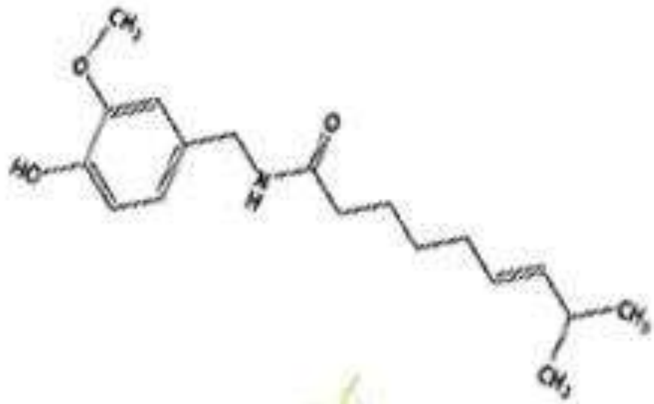
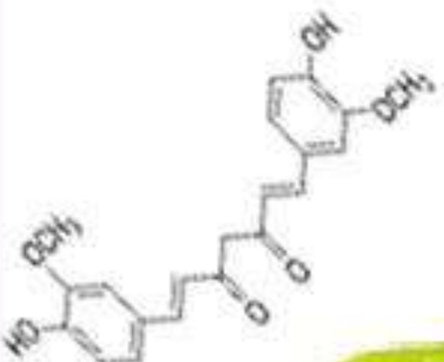
ENTROPY

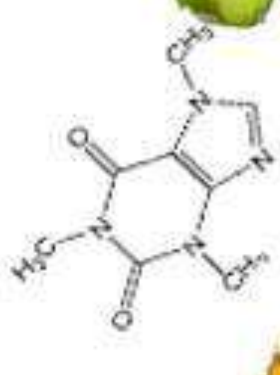
2020

Department of Chemistry
Shri Shikshayatan College

Chemistry in Food : Volume 1







ENTROPY

DEPARTMENTAL MAGAZINE

Issue No. 5

CHEMISTRY

2019-20

SHRI SHIKSHAYATAN COLLEGE, KOLKATA

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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

We are very happy to be able to publish our departmental journal ‘Entropy’ for the year 2019-2020 on the theme ‘Chemistry in Food, Volume 1’.

‘Chemistry in Food’ was chosen as our topic because of its huge significance in our daily lives. Also, due to our modern lifestyles and inappropriate choice of food, obesity is one of the major problems faced today. Having some knowledge about the nutritional and chemical properties of the food items we consume can help us make informed choices while eating. This is particularly true for students, as they are in the formative years of their life, physically and mentally. The importance of a balanced diet is huge, and proper understanding of the components of food is vital for all of us.

Various unfortunate global circumstances related to the COVID 19 pandemic have delayed the publication of this issue considerably. The editorial team is grateful to all the students for their articles and their patience while waiting for this issue to be published. Our gratitude to our principal Dr Aditi Dey for her constant encouragement is also immense. We would also like to thank the entire Chemistry department, as bringing this issue to the final format would not have been possible without their support.

Dr. Agnita Kundu

Smt. Sohini Chakrabarti

Dr. Madhulika Ghose

CONTENTS

DEPARTMENTAL ACTIVITIES

The session of 2019-2020 has been quite interesting for the Department of Chemistry. We are still nurturing a new Honours course. Every new semester is bringing with it new sets of challenges. As a department we are in the learning mode and the learning curve has been quite steep. Yet, we have managed to do quite well, with respect to introducing new activities and reforming the old activities to suite the girls of the Honours course.

Our departmental magazine was unveiled by the principal of our college Dr. Aditi Dey on 17th April, 2019. Also, a book consisting of compilation of the papers presented by the participants in the National seminar held on 1st September, 2018 titled "Bangla Bhasha y Bigyan Charcha" with ISBN number: 978-93-83161-03-4 was unveiled on the same day by our principal. We have done a career counseling course for the Honours students conducted by the faculties of the Department, Smt. Sohini Chakrabarti and Dr. Madhulika Ghose on 28.08.2019. A different career counseling course was conducted for the General students of all three years, by Smt. Shahin Nasrin the faculty of Physics Department of our college on 16.09.2019, keeping in mind that their requirement and expertise are different than the students pursuing an Honours course. A new activity of the department was introduced this year, "The Sharing of Research Experience". This activity was introduced to inculcate in the Honours students an interest in research. The first of the series was given by Smt. Sohini Chakrabarti, who herself is in the course of pursuing her doctoral degree on 23.09.2019. The Active Learning Day was conducted jointly with the Department of Physics on 22.08.2020. The year 2019 was declared by United Nations as the International 150th year of Periodic Table hence, the students were given the topic of Periodic Table and different aspects of it. The new students of 1st semester were assigned the relatively easier topic of history of Periodic Table and the senior students of 3rd semester was given the topics related to functions and properties of Periodic Table.

The topics discussed and presented were as follows:

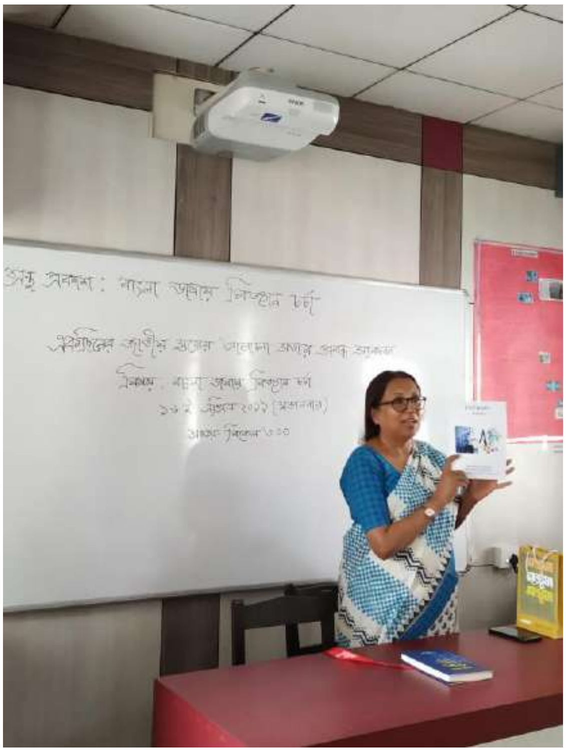
Names	Topic	Semester/ Year
Sneha Paul, Soumata Sanyal	**History of Periodic Table**	1st Semester (H)
Samiya Islam, Apurba Roy, Eram Tahsin	**Importance of Periodic Table**	1st Semester (H)
Sumedha Thakur, Arpita Das,Aditi Maiti,Binita Karmakar	**Position of Hydrogen in Periodic Table**	1st Semester (H)
Tanaya Dey, Mousnita Palit, Disha Ghatak	**Different forms of Periodic Table**	1st Semester (H)
Rashiqua Zama, Tahsin Khan	**Biography of Mendeleve**	3RD Semester (G)
Sneha Gupta, Alisha Sayeed Tasmia Noor, Zeba Nasim	**Trends in Periodic Table**	3RD Semester (G)
Deblipi Bal, Pragya Dugar, Muzaina Khatoon, Ayushi Rajeev Gupta	**Chemistry of p-Block Elements**	3RD year (G)
Rittika Chakraborty, Muskan Sharma,Sinchani Dutta, Mrittika Sarkar	**Transition Elements**	3RD Semester (H)
Rewa Shaw, Pushpanjali Singh, Nabilah Sarfaraz, Poushali Dey	**Lantanidies and Actinides**	3RD Semester (H)
Mitil Biswas, Srijoni Dey, Soumyashree Mitra	**s-Block Elements**	3RD Semester (H)

Five students of 4th semester, Rittika Chakraborty, Rewa Shaw, Pushpanjali Singh, Nabilah Sarfaraz and Poushali Dey worked on a project on “Estimation of Vitamin C content in some fresh fruits”.

The 3rd semester girls arranged for a welcome function for the new entrants. Teachers Day was celebrated by the departmental students with enthusiasm also.

Two groups from 1st Semester participated in the Science Model competition of Kolkata District Level Science Fair, 2019 on 25th September,2019 at Birla Industrial and Technological Museum. Aditi Maiti and Mousnita Palit prepared model on Forest and its Conservation. Arpita Das and Sumedha Thakur prepared a model on Biodiesel Production and its Application.

We hope to continue doing such enriching programs in our department in the future.



Principal, Dr. Aditi Dey unveiling Chemistry Departmental magazine, 2019.

Principal, Dr. Aditi Dey unveiling the book: Bangla Bhasha y Bigyan Charcha

Career Counselling Session of Honours Students

Students presenting on Active Learning Day

Aditi Maiti and Mousnita Palit with their model

Arpita Das and Sumedha Thakur with their model

Sharing of Research Experience

Teachers Day Celebration

Welcome Function

Students working on the departmental project

FOOD CHEMISTRY

Dr. Madhulika Ghose

Faculty, Department of Chemistry

The word 'Food Chemistry' immediately brings to our minds a set of somewhat conflicting images. A snapshot of that steaming hot mug of coffee, a plate of simple comforting home-cooked food or an indulgent lavish restaurant spread, placed beside a rather clinical image of a scientific Chemistry lab. Like most other things in life, this amalgamation of science and sensory perception is what makes this field of study very intriguing and rather fulfilling.

The chemistry of food has been a topic of importance in India since ancient times. The traditional classification of food into *Satvika* (cooked vegetables, milk, fresh fruit, honey), *Tamasika* (meat, liquor, garlic, sour and spicy food) and *Rajsika* (food providing energy for daily work) is very interesting. Although their correlation with the moral constitution of a person is debatable, it is now well known that the food we consume does definitely influence our physical constitution and internal well-being. In Ayurveda, a traditional holistic Indian medicine system, food and diet is given immense importance. *Asaratmaka Nidana* is considered to be the dietary causative factor for a disease. Among the different therapeutic approaches of Ayurveda, *Shodhana*, is done by removing the toxic factors from food and *Pathya vyavastha* is related to providing information about the link between certain food items and diseases.

