The Food Tech Times

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The Spice Spectrum : Unraveling the world of Spices

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The Food Tech Times

A Newsletter by AFST(I) Cochin Chapter

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From Editor's desk

Dr. Abhilash Sasidharan
Editor, The Food Tech Times

Spices are an important group of food ingredients holding significant positions in culinary traditions, healing ad rituals throughout the world. Other than enhancing food flavors for centuries, they have been pivotal in shaping global economies through established trade routes on a global scale. The famous 'Spice Route', the elaborate maritime trade network that connected East to West is an example for the role spices played in the global food economy. The trade transactions that started as a mere exchange of spice goods later transferred to wards cultural levels transforming societies throughout the world. As a food ingredient, spices impart characteristics, flavor, color, and aroma to dishes transferring unique attributes to otherwise dull dishes, allowing chefs to create their individual signatures which are transferred from generation to generation inculcating a sense of uniqueness and kinship. Other than this, spices also hold abundant health benefits promoting the overall well-being of the consumers. The anti-inflammatory and antioxidant properties possessed by spices like turmeric and ginger, antimicrobial properties of cloves and cinnamon, pro-digestion properties of cumin are some examples to be put forth. Also, the medicinal benefits of spices have been acknowledged in ancient health and healing practices like Ayurveda and traditional Chinese medicine, emphasizing their role in general health. The fact that spices like turmeric are used in traditional rituals also enhances their importance as a cultural element. Spices are also an important contributor towards the agricultural economy of India, contributing substantially to its farming output, export income, and ethnic legacy. India's distinct climate and soil conditions present an ideal condition for the culture of a varied variety of spices, making it the largest producer and exporter of spices globally. Indian spice production touched 11.14 million tons in 2023 contributing an export income of US$ 3.73 billion. The Indian spice spectrum is majorly governed by Black Pepper, Cardamom, Turmeric, Cloves, Ginger, and Coriander among many other varieties. India exports spices to over 150 countries, with key markets such as the United States, Europe, and the Middle East. In contemporary years, the requirement for organic and high-quality spices has risen, presenting Indian farmers with beneficial prospects. The Spices Board of India, an apex body for the growth and international promotion of Indian spices, plays a critical role in regulating and improving the quality of spices, thereby ensuring the competency of local spices in the global market. Research institutes such as The Indian Institute of Spices Research (IISR), under the Council of Agricultural Research (ICAR) also contribute towards the R&D developing more productive and disease-resistant varieties of spices including their value addition. The terminology of "Indian Curry" which is a world-famous culinary tradition accepted across different food cultures is heavily inspired by the diverse mix of spices that it encompasses. The Indian cuisine which is equally celebrated worldwide along with many food traditions such as Chinese and Italian is known for its varying degree of hotness and flavor complexity again contributed by the spice combinations. This edition of The Food Tech Times brings you a collection of articles on the topic "The Spice Spectrum: Unraveling the world of Spices". Hope it spices up your knowledge buds towards a better understanding of the contemporary spice spectrum.

"Each spice has a special day to it. For turmeric it is Sunday, when light drips fat and butter-colored into the bins to be soaked up glowing, when you pray to the nine planets for love and luck."

— Chitra Banerjee Divakaruni, The Mistress of Spices

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AFST(I) Cochin Chapter

Newsletter designed by:

Nair Chithra Harinarayanan
Member, AFST(I) Cochin chapter
Associate Editor, The Food Tech Times
Mail ID: chithrahari1999@gmail.com

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About AFST(I) Cochin Chapter.....

AFST(I) is the largest professional body of Indian food scientists and technologists and during the past 8 years, the Chapter has made significant contributions to the academic and industrial community of food science and technology.

The continuing pandemic situation has affected several activities of the association. However routine activities of the Association were carried out without fail. Since the situation is easing out Cochin chapter can also venture out carefully into newer activities.

