cosmetic samples:

Table: Determination of the Toxic Lead Level in Cosmetic-Hair Dye Formulations Using a Screen-Printed Silver Electrode by Jyh-Myng Zen and Annamalai Senthil Kumar, Bulletin of the Chemical Society of Japan, 77 (2), 2004, 311-312.

Material	Total sample	No. of samples Pb mg/kg < 0.5	No. of samples 0.5 < Pb mg/kg < 1	No. of samples 1 < Pb mg/kg < 2	No. of samples 2 < Pb mg/kg < 3	No. of samples Pb mg/kg >3	Average mg/kg
Khol	26	2 (7.69 %)	3 (11.5 %)	4 (15 %)	3 (11.5 %)	14 (53.8 %)	3.80 (0.78)
Make-up	15	15 (100 %)	–	–	–	–	0.15 (0.01)
Hena	15	5 (33.3 %)	2 (13.3 %)	3 (20 %)	4 (26.7 %)	1 (6.76 %)	1.43 (0.38)

Cadmium:

Cadmium is a deep yellow to orange pigment which is mostly present in lipsticks and face powders. The use of cadmium in cosmetics is due to its colour and it is used as a colour pigment in many industries. In the study by Chauhan et al., reported for the different cosmetics products studied, the highest heavy metal (lead and cadmium) contamination was found in bathing soap. Also, the study concluded that though in less amount, beauty cosmetic products are contaminated with heavy metals and hence may results in skin problems. However, evidence reported that the cadmium values in all cosmetic products were significantly lower than the limit set by the Protection and Food Safety organisation of Germany.

Mercury:

Mercury is a metallic element that is naturally occurring in the environment. Mercury can have several forms but is most often recognized as a shiny, silver-white, dense liquid. Mercury in cosmetics exists in two forms: inorganic and organic. Inorganic mercury (e.g. ammoniated mercury) is used in skin lightening soaps and creams. Organic mercury compounds (thiomersal [ethyl mercury] and phenyl mercuric salts) are used as cosmetic preservatives in eye makeup cleansing products and mascara [40-42]. Chronic exposure of the body to mercury at very low levels can cause long-lasting neurological and kidney disturbance.

Arsenic:

Arsenic, a redox inactive metalloid, is a notoriously hazardous inorganic element and is present almost everywhere as a major contaminant in the environment. It can bind sulfydryl groups of proteins and deplete glutathione. The higher contents of arsenic in contraband eye shadows and eyebrow pencils are an issue that should be taken into considerations by the relevant authorities. Long-term exposure to arsenic can lead to hyperpigmentation, keratosis and various types of cancer and vascular diseases.

Nickel:

Nickel is present naturally in the earth. Chronic exposure to nickel may cause skin allergic reaction, skin rash, etc. IARC has classified nickel compounds in Group 1 (carcinogenic to humans) and metallic nickel in Group 2B (possibly carcinogenic to humans) [61]. Nickel is an important cause of allergic contact dermatitis in the general population, both among children and adults, with a worldwide prevalence of around 8.6%. The prevalence among young females is even higher, around 17%[62-64]. Clinical features of exposure to nickel include involvement of previous exposed areas (flare-up of dermatitis and/or patch test sites), as well as unexposed areas (e.g., maculopapular exanthema, pompholyx, flexural eczema, “baboon syndrome”, and vasculitis-like lesions) and general symptoms (e.g., headache, malaise, fever, arthralgia, pirosis, nausea, diarrhoea and vomiting).

Chromium:

Chromium can exist in multiple valence states, with trivalent being most common. Chromium is the most commonly found in food-stuffs, nutritional supplements, biological systems and is associated with a very low degree of toxicity. Several reported has demonstrated the potential toxic effects that result from chromium pollution in different exposure routes. These include oral exposure (e.g., lung cancer following inhalation exposure, and allergic contact dermatitis) following dermal exposure. Also, chromium can be easily absorbed by the skin probably due to its strong binding capacity to the skin proteins. Sweat enhances the absorption rate of chromium into the skin causing sensitizing effects. Contact allergies are also observed in sensitive individuals via dermal contact with the chromium compound.

Iron:

Inorganic and iron compounds are present widely in the human environment. Iron compounds are used commercially in plastics, textiles and cosmetics, where advantage is taken of their

colour range and the safety in use afforded by various ferrous and ferric salts. On the other hand, iron is an important nutrient in the human body. Also, its major function in the metabolism of oxygen radicals makes iron play a central role in maintenance, growth and normal physiology of the skin and its appendages. It is not clear to what extent iron in cosmetic formulations improves the health of the skin. However, the nature of the human skin and its excretions, can be expected to permit the absorption of some quantity applied to its surface, albeit at very low levels.

Conclusion:

The inference we get after reading, researching and discussing on the various aspects of this topic is that heavy metals like lead, arsenic, chromium and mercury are injurious to health and people should be informed about how these heavy metals are incorporated into the human body via cosmetic products. Makeup items which in olden days might have been used as a luxury item by the privileged, have now become much more common. These items when used and applied on the skin over long periods of time result in wrinkling of the skin along with allergic reactions and ulcerations due to accumulation of these hazardous substances in the lower strata of the epidermal layer of the skin, sometimes even causing skin cancer and death. People should be cautious before purchasing any cosmetic products and should go through the contents carefully. Particular care should be taken to check for chemicals such as lead acetate, chromium, thimerosal, hydrogenated cotton seed oil and sodium hexametaphosphate as they have been proven to be dangerous. People should generate the habit of using natural and organic beauty care products as they are harmless, truly effective when used diligently over a long period of time and definitely much more risk free than the chemical alternatives.

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