Globally, the scientific analysis of food in a well-documented format started in the eighteenth century. Antoine Lavoisier, the French chemist who is well-known for his breakthrough research on the role of oxygen in combustion, was one of the first few scientists to study food composition in the laboratory. In 1870, Takaki Kanehiro, a Japanese physician, was the first to document the correlation between food and disease. In subsequent years after a lot of meticulous research, several diseases such as rickets and scurvy could be identified as deficiency diseases and treated accordingly.

Today we stand in a world which has moved beyond just understanding the composition and benefits of food. Maximizing nutrition and economic profits are factors which need to be addressed now. The GM (genetically modified) food debate, which started in 1996 with the production of the first GM corn is a matter of concern till date. In GM food, recombinant DNA technology is used to genetically modify the item to increase its nutritional content, resistance to pests and diseases and to overall magnify its yield. This does seem to be the best solution for the global problems of malnutrition and hunger, but there are some pressing concerns with these genetically engineered items. It is observed that GM crops have led to the emergence of superweeds and super pests. Also, their long-term effect on human health and the eco-system are still under scientific study. Whichever side of the debate we individually find ourselves, the huge link between food and our survival is undeniable. To live a healthy life with a strong body and mind, proper consumption of suitable food is of primary importance. Knowledge regarding the chemistry of food is the first step in that direction. The quote by the great Budhha is as pertinent today as it was in his time, 'To keep the body in good health is a duty…otherwise we shall not be able to keep our mind strong and clear.'

References

1. Traditional and ayurvedic food of Indian origin. P. Sarkar, D.H.L. Kumar, C. Dhumal, S. S. Panigrahi, R. Choudhury. J Ethn Foods 2 (2015) 97-109.
2. Public perception of genetically-modified (GM) food: A Nationwide Chinese Consumer Survey. K Cui, P. Shoemaker. npj Science of Food (2018) 10.
3. History: The changing notion of food. N. Stafford. Nature (2010) 468, S16-S17.

BIOCHEMISTRY OF CLOVES AND CARDAMOM

Poulami Biswas, Payel Majumder, Oorjaswita Sil, Samarpita Banerjee, Saumya Pramanik

(4th Semester)

Botany Honours

Cloves

Clove (Syzygium aromaticum (L.) Merril. & Perry, syn. Eugenia aromaticum or E. caryophyllata) is one of the most ancient and valuable spices of the Orient. It is a member of the family Myrtaceae. The clove of commerce is its dried unopened flower buds. The word ‘clove’ was derived either from the Latin word clavus, or the French form clou, meaning ‘nail’. The buds resemble irregular nails. Cloves are best used whole. The flavour deteriorates quickly once it is powdered. Whole and ground cloves are used to enhance the flavour of meat and rice dishes.

They are used widely in curry powders and masalas and are highly valued in medicine as a carminative and stimulant. Cloves are said to be a natural anthelmintic. Clove oil is used in aromatherapy and oil of cloves is used widely to treat toothache. It is used in medicine for its antibacterial, antiseptic and antibiotic properties. The oil has many industrial applications and is used extensively in perfumes, soaps and as a clearing agent in histological work. It is an ingredient in many toothpastes and mouthwashes. It is also used for flavouring oral preparations and chewing gums.

General Composition

The composition of the clove varies according to the agroclimatic conditions under which it is grown, processed and stored. The dried clove bud contains carbohydrates, fixed oil, steam-volatile oil, resins, tannins, proteins, cellulose, pentosans and mineral elements. Carbohydrates comprise about two-thirds of the weight of the spice (Purseglove et al., 1981). The dried dark and flower buds also contain nutrients like proteins, minerals, vitamins, etc. Nutrient composition of 100 g of clove is 61 % carbohydrates, 20% fat and the rest is contributed by secondary metabolites, vitamins and minerals. Cloves are an excellent source of manganese, a very good source of dietary fibre, vitamin C, vitamin K and ω-3 fatty acids and a good source of calcium and magnesium. Volatile oil can be extracted from the leaf, stem and buds of clove. Volatile oil is present in oval cavities, two or three rows below the epidermis. The major component of the volatile oil is a phenol, namely eugenol. Phenolic activity is greater at the outer glandular regions of the hypanthium than in the inner aerenchymatous spongy tissue.

Chemistry:Volatiles

Clove yields three types of volatile oil – oil extracted from the leaves, the stem and the buds. These oils differ considerably in yield and quality. The yield and composition of the oil obtained are influenced by its origin, season, variety and quality of raw material, maturity at harvest, pre- and post-distillation treatments and method of distillation. The chief component of the oil is eugenol.

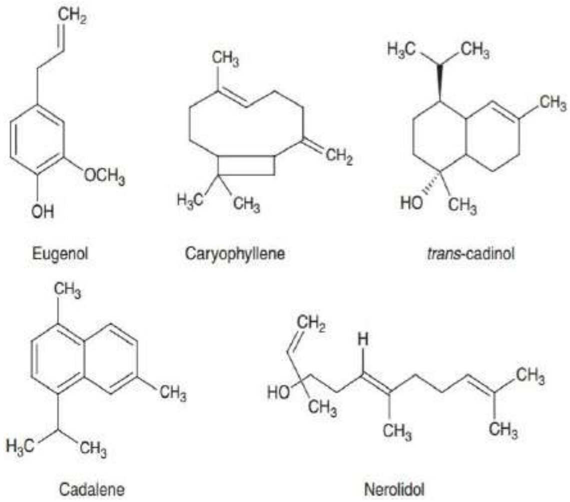


Figure 1: Volatiles from clove.

(I)Bud oil

Good-quality clove buds contain 15–20% essential oil (Gopalakrishnan et al., 1988; Pino et al., 2001; Raina et al., 2001; Zachariah et al., 2005). The oil is dominated by eugenol (70–85%), eugenyl acetate (15%) and β-caryophyllene (5–12%), which together make up 99% of the oil. The constituents of the oil also include methylamylketone, methylsalicylate, - α and β- humulene, benzaldehyde, β-ylangene and chavicol. The minor constituents like methylamylketone, methylsalicylate, etc., are responsible for the characteristic pleasant odour of cloves. Gopalakrishnan et al. (1984) characterized six sesquiterpenes, namely: α-cubebene (1.3%), α-copaene (0.4%), β -humulene (9.1%), β-caryophyllene (64.5%), γ-cadinene (2.6%) and δ-cadinene (2.6%), in the hydrocarbon fraction of the freshly distilled Indian clove bud oil. The oil from the Malagasy Republic (Madagascar) was dominated by eugenol (72–73%), eugenyl acetate (6.3–7.8%) and caryophellene (15.7%) (Lawrence and Reynolds, 1989).

(II)Leaf oil

Clove leaves yield 3.0–4.8% essential oil (Raina et al., 2001). In Zanzibar, oil is distilled from dried fallen leaf or fresh leaf after trimming the upper part of the tree. Crude leaf oil is harsh and woody, with a phenolic, sweet aroma quite different from bud oil. Rectified oil is clear pale yellow in colour with a sweeter, less harsh, dry woody odour close to that of eugenol. The oil contained 94.4% eugenol followed by β-caryophyllene (2.9%), nerol (0.79%) and β-caryophyllene oxide (0.67%) (Raina et al.,2001). The leaf oil from Cuba contained 31 volatile compounds. Eugenol (78.1%) and β -caryophyllene (20.5%) were the main constituents in the oil (Pino et al., 2001). Cuban leaf oil contained a higher amount of β -caryophyllene compared with that from Little Andaman.Clove stem oil. Clove stem yields 6% volatile oil (Gopalakrishnan et al., 1988). The oil is a pale to light yellow liquid containing 80.2% eugenol and 6.6% β-caryophyllene, besides several minor components. Stem oil is used mainly in flavouring and perfumery and also to adulterate bud oil. Stem oil from Madagascar contains 77.10% eugenol and 11.20% β-caryophyllene as the major compounds (Gaydou and Randriamiharisoa, 1987).

(III)Clove stem oil

Clove stem yields 6% volatile oil (Gopalakrishnan et al., 1988). The oil is a pale to light yellow liquid containing 80.2% eugenol and 6.6% β -caryophyllene, besides several minor components. Stem oil is used mainly in flavouring and perfumery and also to adulterate bud oil. Stem oil from Madagascar contains 77.10% eugenol and 11.20% β -caryophyllene as the major com-pounds (Gaydou and Randriamiharisoa, 1987).

(IV)Fruit oil

Ripe fruits yield 2% of oil, which is comprise of 50–55% eugenol.

Non-volatiles

So far, a few non-volatiles have been isolated from clove, which include tannins, sterols, triterpenes and flavonoids. Wild uncultivated treeof the Moluccas contained the crystalline compounds eugenone, eugenine, eugenitin and isoeugenitol (Guenther, 1950).