In 2016 Cochin Chapter of AFST(I) conducted "Food Entrepreneur's Conclave" in association with the Kerala University of Fisheries & Ocean Studies (KUFOS), Kochi. Prof (Dr) A Ramachandran, Vice Chancellor, KUFOS inaugurated the programme. Mr. James Joseph the techie turned entrepreneur and Founder, Jackfruit365.com made a presentation on his experience in jackfruit utilisation. Smt. Omana Muraleedharan who has come up with a prawn based snack, 'Prawnoes'. Described her experience in launching the first prawn flavoured ready to eat snack food. K.Aravindakshan, Deputy General Manager , KSIDC, Kochi, Vikas Temani , Strategic Growth Areas, Synthite Industries Ltd, Ernakulam, Baiju, Nedumkery, Founder and Chairman, Agropark and Technolodge ,Piravom ,T.Johnson , Entrepreneur Consultant, Food Processing Technologies, Dr.C O Mohan, Sr.Scientist, ,Central Institute of Fisheries Technology, Kochi and Dr.Satyen Kumar Panda, Sr.Scientist ,Quality Assurance & Management Division, CIFT, were the resource persons in the Conclave. Conclave was attended by 158 registered participants. In 2017 AFST (I) Cochin Chapter, KUFOS and Bakers Association Kerala (BAKE) jointly organised Trainers' Training Workshop for Bakery Professionals at KUFOS which was held as part of the Diamond Jubilee Celebrations of AFST (I). Prof (Dr). A .Ramachandran, Vice Chancellor of KUFOS, inaugurated the workshop. Dr VM Victor George Registrar, KUFOS, P M Sankaran, President Indian Bakers Federation, Dr K Gopakumar Former Deputy Director General, ICAR also spoke on the occasion. Classes were conducted by eminent Resource Persons in the field . They include Reshmi Rajan, Nodal Food Safety Officer Govt of Kerala, Rachel Jacob ,Former GM Quality Control ,Modern Food Industry Ltd, Dr C.P.S .Menon, formerly with Britannia Industries. Selected experts from the bakery industry also shared their success experience in the sector. The workshop was attended by about 90 participants for whom it was a great occasion to clarify their apprehensions and doubts.

AFST(I) Cochin chapter regularly observed World Food Day every year by organizing workshops, meeting, training sessions and Quiz Programmes by associating with leading academic institutions. In 2019 a workshop on "Prospects & challenges of Catering Industry in Kerala" was conducted. The function was inaugurated by Dr A Ramachandran – Vice chancellor, KUFOS . Mr V K Varghese having astounding experience in food catering industry also shared his experience. Lectures were given by Mr Jacob Thomas (Asst Commissioner –Food Safety Ernakulam), Mr Biju P Abraham (MIE, General Manager), Dr Bhadran A (Former Government Analyst- Regional Laboratory, Kakkanad) and Dr P E Doles (FSSAI, Kochi). Other institutions with which the Chapter associated in celebrating World Food Day are IGNOU Regional Centre, Kaloor ,St Theresa's College, SH College ,Thevara, and St Gits College, Kottayam.

AFSTI Cochin Chapter conducted several FOSTAC Food Safety Supervisor training on Advanced manufacturing (Level 2) . Two batches of two day FoSTaC Level 3 (Special) training on Milk and milk products were organised by KUFOS ,Panangad and AFST(I) Cochin Chapter at the University campus in 2018. Late Job Elias , National Trainer provided the training. Dr. C T Chacko, Former Managing Director, Kerala Livestock Development Board guided the participants through cattle rearing issues. In the coming years our Association can take up more activities supporting food entrepreneurs and student community in the discipline of Food Technology.

About the Newsletter.....

The Association of Food Scientists and Technologists (India), Cochin Chapter is coming up with a newsletter titled “The Food Technology Times”. The newsletter is intending to provide information regarding the activities of the chapter, achievements of the members, remembering the pioneers of the food industry that inspire our journey forward and also valuable and informative articles from eminent experts from the field.