Small cardamom

Small cardamom, known as the 'queen of spices', which belongs to the family of Zingiberaceae, is a rich spice obtained from the seeds of a perennial plant, Elettaria cardamomum Maton. It is one of the highly prized spices of the world and is the third most expensive spice after saffron and vanilla. Cardamom is one of those spices that cross the sweet/savoury boundary between desserts and main dishes. The original home of this precious spice is the mountains of the south-western parts of the Indian Peninsula.Cardamom is used as an aromatic, carminative and stimulant. The seeds have a warm, slightly pungent aromatic flavour. It is used mainly as a flavouring agent in tea and food preparations. Cardamom oil is a precious ingredient in food preparations, perfumery, health foods, medicine and beverages

General Composition

The content of volatile oil in the seeds is strongly dependent on storage conditions, with an average yield from to 5%. The oil is described as sweet, spicy, warm, lightly camphorated and citrusy (Robert, 1986; Boiswert and Hubert, 1998). The volatile oil contains about 1.5% α-pinene, 0.2% β-pinene, 2.8% sabinene, 1.6% myrcene, 0.2% α-phellandrene, 11.6% limonene, 36.3% 1,8-cineole, 0.7% γ-terpinene, 0.5% terpinolene, 3% linalool, 2.5% linalyl acetate, 0.9% terpinen 4-ol, 2.6% α-terpineol, 31.3% α-terpinyl acetate, 0.3% citronellol, 0.5% nerd, 0.5% geraniol, 0.2% methyl eugenol and 2.7% trans-nerolidol (Korikanthimath et al., 1999). The basic cardamom aroma is produced by a combination of the major components, 1,8-cineole and α-terpinyl acetate (Lawrence, 1978).

Chemistry: Volatiles

Main components of volatile oil present in small cardamom are α-Pinene, β-Pinene, Sabinene, Myrcene, α-Phellandrene, Limonene, 1,8-Cineole, γ-Terpinene, ρ-Cymene, Terpinolene, Linalool, Linalyl acetate, Terpinen-4-ol, α-Terpineol, α-Terpinyl acetate, Citronellol, Nerol, Geraniol, Methyl eugenol, trans-Nerolidol [Lawrence (1978); Govindarajan et al. (1982)].

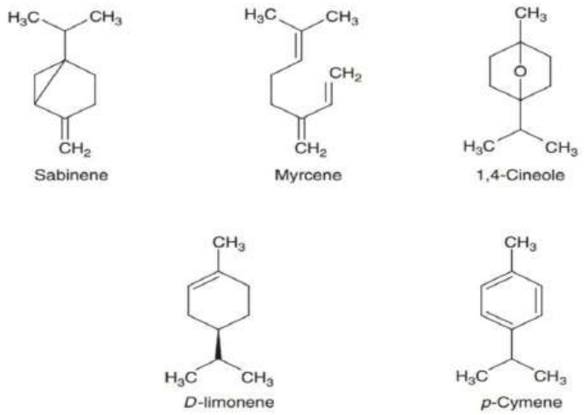


Figure 2: Major essential oil components in small cardamom.

(I)Fixed oils

Cardamom seeds also contain fixed oils, which are constituted mainly by oleic and palmitic acidsThe non- saponifiable fraction consists mainly of waxes (n-alkanes andn-alkenes) and sterols (β-sitosterol and γ-sitosterol) (Kasturi and Iyer, 1955; Gopalakrishnan et al., 1990).

Large cardamom

India is the largest producer of large cardamom (Amomum subulatum Roxburgh), Large cardamom is also known as 'black cardamom'. The pods are used as a spice, in a manner similar to the green Indian cardamom pods, but it has a drastically different flavour. Unlike green cardamom, this spice is used rarely in sweet dishes. Its strong, smoky flavour and aroma are derived from the traditional drying procedure, which involves drying over open flames. Large cardamom is the dried fruit of a perennial herbaceous plant. Its quality characteristics are different from those of small cardamom. It is valued for its acceptable taste, flavour and aroma. The spice is used in rice preparations and meat dishes, besides a wide range of beverages and sweets. Large cardamom also possesses curative properties in the Ayurvedic and Unani systems of medicine.

General Composition

The chemical composition of large cardamom differs with variety, region and age. The seeds contain 3% essential oil, which is dominated by 1,8-cineole (more than 70%). Smaller and variable amounts of limonene, terpinene, terpineol, terpinyl acetate and sabinene have also been reported.

Chemistry: volatiles

Volatile oil is the principal aroma-giving compound in the large cardamom. Steam distillation of the crushed seeds gives a dark brown oil (2.5%) with a cineol-like aroma.Quantitative chromatographic analysis of the composition of distilled essential oil was reported previously by Nigam and Purohit (1960) and by Lawrence (1970). The major constituent of large cardamom essential oil is 1,8-cineole (65–80%), while the content of α-terpenyl acetate is low (traces to 5%). The monoterpene hydrocarbon content is in the range of 5–7%, of which limonene, sabinene, terpinene and pinene are significant components. The terpinols comprise approximately 5–7% of the oil. The high cineole and low terpenyl acetate probably account for the very harsh aroma of this spice in comparison with that of true cardamom (Pruthi, 1993).

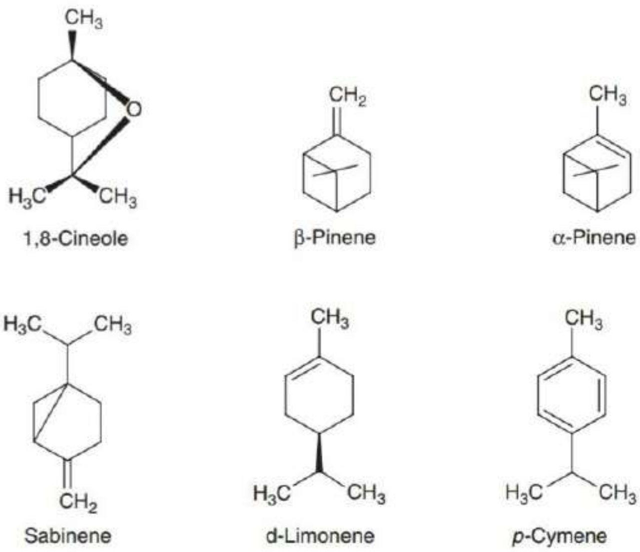


Figure 3: Major essential oil components in large cardamom.

(I)Seed oil

Analysis of the steam-distilled volatile oil of the seeds of the large cardamom grown in Sikkim, India, using GC-MS, identified 25 components, of which 16.3% was monoterpene hydrocarbons and 75.3% was oxygenated monoterpenes, with 1,8-cineole [eucalyptol]

(61.3%) being the major component. α-Terpineol, α- and β-pineneand allo-aromadendrene were also detected (Gurudutt et al., 1996).

(II)Husk oil

The major compounds characterized were 1,8-cineole (38.7%), β-pinene (13.6%), α-terpineol (12.6%), spathulenol (8.3%), 4-terpineol (4.5%), germacrene D (3.0%), α-pinene (2.8%) and β-selinene (2.7%). GC and GC-MS data revealed that the 1,8-cineole content was less than 50% when compared with the seed oil (Naik et al., 2004).

Non-volatiles: Pigments

Extraction of fresh large cardamom pod husks with methanolic HCl yielded amixture of two (deep pinkish-red) pigments. The pigments, present in the ratio of 1:2, were separated by paper chromatography, characterized as cyanidin 3-glucoside and cyanidin 3.5-diglucoside by chemical and spectroscopic analysis and confirmed by comparison with authentic samples (Naik et al., 2004).

MEDICAL PROPERTIES OF COUMARIN: CHEMICAL PERSPECTIVE

Poorvi Ghosh, Diya Bhowmick, Pragya Agarwal, Shayesta Akram, Satavisha Ghosh, Anwesha Sarkar, Sanjula Sarkar, Anushka Das, Kahkashan Nizam

(4^{th} Semester)

Botany Honours

Food chemistry is the branch of chemistry that deals with the biochemical nature of food, their properties and how they are processed in the body. It involves the studies of chemical components from proteins to carbohydrates and more present in different food items.

Cinnamon is a spice obtained from the inner bark of several tree species from the genus Cinnamomum. Cinnamon is used mainly as an aromatic condiment and flavouring additive in a wide variety of cuisines. Coumarin is the flavouring substance which is present in relatively high concentrations in Cinnamon.

Definition of coumarin:

Coumarin is a colourless crystalline solid with a sweet odor resembling the scent of vanilla and a bitter taste which was formerly used for flavouring food. It is found in many plants, where it may serve as a chemical defense against predators. By inhibiting synthesis of vitamin k, a related compound is used as the prescription drug warfarin – an anticoagulant, to inhibit formation of blood clots, deep vein thrombosis, and pulmonary embolism. Coumarins are widely-used oral anticoagulants for the prevention of venous thromboembolism and strokes. Coumarin is moderately toxic to the liver and kidneys, Although it is somewhat dangerous to humans, coumarin is hepatotoxic in rats, but less so in mice.

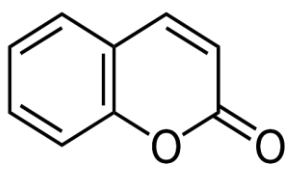


Figure 1: Structure of Coumarin

Chemical formula of coumarin:

Coumarin or 2H-chromen-2-one is an aromatic organic chemical compound with formula C9H6O. Its molecule can be described as a benzene molecule with two adjacent hydrogen atoms replaced by a lactone-like chain −(CH)=(CH)−(C=O)−O−, forming a second six-membered heterocycle that shares two carbons with the benzene ring. It can be placed in the benzopyrone chemical class and considered as a lactone. Coumarin is a chromenone having the keto group located at the 2-position. It has a role as a fluorescent dye, a plant metabolite and a human metabolite.

Chemical formula - C9H6O2

Molar mass - 146.145 g·mol−1

Appearance - colorless to white crystals

Odor - pleasant, like vanilla beans

Density - 0.935 g/cm3 (20 °C (68 °F))

Melting point - 71 °C (160 °F; 344 K)

Boiling point - 301.71 °C (575.08 °F; 574.86 K)

Solubility in water - 0.17 g / 100 mL

Solubility - very soluble in ether, diethyl ether, chloroform, oil, pyridine

soluble in ethanol

log P - 1.39

Vapor pressure - 1.3 hPa (106 °C (223 °F))

Magnetic susceptibility (χ) - −82.5×10−6 cm3/mol

Crystal structure - orthorhombic

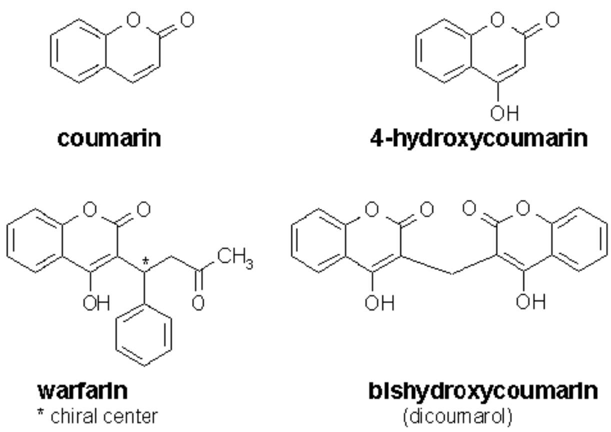


Figure 2: Some Coumarin molecules

Structure of coumarin:

Coumarin is an organic compound that has two six-membered rings fused together, with one of the rings being a benzene ring and the other containing an alkene functionality and an ester functional group. Coumarins play an important role in both natural systems like plants and also in medicinal applications as drug molecules.

Coumarin actually belongs to a broader class of compounds called the benzopyrones. A benzopyrone is simple to identify, it's just two six-membered rings fused together with one of the rings being a benzene ring, and the other ring containing an alkene and ester functional group inside the ring.

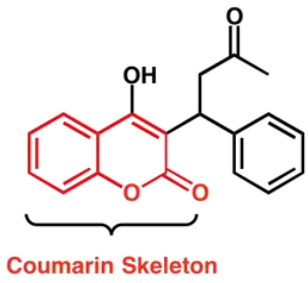


Figure 3: Coumarin skeleton

Utility of coumarin:

Coumarin is a fragrant organic compound widely used as flavour enhancer in tobacco and beverage industries. As an aroma enhancer, Coumarin can be used in a wide variety of industries including: food production, pharmaceutical, and various other industries. Coumarin is widely used as flavour enhancer in food industries to enhance aroma. It is also used as Anticoagulants, intermediate in Pharmaceutical. As Anticoagulants: in treatment of Thrombosis. As intermediate: in medicine manufacturing.

Coumarin is used in varieties of beverage, Cosmetics, and in Agriculture/Animal Feed. Coumarin acts as a versatile framework in organic synthesis and drug development due to exhibit useful and diverse biological activities. We summarize recent instances of coumarin derivative. As interest in the synthesis of coumarins fused or linked with different heterocycle derivatives has been ahead importance over past eras, reflecting the importance of such compounds in both medical and chemical research. Emphasis is placed on the search for innovative coumarin synthesis techniques and the diverse array of biological activities of coumarins. Coumarin compounds represent an important type of naturally occurring and synthetic oxygen-containing heterocycles with typical benzopyrone framework. This type of special benzopyrone structure enables its derivatives readily interact with a diversity of enzymes and receptors in organisms through weak bond interactions, thereby exhibit wide potentiality as medicinal drugs. So far, some coumarin-based drugs such as anticoagulant and anti neuro-degenerative agents have been extensively used in clinic. Coumarin-containing supramolecular medicinal agents as a new increasing expansion of supramolecular chemistry in pharmaceutical science have also been actively investigated in recent years. Coumarin-derived artificial ion receptors, fluorescent probes and biological stains are growing quickly and have a variety of potential applications in monitoring timely enzyme activity, complex biological events as well as accurate pharmacological and pharmacokinetic properties. This review provides a systematic summary and insight of the whole range of medicinal chemistry in the current developments of coumarin compounds as anticoagulant, anti neuro-degenerative, anticancer, antioxidative, antibacterial, antifungal, antiviral, antiparasitic, anti-inflammatory and analgesic, antidiabetic, antidepressive and other bioactive agents as well as supramolecular medicinal drugs, diagnostic agents and pathologic probes, and biological stains. The perspectives of the future development of coumarin based medicinal chemistry are also presented.

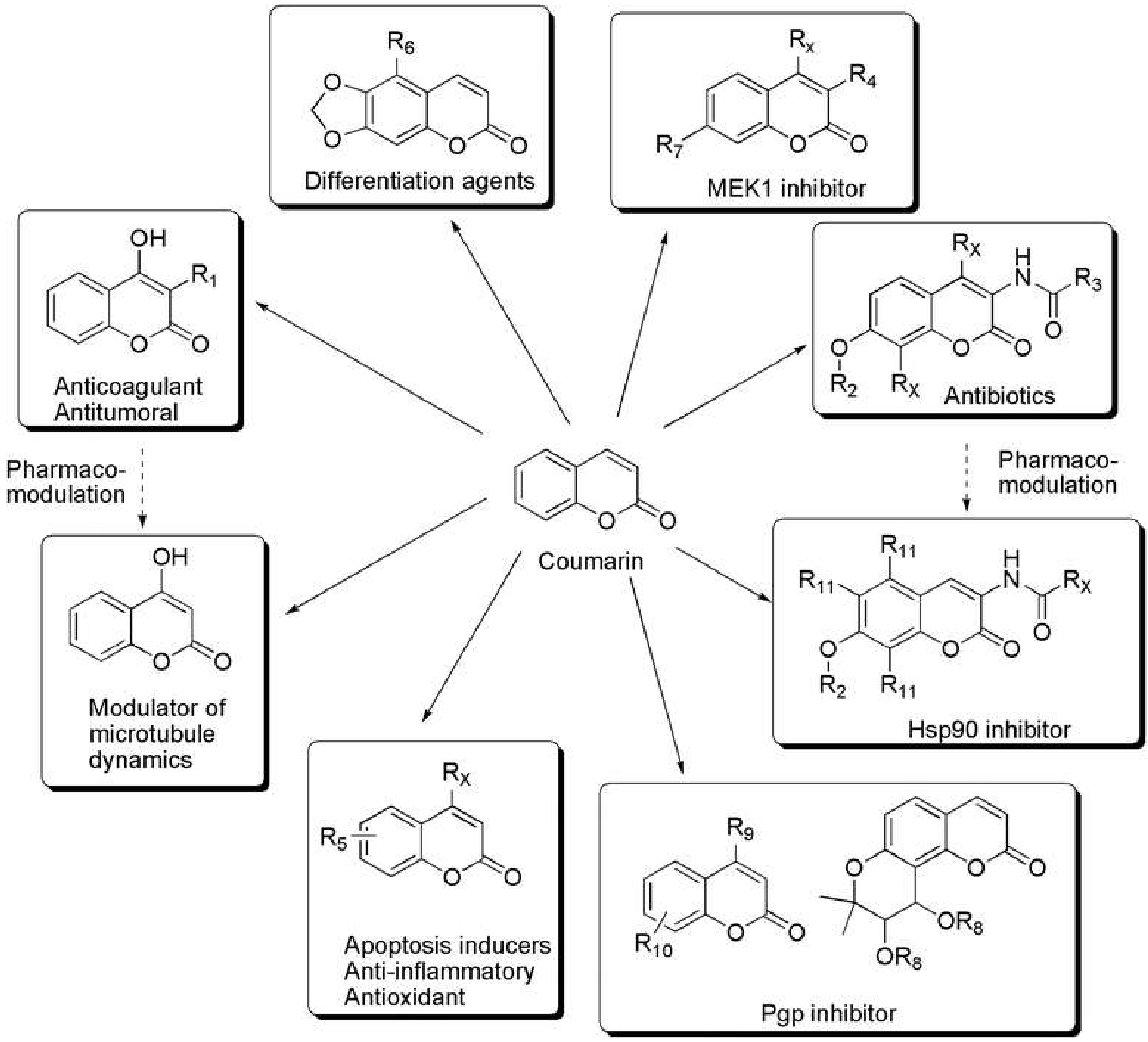


Figure 4: Some useful compounds containing coumarin

Adverse Effects of Coumarin:

According, to a study on cinnamon it had been found that Coumarin may cause damage to the liver of some sensitive people. Poisoning with coumarin may cause nosebleeds, bleeding gums, bloody urine, extensive injury in the absence of injury or Ecchymoses, fatigue, shortness of breath or Dyspnea and fluid in the lungs.

Another side effect of coumarin in humans is that it can cause allergic skin reactions, with symptoms of redness and pain. Multiple or long-term exposure to this chemical may cause damage to the body organs. The body systems that are adversely affected by coumarin is the digestive, integumentary and the respiratory system.

Conclusion

Coumarin and its heterocyclic derivatives exhibit beneficial and diverse biological activities, including anti-tumor, antibacterial, anti-inflammation activities and inhibition of human carbonic anhydrase.

Coumarins have shown some evidence of biological activity and have limited approval for use as pharmaceuticals. They are also used in preparation of laser dyes and perfumes.

Though there are many good use and effects of coumarin, it has many side effects like loss of appetite, nausea, diarrhea or blurred vision may occur at first as your body adjusts to the medication. One must inform the doctor if they experience unusual bleeding or bruising, blood in the urine or stools, severe headache. May cause urine to turn orange-red in colour.

European health agencies have warned against consuming high amounts of Cassia bark, one of the four main species of cinnamon, because of its coumarin content.

CARBOHYDRATE

Sinchani Dutta, Mrittika Sarkar, Muskan Sharma

(4th Semester)

Chemistry Honours

Carbohydrates are one of the major types of nutrients- most important source of energy for our body. They come in simple forms such as sugars, and in complex forms such as starch and fiber.

Now, these biomolecule consist of carbon, hydrogen, and oxygen atoms usually with empirical formula $C_m(H_2O)_n$. carbohydrates are divided into three chemical groups.