We have also strived to make the newsletter student-friendly by including student articles and information that could be utilized by the student community to fuel their academic as well as professional endeavors.

The 11th edition of our newsletter especially focuses on the theme "The Spice Spectrum: Unraveling the world of Spices" so that the readers can get acquainted with or gain more knowledge on what is spices, the chemistry behind them, nutritional quality, oleoresin extraction and also its processing.

Wish you all a very happy reading!!!

THE SPICE SPECTRUM: UNRAVELING THE WORLD OF FLAVOURS

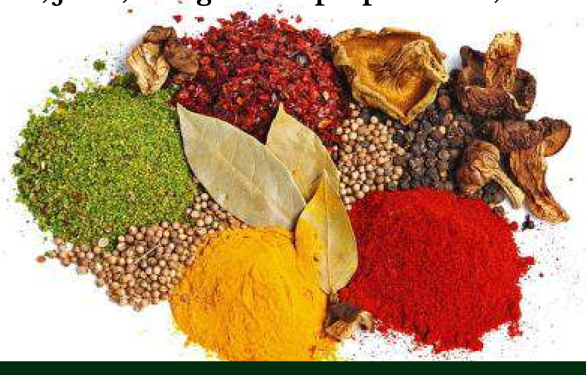
GEORGE THOMAS &ANJALI KRISHNA
FRUITOMANS

The world of spices do create a mesmerizing spectrum not only due to its appearance but also in terms of their Flavours, aromas and most importantly with its huge array of Health benefits. Spices have been integral to human civilization for millennia, shaping cultures, economies, and histories. This essay delves into the spectrum of spices, exploring their origins, uses, and the remarkable impact they have on our palates and lives. India's spice market is undergoing a remarkable transformation, bridging the timeless allure of classic blends and traditional masalas with contemporary creations. Fuelled by the spirit of experimentation and inspired by global culinary trends, spice brands and manufacturers are at the vanguard of innovation, pushing the boundaries of creativity to create bold new blends and avant-garde seasonings. This dynamic evolution reflects a concerted effort to cater to the discerning tastes of modern consumers who seek not only tradition but also novelty and sophistication in their culinary experiences.

Different spices evoke unique flavors and sensations, transporting us to diverse cultural and geographical landscapes. Cumin, coriander, and turmeric commonly used in Indian and Middle Eastern cuisine evoke warm earthy flavors. Cumin adds a slightly bitter-nutty taste, while coriander provides a sweet citrusy note. Turmeric with its bright yellow color imparts a slightly bitter-earthy flavor. In contrast, the bold pungent flavors of chili peppers popular in Latin American and Asian cuisine, add a spicy kick. Paprika, with its smoky sweetness, is a staple in Hungarian and Spanish cooking. The aromatic flavours of cinnamon, nutmeg and cardamom, commonly used in baked goods and desserts evoke a sense of warmth and comfort. Cinnamon adds a sweet woody flavor, while nutmeg provides a slightly sweet, nutty taste. Cardamom, with its unique sweet-savoury flavor, is a staple in Scandinavian and Indian baking. Ginger, garlic, and onion add a savoury, slightly sweet flavor to various dishes, while herbs like basil, oregano, and thyme provide bright, refreshing notes.