Monosaccharide -- 1. Glucose. 2.Fructose.

Oligosaccharide – 1. Lactose. 2.Maltose.

Polysaccharide – 1. Starch. 2.Glycogen.

Reactions:

Cyanohydrin reaction:

Reaction by an aldehyde on ketone with a cyanide anion or a nitrite to form a cyanohydrin.

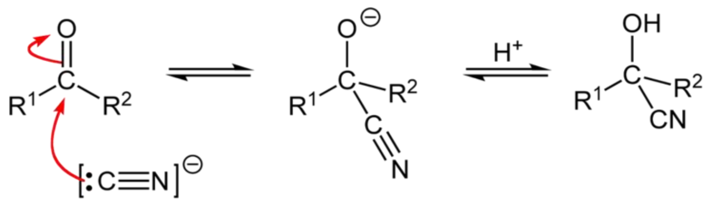


Figure 1: Mechanism of Cyanohydrin reaction

Amadori rearrangement:

It is an organic reaction describing the acid on base catalyzed isomerization or rearrangement reaction of the N- glycoside of an aldose or the glycosylamine to the corresponding I- amino I- deoxy ketone.

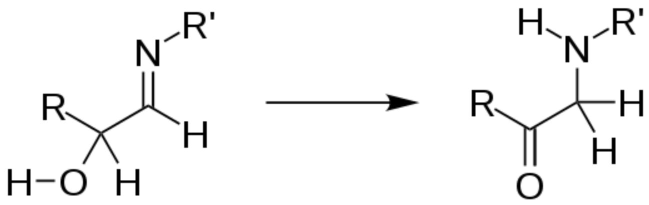


Figure 2: Amadori rearrangement

In this reaction, which is associated with the Maillard reaction, the reagents are naturally occurring sugars and amino acids. Thus, it has a significance in food chemistry.

Metabolism of Carbohydrates:

The most important carbohydrates is glucose, a simple sugar that is metabolized by nearly all known organisms.

Anabolism: Plants synthesize carbohydrates from CO_2 & H_2O by photosynthesis, storing the absorbed energy internally.

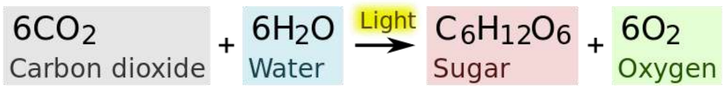


Figure 3: Photosynthesis reaction

Catabolism: Catabolism are the metabolic reactions which cells undergo to breakdown larger molecules, extracting energy. Humans consume a variety of carbohydrates and by the process of digestion break down complex carbohydrates into a few simple monomers: glucose, fructose, and galactose. Glucose constitutes about 80% of these breakdown products and is the primary structure that is distributed to cells in the tissues, where it is broken down or stored as glycogen. There are pathways like glycolysis, citric acid cycle by which glucose molecules produce energy.

Though often maligned from the trendy diets, carbohydrates are a basic food groups and are important for a healthy diet. What’s important is the type of carbohydrate that we choose to eat, because some sources are better than others. The type of carbohydrate present in the food is more important than the amount of carbohydrate present. It is advised to have carbohydrates from healthy foods rather than following strict diet, limiting or counting the number of carbohydrates consumed.

FATS

Mitil Biswas, Soumyasree Mitra, Srijoni Dey

(4th Semester)

Chemistry Honours

Fats are an important part of our diet. There are different types of fats, with some fats being healthier than others. To help make sure you stay healthy, it is important to eat unsaturated fats in small amounts as part of a balanced diet. When eaten in large amounts, all fats, including healthy fats, can contribute to weight gain. Fat is higher in energy (kilojoules) than any other nutrient and so eating less fat overall is likely to help with weight loss. Eating less saturated and trans fats may help lower your risk of heart disease. Fats are one of the three main macronutrients, along with carbohydrates and proteins. Fat molecules consist of carbon and hydrogen atoms and are therefore hydrophobic and are soluble in organic solvents and insoluble in water. Examples: cholesterol, phospholipids, and triglycerides. Cholesterol is a type of fat found in food, but also in our blood. Oil normally refers to a lipid with short or unsaturated fatty acid chains that is liquid at room temperature, while fat specifically refers to lipids that are solids at room temperature – however, fat (in the broad sense) may be used in food science as a synonym for lipid. There are two essential fatty acids (EFAs) in human nutrition: alpha-linolenic acid (an omega-3 fatty acid) and linoleic acid (an omega-6 fatty acid). Other lipids needed by the body can be synthesized from these and other fats. Fats and other lipids are broken down in the body by enzymes called lipases produced in the pancreas.

Categorization of fats:

Fats and oils are categorized according to the number and bonding of the carbon atoms in the aliphatic chain. Unsaturated fats have one or more double bonded carbons in the chain. The nomenclature is based on the non-acid (non-carbonyl) end of the chain. This end is called the omega end or the n-end. Thus alpha-linolenic acid is called an omega-3 fatty acid because the 3rd carbon from that end is the first double bonded carbon in the chain counting from that end. Some oils and fats have multiple double bonds and are therefore called polyunsaturated fats. Unsaturated fats can be further divided into cis fats, which are the most common in nature, and trans fats, which are rare in nature. Unsaturated fats can be altered by reaction with hydrogen promoted by a catalyst. This action, called hydrogenation, tends to break all the double bonds and makes a fully saturated fat.

Fats that are saturated fats have no double bonds between the carbons in the chain. Saturated fats can stack themselves in a closely packed arrangement, so they can solidify easily and are typically solid at room temperature. For example, animal fats tallow and lard are high in saturated fatty acid content and are solids. Olive and linseed oils on the other hand are unsaturated and liquid.

Fats serve both as an energy store and energy source for the body. Each gram of fat when burned or metabolized releases about 9 calories, which is a lot of energy. Fats are broken down in the healthy body to release their constituents, glycerol and fatty acids. Glycerol itself can be converted to glucose by the liver and so become a source of energy.

Fatty acid chains may also differ by length, often categorized as short to very long.

- Short-chain fatty acids (SCFA) are fatty acids with aliphatic tails of fewer than six carbons (i.e. butyric acid).
- Medium-chain fatty acids (MCFA) are fatty acids with aliphatic tails of 6–12 carbons, which can form medium-chain triglycerides.
- Long-chain fatty acids (LCFA) are fatty acids with aliphatic tails of 13 to 21 carbons.
- Very long chain fatty acids (VLCFA) are fatty acids with aliphatic tails of 22 or more carbons.

Structure:

A fat is formed when a glycerol joins with three fatty acids. Glycerol is part of the structure of fat and is made up of three carbon atoms. Each carbon atom can bond, or attach, to four other atoms. One of those bonds is made with a hydroxyl-group, or a hydrogen and oxygen. The other three bonds are with carbon and hydrogen atoms. Fats are also made up of fatty acids, which have a long chain of carbons. On one end of the chain there is a carboxyl-group, or a carbon double bonded to an oxygen and single bonded to an oxygen and hydrogen.

Functions:

Triglycerides, cholesterol and other essential fatty acids--the scientific term for fats the body can't make on its own--store energy, insulate us and protect our vital organs. They act as messengers, helping proteins do their jobs. They also start chemical reactions involved in growth, immune function, reproduction and other aspects of basic metabolism. The cycle of making, breaking, storing and mobilizing fats is at the core of how humans and all animals regulate their energy. An imbalance in any step can result in disease, including heart disease and diabetes. For instance, having too many triglycerides in our bloodstream raises our risk of clogged arteries, which can lead to heart attack and stroke.Fats help the body stockpile certain nutrients as well. The so-called "fat-soluble" vitamins--A, D, E and K--are stored in the liver and in fatty tissues.

Fat rich foods:

Salmon, trout, mackerel, sardines, herring, avocados, cheese, dark chocolates, whole eggs, nuts, chia seeds, extra Virgin olive oil, coconut and coconut oil, full-fat yoghurt.

Adverse effects of excess fat consumption and alternatives suggested by research:

Dietary consumption of fatty acids has effects on human health. Studies have found that replacing saturated fats with cis unsaturated fats in the diet reduces the risk of cardiovascular disease. For example, a 2015 systematic review of randomized control trials by the Cochrane Library concluded: "Lifestyle advice to all those at risk of cardiovascular disease and to lower risk population groups should continue to include permanent reduction of dietary saturated fat and partial replacement by unsaturated fats."

Numerous studies have also found that consumption of trans fats increases risk of cardiovascular disease. The Harvard School of Public Health advises that replacing trans fats and saturated fats with cis monounsaturated and polyunsaturated fats is beneficial for health. A 2014 meta-analyses of randomized controlled trials found that reducing fat and cholesterol intake does not affect cardiovascular disease or all cause mortality. The easiest solution, however, is to incorporate sufficient physical activity in our daily routine. Consuming a balanced diet and being physically active can go a long way in helping us maintain a healthy life.

FOOD ADDITIVES

Pragya Dugar, Deblipi Bal, Muzaina Khatoon, Kanika Bhattacharyya

3rd year

B.Sc (General)

Food additives consist of those substances like flavour, colour, preservatives etc. which make the food more colourful, attractive, palatable and can be stored for long time without deterioration in quality. During the processing of food products, the flavour sometimes becomes very weak and colour fades. To supplement these weaknesses synthetic flavours and colours are added which do not affect health adversely. Some additives have been used for centuries; for example, preserving food by pickling (with vinegar), salting, as with bacon, preserving sweets or using sulphur dioxide as with wines. With the advent of processed foods in the second half of the twentieth century, many more additives have been introduced, of both natural and artificial origin. Food additives can be grouped into three broad categories: food flavours, food colours and food preservatives.

I. Food Flavour includes both natural and synthetic flavouring materials. There are three principal types of flavourings used in foods. They are as follows:

Types	**Description**
1. Natural flavouring substances	Substances which are extracted from vegetable or animal materials and are not further chemically modified or changed. It includes spices (like black pepper, cumin seed, cloves, cinnamon, mustard seed, etc) , essential oils, herbs and plant extracts (like vanilla extract).
2. Nature – identical flavouring substances	Substances that are chemically identical to natural substances, but which are obtained by chemical processes or by chemical modification of other natural substances. An example is vanillin, not obtained from vanilla bean, but synthesized chemically.
3. Artificial flavouring substances	Substances obtained by chemical synthesis or chemical modification of natural substances, but which are not normally present in natural products. The known flavouring agents include thousands of molecular compounds like esters, often described as being sweet or fruity.

Related to flavours are the additives known as **Flavour Enhancers.** The most common among them is monosodium glutamate (MSG) which does not have a unique flavour at low concentrations, but intensifies the flavour of other compounds present in food. Maltol is another flavour enhancer which increases sweetness.

II. A **Food Color** is any dye, pigment or substance which when added or applied to food is capable of imparting color. Color additives are used in food for various reasons:

1) To offset color loss due to environmental and storage conditions; 2) To correct natural variations in color and to enhance naturally occurring colors; 3) To provide color to colorless foods.

Without food colors, colas wouldn't be brown and mint ice creams wouldn't be green. Thus, they are an important part of almost all processed foods. In fact, a food is largely determined by its appearance and humans are accustomed to standard colors of food product. Only certified colors fit for consumption are allowed to be used in food. Natural coloring agents like turmeric, saffron can be used to impart yellow, orange color while Amatto is used in butter and cheese. Caramel can be produced from burnt sugar to give a brown color. However, pure synthetic dyestuffs are mostly used owing to their low cost and high coloring power. As colors should also remain stable during food processing, only coal tar dyes are fit for human consumption. It is used in soft drinks, candies and desserts. Other such usable colors are-Amaranth and erythrosine dye for red, Tartrazine and Sunset yellow for yellow, Fast green for green and Indigotine for blue. Some uncertified dyes, which are usually azo and amine compounds like metanil yellow, malachite green, congo red or rhodamine B are sometimes used to color food and vegetables in our country. These chemical substances are carcinogenic and unfit for prolonged human consumption.

III. Food Preservative is a chemical that is added to products such as food and beverages to prevent decomposition by microbial growth or undesirable chemical changes. Chemical preservation entails the addition of chemical compounds to food. Preservative food additives reduce the risk of food borne infections, decrease microbial spoilage, and preserve the fresh attributes and nutritional quality of food. Chemical preservatives lenghthen the life of food products to a considerable extent. Organic and inorganic acid preservatives may be added in the form of the undissociated acid or a variety of salts.These include lactic acid and lactates, propionic acid and propionates, citric acid,acetic acid, sorbic acid, and sorbates, benzoic acid and benzoates, and methyl and propyl parabens (benzoic acid derivatives). Benzoates are most effective when undissociated; therefore, they require low pH values for activity (2.5–4.0). The sodium salt of benzoate is used due to improved solubility in food. Benzoates are primarily used in high-acid foods (jams, jellies, juices, soft drinks, ketchup, salad dressings, and margarine). They are active against yeast and molds, but minimally against bacteria. Sorbic acid and sorbate salts (potassium most effective) are effective at pH values less than 6.5. Sorbates are used in cheeses, baked or non-yeast goods, beverages, jellies, jams, salad dressings, dried fruits and pickles. They prevent yeast growth during vegetable fermentations and can be used at levels up to 0.3%. Propionic acid and propionate salts (calcium most common) are active against molds at pH values less than 6. They have limited activity against yeasts and bacteria. They are widely used in baked products and cheeses. Acetic acid is most active against bacteria, and has some yeast and mold activity, though less active than sorbates or propionates. Lactic acid, citric acid, and their salts can be added as preservatives, to lower pH. Antioxidants prevent rancidity of fats, oils and fat containing foods like cooking oil, potato chips, soap mixes, margarine, cooked fish and meat. Reports are also available on the application of antibiotics and ionizing radiation as means of food preservation.

The use of food additives is only justified when their use does not mislead consumers, and serves a well-defined technological function, such as preservation of the nutritional quality of food or enhances the stability of the food. The evaluation of risk to human health with food additives is conducted by the Joint FAO/WHO Expert Committee on Food Additives (JECFA). This is an independent, international expert scientific group responsible for assessing the risks to human health from food additives. As per WHO, only the food additives that undergo a JECFA safety assessment can be used. The above applies whether food additives are derived from a natural source or synthetic. National authorities, either based on the JECFA assessment or based on an independent national assessment, can then authorize the use of food additives at specified levels for specific foods. The evaluation by JECFA is based on scientific reviews of all available biochemical, toxicological, and other relevant data on a given additive. Acceptable Daily Intake (ADI) is the starting point for determining whether a food additive can be used without having harmful effects. The ADI is an estimate of the amount of an additive in food or drinking water that can be safely consumed daily over a lifetime without adverse health effects.

CHEMISTRY IN THE KITCHEN

Arpita Das and Sumedha Thakur

(1st Semester)

Chemistry Honours

Introduction

Earnest websites, advertisements and well-meaning popular articles routinely warn us about nasty “chemicals” lurking in our homes and kitchens. Many talk about the benefits of switching to a “chemical-free lifestyle”.

The problem is the term ‘chemical free’ does not make much sense. Everything is a chemical – common table salt (sodium chloride), for instance, and even water (dihydrogen oxide).

Lessons in the kitchen can be entertaining and creative to teach some basic concepts of both cooking and chemistry. Mixing ingredients together often causes chemical reactions to occur, many of which are advantageous in cooking.

Testing the effects of salt

Salt not only depresses the freezing point of water but also raises the boiling point of water. Freezing ice cream depends on lowering the freezing point of water. By adding salt to a container of ice surrounding an inner chamber containing ice cream ingredients, the salt will melt the ice and the ultra-cold water will surround the chamber and freeze the ingredients to form ice cream. Though salting water may cause it to boil more slowly, it is often done to flavour rice or pasta. Two pots of water holding the same volume of water, with the same heat applied will boil at different temperatures if one contains salt and other does not.

Use apples to learn oxidation

Many fruits and vegetables produce chemicals known as oxidases, which carry out oxidation. Through a series of physical changes, these chemicals can produce brownness. This can be observed by cutting an apple or avocado in half and letting it sit for an hour or so. Because oxidases are enzymes, which are proteins, they can be destroyed by physical factors such as excess heat or acid. Adding lemon juice, citric acid or briefly heating the apple by immersing it in boiling water will destroy these enzymes and inhibit the chemical reaction that causes browning.

A bubbly acid base reaction

Acids and bases react in ways that are advantageous in the kitchen. When baking soda, which is a base, comes into contact with an acid, the composition of both change and usually create carbon dioxide bubbles. For instance, vinegar or lemon juice and baking soda mixed together fizzes strongly and can be used to clean kitchen surfaces. Carbon dioxide bubbles are useful in baking because they help baked goods rise; so, many recipes call for both baking soda and an acidic ingredient such as sour cream.

List of acidic liquids

FRUIT JUICES :- Acidic liquids have low pH levels. Many fruit juices qualify as acidic liquids. Some of the more acidic fruit juices are orange juice, lemon juice, grapefruit juice, tomato juice and red currant juice. These fruit juices are often used in marinades for meats, particularly tougher cuts of meat because their acidic nature helps to break down and tenderize it.

CLEANERS :- Lots of different household cleaners contain acids that help remove stains, dirt and grime. The most commonly used acidic household cleaner is bleach. Reducing bleach uses acids to turn the stain into a water-soluble substance that can easily be cleaned.

VINEGAR :- It is another type of acidic liquid. There are many different types of vinegar, as it can be made out of any sugar containing liquid. Examples include: apple cider vinegar, red wine vinegar, balsamic vinegar, etc. It is used in many food items, such as pickles and salad dressings. It is also often used in cleaners as its acids can cut through grease and grime.

Chemical reactions that occur during baking

PROTEIN BONDING:- Flour contains two important proteins – glutenin and gliadin. When water is added to flour to make dough, it allows these proteins to bond together and form a new protein called gluten. Kneading the dough intensifies these gluten bonds. After the dough is placed into a heated oven, it begins to rise and grow the gluten network. This network eventually hardens during the baking process, giving the inside of a loaf of bread its signature structure.

MAGIC LEAVENERS:- Leavening agents such as yeast, baking powder and baking soda give baked dough its lightness. Baking soda achieves this by reacting with acids in the dough to produce CO_2 gas, which puffs up the dough. Baking powder releases CO_2 twice during the process – once when it hits water and once when it reaches a certain temperature in the oven.

When yeast is added to dough it begins to feed on starches, producing alcohol and CO_2 as by products. The CO_2 produced by it causes the dough to rise.

MAILLARD REACTIONS :- It occurs when proteins and sugars are broken down and rearranged by high temperatures. These reactions produce ring shaped organic compounds that darken the surface of baking dough.

FLAVOURS OF CARAMELIZATION :- Caramelization occurs at 356 degrees Fahrenheit and is the last chemical reaction to occur during the baking process. The reaction occurs when high heat causes sugar molecules to break down and release water, which turns into steam. Diacetyl, which gives caramel its butterscotch flavour, is produced during the first stages of caramelization. Next, esters and lactones, which have rum-like flavour are produced. Finally, the production of furan molecules imparts a nutty flavour, and a molecule called maltol imparts a toasty flavor to the baked item.

Crying while chopping onions

Onions produce the chemical irritant known as SYNPROPANETHIAL-S-OXIDE. It stimulates the eyes' lachrymal glands to release tears. Scientists used to blame the enzyme allinase for the instability of substances in a cut onion. Recent studies from Japan, however, prove that lachrymatory- factor synthase (a previously undiscovered enzyme) is the culprit.