Spices come in a variety of forms like whole, ground cracked flaked or infused each with its own distinct properties and culinary uses. Whole spices, like cloves and cinnamon sticks, which are unprocessed retain their natural flavour and aroma. Ground spices, like cumin and turmeric, which are finely powdered for easy mixing and distribution. Cracked spices, like black pepper and coriander seeds, which are broken into smaller pieces for added texture and flavour release. Flakes, like garlic and onion, which are dried and flaked for convenient use. Powdered spices, like paprika and chili powder, which are dried and powdered for intense flavour. Infused oils, like chili oil and garlic oil, which are flavoured with spices for added depth. Spice blends, like curry powder and garam masala, which combine multiple spices for complex flavour profiles. Fresh spices, like ginger and cilantro, which are used in their natural state for bright, vibrant flavour. Dried spices, like thyme and oregano, which are preserved through drying for long-term use. Freeze-dried spices, like basil and mint, which are frozen and then dried to preserve their flavour and aroma. Another important flavour contribution is from the spice oleoresins. Concentrated oleoresins pack a potent flavour punch, elevating the overall flavour experience and ensure consistent quality with an excellent shelf life. Oleoresins are the concentrated extract obtained from different parts of plants, spices, and herbs. Different from essential oils, oleoresins comprise, in addition to volatile compounds, non-volatile compounds (pigments, pungency), making them more complex extracts (Sowbhagya, 2019). As they show a more complete aromatic and flavour profile, this product can be used in smaller quantities than essential oils and raw spices. These extracts are rich in compounds capable of providing aroma, taste, colour, and pungency making oleoresins additives of interest to the food industry (Shahidi & Hossain, 2018).

Oleoresins are a naturally occurring combination of oil and resin that can be extracted from plants. Different plants require different methods of extraction; common ways to extract are through water (steam distillation), oil, and alcohol, and each can vary in the level of concentration they produce. The content can be controlled and fine-tuned through the use of various solvents and pressures. For final use, these products are typically dispersed in a dry neutral carrier or liquid such as vegetable oil to the desired strength. They have many applications as a colouring agent in butter, cheese, meats, snack foods, and cereals, in jellies, jams, and gelatine preparations, in



poultry feed to enhance the colour of eggs and poultry, in frozen foods, desserts, soups, fish preserved in oil, meat sauces, or any prepared food where a more vibrant colour is desired, in the preparation of some medicines. Because they have the same properties as the original spice, they can replace whole or ground spices without compromising aroma, flavour or texture. As a result, oleoresins have a lot of advantages over whole or ground spices. Oleoresins are easy to store and transport because concentrated forms reduce space and bulk. They can be more heat stable than raw spices and have a longer shelf life due to lower moisture content.

In conclusion, the world of spices is a vast and complex tapestry of flavours, aromas, and cultures. Through their unique characteristics and blend of compounds, spices have the power to evoke emotions, create connections, and bring people together. The spice industry is growing at a pace faster than ever, thanks to innovative applications in diverse fields like seasonings, flavours and the increasing interest in the immune-boosting properties of spices. The latter has found favour with the nutraceutical, wellness and health segment. Spices remain one of the very few sectors in the global economy to emerge relatively unscathed from the challenges posed by the COVID-19 pandemic. Prospects for the spice industry are therefore very bright but despite the rosy picture there are quite a few challenges that need to be tackled so that growth can be achieved without any major hindrance. As we continue to explore and discover new spices and flavours, we unravel the rich history and diversity of the spice world. Whether used in cooking, medicine, or rituals, spices remain an integral part of our lives, weaving a shared narrative of human experience and cultural exchange. So let us embrace the unravelling world of flavours and savour the richness that spices bring to our lives."

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SPICES: THE FLAVOR OF FOODS

Alvina Rose

PG Student, M.Voc. Food Processing Technology, St. Teresa's College, Ernakulam

Spices have been the cornerstone of global cuisine for centuries adding depth, complexity and aroma to various dishes. The spice spectrum is a kaleidoscope of flavor, aroma and texture that have captivated the senses of culinary enthusiasts for centuries. The use of spices spans centuries, cultures and cuisines, playing a fundamental role in defining the sensory experience of food. From the fiery heat of chili peppers to the warm complexity of cinnamon and the citrusy brightness of coriander, spices offer a diverse spectrum of flavors that contribute to the art of culinary creation (Ravindran, 2017).