The process goes as follows:

1. Lachrymatory-factor synthase is released into the air when we cut an onion.
2. The synthase enzyme converts the amino acid sulfoxides of the onion into sulfenic acid.
3. The unstable sulfenic acid rearranges itself into syn-ropanethial-S-oxide.
4. Syn-propanethial-S-oxide gets into the air and comes in contact with our eyes. The lachrymal glands become irritated and produce tears as a secretion from our eyes.

Conclusion

Thus, the article on "kitchen chemistry" shows that chemistry and science are related to one another and is something that we see on a daily base. Understanding the chemistry behind various everyday phenomena in the kitchen leads to the development of a more wholesome scientifically sound mindset. Science, hence, leads to our cognitive development and creates a better image of ourselves with manual functions and skills thereby giving us self – confidence.

FOOD PRESERVATIVES

Sneha Paul and Samiya Islam

(1st Semester)

Chemistry Honours

What are preservatives?

Preservatives are substances or chemicals that are added to products such as food, beverages, pharmaceutical drugs, paints, cosmetics and many other products to prevent decomposition by microbial growth or by undesirable chemical changes.

Food preservation

Food is so important for the survival, so food preservation is one of the oldest technologies used by human beings to avoid its spoilage. Different ways and means have been found and improved for the purpose. Boiling, freezing & refrigeration, pasteurizing, dehydrating, pickling are the traditional few. Sugar, mineral salt and salt are also often used as preservatives food. Nuclear radiation is also being used now as food preservatives. Modified packaging techniques like vacuum packing and hypobaric packing also work as food preservatives.

Food Preservation is basically done for three reasons:

- To preserve the natural characteristics of food
- To preserve the appearance of food
- To increase the shelf value of food for storage.

Natural Food Preservatives

In the category of natural food preservatives comes the salt, sugar, alcohol, vinegar etc. These are the traditional preservatives in food that are also used at home while making pickles, jams and juices etc. Also the freezing, boiling, smoking, salting are considered to be the natural ways of preserving food. Coffee powder and soup are dehydrated and freeze-dried for preservation. In this section the citrus food preservatives like citrus acid and ascorbic acid work on enzymes and disrupt their metabolism leading to the preservation.

Sugar and salt are the earliest natural food preservatives that very efficiently drop the growth of bacteria in food. To preserve meat and fish, salt is still used as a natural food preservative.

Chemical Food Preservatives

Chemical food preservatives are also being used for quite some time now. They seem to be the best and the most effective for a longer shelf life and are generally fool proof for the preservation purpose. Examples of chemical food preservatives are:

- Benzoates (such as sodium benzoate, benzoic acid)

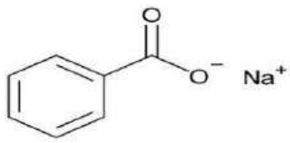


Figure 1: Sodium Benzoate

- Nitrites (such as sodium nitrite)

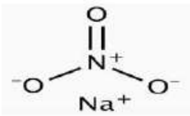


Figure 2: Sodium Nitrite

- Sulphites (such as sulphur dioxide)

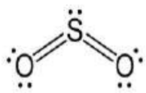


Figure 3: Sulphur dioxide

- Sorbates (such as sodium sorbate, potassium sorbate)

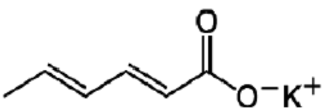


Figure 4: Potassium sorbate

Antioxidants are also the chemical food preservatives that act as free radical scavengers. In this category of preservatives in food comes the vitamin C, BHA (butylated hydroxyanisole), bacterial growth inhibitors like sodium nitrite, sulfur dioxide and benzoic acid.

Artificial Food Preservatives

- In antimicrobial comes Sodium benzoate, Sorbates and Nitrites.
- Antioxidants include the Sulfites, Vitamin E, Vitamin C and Butylated hydroxytoluene (BHT).
- Chelating agent has the Disodium ethylenediaminetetraacetic acid (EDTA), Polyphosphates and Citric acid.

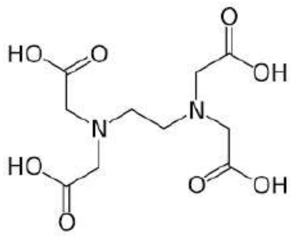


Figure 5: EDTA

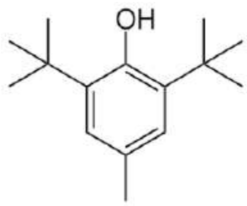


Figure 6: BHT

Harmful food preservatives

Benzoates

This group of chemical food preservative has been banned in Russia because of its role in triggering allergies, asthma and skin rashes. It is also considered to cause the brain damage. This food preservative is used in fruit juices, tea, coffee etc.

Butylates

This chemical food preservative is expected to cause high blood pressure and cholesterol level. This can affect the kidney and liver function. It is found in butter, vegetable oils and margarine.

BHA (butylated hydroxyanisole)

BHA is expected to cause the live diseases and cancer. This food preservative is used to preserve the fresh pork and pork sausages, potato chips, instant teas, cake mixes and many more.

Caramel

Caramel is the coloring agent that causes the vitamin B6 deficiencies, genetic effects and cancer. It is found in candies, bread, brown colored food and frozen pizza.

In addition to this there are many other harmful food preservatives. These are Bromates, Caffeine, Carrageenan, Chlorines, Coal Tar AZO Dies, Gallates, Glutamates, Mono- and Di-glycerides, Nitrates/Nitrites, Saccharin, Sodium Erythrobate, Sulphites and Tannin.

Table 1: Some common preservatives and their primary activity

Chemical Affected	**Organism(s)**	**Action**	**Use in Foods**
Sulfites	Insects & Microorganisms	Antioxidant	Dried Fruits, Wine, Juice
Sodium Nitrite	Clostridia	Antimicrobial	Cured Meats
Propionic Acid	Molds	Antimicrobial	Bread, Cakes, Cheeses
Sorbic Acid	Molds	Antimicrobial	Cheeses, Cakes, Salad Dressing
Benzoic Acid	Yeasts & Molds	Antimicrobial	Soft Drinks, Ketchup, Salad Dressings

EMULSIFIERS IN FOOD INDUSTRY

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Chemistry Honours

The word "emulsion" comes from the Latin mulgeo, mulgere "to milk", as milk is an emulsion of fat and water, along with other components. An emulsion is a mixture of two or more liquids that are normally immiscible (unmixable or unblendable). Emulsions are part of a more general class of two-phase systems of matter called colloids. Although the terms colloid and emulsion are sometimes used interchangeably, emulsion should be used when both phases, dispersed and continuous, are liquids. In an emulsion, one liquid (the dispersed phase) is dispersed in the other (the continuous phase). Examples of emulsions include vinaigrettes, homogenized milk, and some cutting fluids for metal working.

Two liquids can form different types of emulsions. As an example, oil and water can form, first, an oil-in-water emulsion, wherein the oil is the dispersed phase, and water is the continuous phase. (Lipoproteins, used by all complex living organisms, are one example of this.) Second, they can form a water-in-oil emulsion, wherein water is the dispersed phase and oil is the continuous phase. Multiple emulsions are also possible, including a "water-in-oil-in-water" emulsion and an "oil-in-water-in-oil" emulsion.

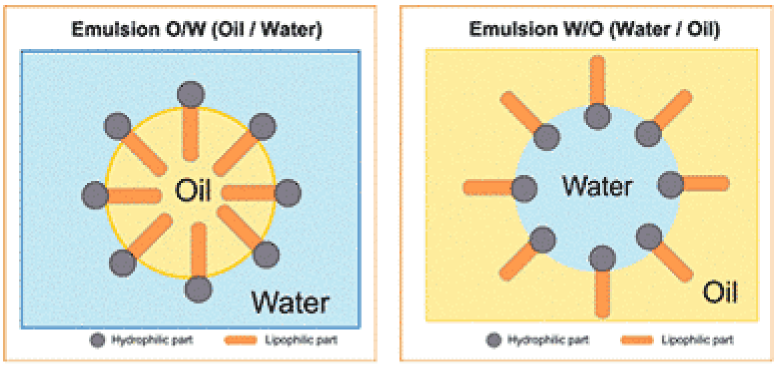

Figure 1: Types of emulsion

Emulsions, being liquids, do not exhibit a static internal structure. The droplets dispersed in the continuous phase (sometimes referred to as the "dispersion medium") are usually assumed to be statistically distributed.

The term "emulsion" is also used to refer to the photo-sensitive side of photographic film. Such a photographic emulsion consists of silver halide colloidal particles dispersed in a gelatin matrix. Nuclear emulsions are similar to photographic emulsions, except that they are used in particle physics to detect high-energy elementary particles.

Emulsifiers, stabilizers, and related compounds are also used in the preparation of cosmetics, lotions, and certain pharmaceuticals, where they serve much the same purpose as in foods—i.e., they prevent separation of ingredients and extend storage life.

FAQ: HLB Value

A common method for choosing an emulsifier is the Hydrophilic-Lipophilic Balance (HLB) system which uses a scale of 0 to 20 based on their affinity for oil and water. Emulsifiers with low HLB-values are more lipophilic (bind oils), while higher HLB compounds are hydrophilic (bind water).

In general, emulsifiers with HLB-values of 3 – 8 give w/o-emulsions, whereas those with values of above 9 are more water-soluble and result in o/w-emulsions. The following list shows the emulsifier properties depending on their HLB Value:

HLB 1 - 3: Antifoaming Properties

HLB 3 - 8: w/o-Emulsification

HLB 7 - 9: Wetting Properties

HLB 9 - 18: o/w-Emulsification

HLB 15 - 20: Solubilizing Properties

Appearance and Properties

Emulsions contain both a dispersed and a continuous phase, with the boundary between the phases called the "interface". Emulsions tend to have a cloudy appearance because the many phase interfaces scatter light as it passes through the emulsion. Emulsions appear white when all light is scattered equally. If the emulsion is dilute enough, higher-frequency (low-wavelength) light will be scattered more, and the emulsion will appear bluer – this is called the "Tyndall effect". If the emulsion is concentrated enough, the color will be distorted toward comparatively longer wavelengths, and will appear more yellow. This phenomenon is easily observable when comparing skimmed milk, which contains little fat, to cream, which contains a much higher concentration of milk fat. One example would be a mixture of water and oil.

Two special classes of emulsions – microemulsions and nano emulsions, with droplet sizes below 100 nm – appear translucent. This property is due to the fact that light waves are scattered by the droplets only if their sizes exceed about one-quarter of the wavelength of the incident light. Since the visible spectrum of light is composed of wavelengths between 390 and 750 nanometers (nm), if the droplet sizes in the emulsion are below about 100 nm, the light can penetrate through the emulsion without being scattered.

Emulsifiers

An emulsifier (also known as an "emulgent") is a substance that stabilizes an emulsion by increasing its kinetic stability. One class of emulsifiers is known as "surface active agents", or surfactants. Emulsifiers are compounds that typically have a polar or hydrophilic (i.e. water-soluble) part and a non-polar (i.e. hydrophobic or lipophilic) part. Because of this, emulsifiers tend to have more or less solubility either in water or in oil. Emulsifiers that are more soluble in water (and conversely, less soluble in oil) will generally form oil-in-water emulsions, while emulsifiers that are more soluble in oil will form water-in-oil emulsions.

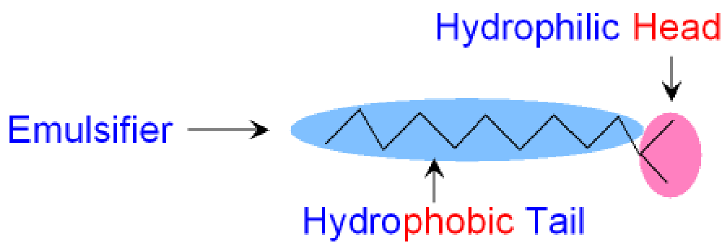

Figure 2: Parts of an emulsifier

Function of emulsifier

1. To promote emulsion stability, stabilize aerated systems, and control agglomeration of fat globules.
2. To modify texture, shelf life and rheological properties by complexing with starch and protein components
3. To improve the texture of fat-based foods by controlling the polymorphism of fats.

Uses (Food Industry):

Oil-in-water emulsions are common in food products:

- Crema (foam) in espresso – coffee oil in water (brewed coffee), unstable emulsion
- Mayonnaise and Hollandaise sauces – these are oil-in-water emulsions stabilized with egg yolk lecithin, or with other types of food additives, such as sodium stearoyl lactylate
- Homogenized milk – an emulsion of milk fat in water, with milk proteins as the emulsifier
- Vinaigrette – an emulsion of vegetable oil in vinegar, if this is prepared using only oil and vinegar (i.e., without an emulsifier), an unstable emulsion results.

Water-in-oil emulsions are less common in food, but still exist:

- Butter – an emulsion of water in butterfat
- Margarine

Other foods can be turned into products similar to emulsions, for example meat emulsion is a suspension of meat in liquid that is similar to true emulsions.

Foaming

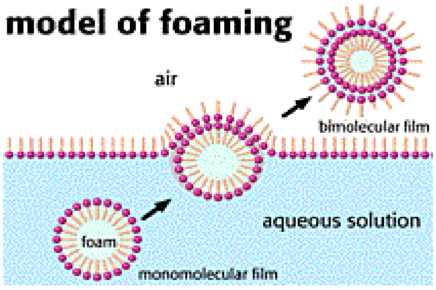

Figure 3: Model of foaming

Foaming ability is one of the major characteristics of emulsifiers. When a solution containing an emulsifier is stirred, the emulsifier is adsorbed on the surface of the produced foam to make a mono-molecular layer and the foam outside of the solution makes a bimolecular layer of the emulsifier.

The film coating a bubble is about 100 times thicker than a bimolecular layer, but a bubble breaks off as soon as migration of liquid trapped between bimolecular films occurs.

The addition of emulsifier enables foaming and stabilizes emulsion state of products, Thus, smooth texture and expanded volume can be obtained. Typically, emulsifier for ability above is used for cakes, ice cream, moose, whipped topping, etc.

Anti-foaming / Defoaming

Emulsifier also has anti-foaming and defoaming ability. Anti-foaming or defoaming agents are used in food production where undesirable foaming may occur in the presence of protein, starch etc.

Anti-Foaming/Defoaming Agents Characteristics:

• water insoluble

• floatable on the surface because of its small specific gravity

• small surface tension and easy spreading on liquid surface

These characteristics lower the surface tension, and the foam will get thinner. As these agents spread on the liquid surface, all foam will be diminished.

Wetting

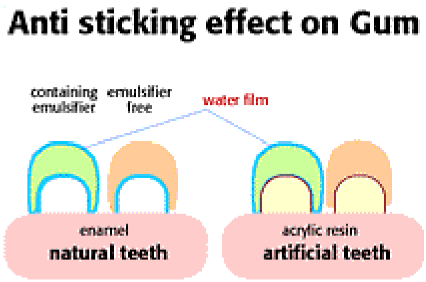

Figure 4: Anti sticking effect on gum

Wetting effects of emulsifiers moisten the solid surfaces on which they are spread. If a solid material is mixed with an emulsifier or its surface is covered with an emulsifier, the surface then becomes hydrophilic. This is the reason why chewing gum sticks to artificial teeth more than natural teeth.

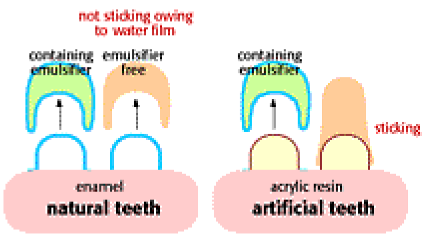

Figure 5: Sticking of gum in natural and artificial teeth

Adhesion to natural teeth does not occur easily because the enamel is hydrophilic and always wet, whereas adhesion to artificial teeth occurs easily. We can prevent adhesion by wetting the surface of chewing gum by adding emulsifier.

Bacteriostatic Effects

Monoglycerides of middle chain fatty acid and some polyglycerol esters have specific bacteriostatic effects and are used as bacteriostatic agents. They are typically used in hot vendor drinks, flour paste, and canned soup.

Action on Starch

Fresh bread is soft, but it becomes elastic and hardens over time. Starch particles consist of spherical shaped amylopectin and amylose. Raw starch called beta-starch is insoluble in water. When heated to a certain temperature, the starch absorbs water and changes into the crystalline form. The amylose gets hard easily with cooling and amylopectin becomes hard gradually with time. The immediate hardening of bread by cooling is mainly due to the change of amylose.

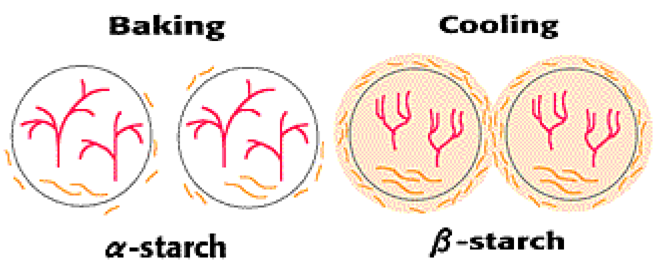

Figure 6: Change in structure of bread on baking and cooling

Amylose changes to a helix structure, a kind of spiral structure by heating. If monoglycerides are introduced, they can be anchored into the helix structure. Since the anchoring ensures that the structure of amylose does not change even after cooling, softness is maintained.

This function is also utilized for instant mashed potatoes, noodles and rice.

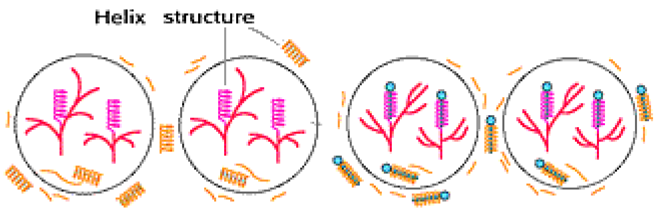

Figure 7: Change in structure of bread on baking and cooling after addition of monoglyceride

Action on Protein

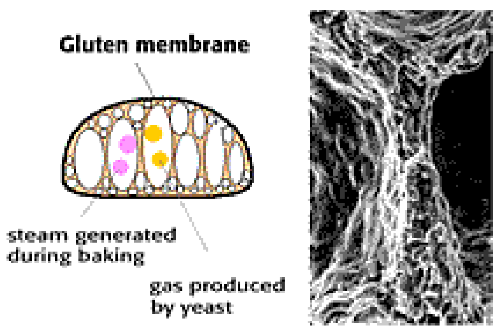

Figure 8: Change in gluten on baking

Wheat flour contains protein called gluten which takes the shape of a mesh-like structured when mixed with water. This wheat flour and water-based dough is filled with carbon dioxide produced by fermentation and steam generated during baking, which produces raised bread.

When the gluten content is small, the dough only rises a little. An emulsifier modifies gluten molecules and enhances its film-forming power resulting in good spreading ability and improvement of working efficiency. Thus, easy-rising bread can be obtained.

Action on Oils and Fats

When fats and oils form into crystal, an emulsifier promotes and inhibits the growth which prevents the formation of abnormal crystal.
This function is utilized for margarine, shortening and chocolate.