1. HISTORY OF SPICES

Spices have been a vital part of human history, playing a significant role in shaping global cuisine, trade and culture. From ancient civilizations to modern-day cooking, spices have added flavor, aroma and depth to various dishes making them an integral part of our culinary traditions. The history of spices dates back thousands of years, with evidence of spice trade and use found in ancient civilizations such as Egypt, China and India (Fernández-Armesto, 2013). Spices like pepper and cinnamon were highly valued for their flavor, medicinal properties and preservative qualities, leading to the establishment of the spice trade (Harrison, 2008). Spices were not only a luxury item but also a symbol of wealth, power and status. The spice trade played a significant role in shaping global cuisine, with different cultures adopting and adapting various spices to create unique flavor profiles (Saldanha, 2016). The Silk Road, a network of ancient trade routes, facilitated the exchange of spices, ideas and cultures between East and West (Liu, 2010). Today, spices continue to be an essential part of cooking with their unique flavor and aroma evoking emotions, memories and cultural identities.

The science behind spices reveals the presence of volatile compounds which are responsible for their aroma and taste (Fennema, 2007).

2. SCIENCE OF SPICES

Spices consist of various bioactive compounds which is responsible for its distinctive flavor, aroma and color. The flavor of spices is attributed due to the presence of volatile compounds, which is responsible for their aroma and taste.

These compounds can be affected by factors such as climate, soil and processing methods (Fennema, 2007). The various bioactive components present in spices are:

2.1. *Volatile Oils*: Volatile oils are also known as essential oils, are a class of organic compounds found in spices, characterized by their high vapor pressure and strong fragrance. Volatile oils are the flavorful compounds in spices responsible for its aroma and flavor (Fennema, 2007). Volatile oils are composed of terpenes, esters, and aldehydes which are highly reactive and prone to oxidation (Friedman, 2014).

2.2. *Phenolic Acids*: Phenolic acids are a class of organic compounds found in spices, consist of a phenolic ring and a carboxylic acid group. Phenolic acids such as ferulic acid and cinnamic acid are abundant in spices like turmeric, ginger and cinnamon (Raghavan, 2006). These compounds are known for their antioxidant and anti-inflammatory properties, making them potential candidates for health promotion (Kaur et al., 2020).

2.3. *Alkaloids*: Alkaloids are a class of organic compounds found in spices consist of a nitrogen-containing ring and a basic pH. Alkaloids like piperine in pepper and capsaicin in chili peppers, are responsible for the pungency and heat of spices (Chen et al., 2019). These compounds have been studied for their bioavailability and pharmacokinetics, showing potential applications in medicine (Patel et al., 2022).

2.4. *Flavonoids*: Flavonoids are a class of organic compounds found in spices consisting of flavan and hydroxyl groups. Flavonoids present in spices like cloves and allspice, are known for their antioxidant and anti-inflammatory properties (Gupta, 2013). These compounds have been shown to have potential health benefits, including cardiovascular protection and neuroprotection (Guven et al., 2019).

3. CLASSIFICATION OF SPICES

A. On the basis of cotyledons		
1.	Dicotyledoneae	Chilli, paprika, red pepper, sesame, chicory, long pepper, pepper, mace, nutmeg, bay leaf, cassia, cinnamon, star-anise, mustard, wasabi, allspice, clove, celery, coriander, cumin, dill, fennel and parsley
2.	Monocotyledoneae	Garlic, onion, saffron, cardamom, ginger, turmeric and vanilla
B. On the basis of family		
1.	Zingiberaceae	Cardamom, ginger and turmeric
2.	Solanaceae	Chilli
3.	Piperaceae	Pepper and pepper long
4.	Apiaceae	Coriander, cumin, fennel, celery, aniseed, ajowan, caraway, dill, garlic, parsely, asafoetida and lovage
5.	Fabaceae	Fenugreek
6.	Lauraceae	Cinnamon, cassia and bay leaf
7.	Rutaceae	Curry leaf
8.	Clusiaceae	Kokam and camboge
9.	Lamiaceae	Mint, basil, rosemary, sage, savory, thyme and oregano
10.	Brassicaceae	Mustard and horse radish
11.	Iridaceae	Saffron
12.	Orchidaceae	Vanilla
13.	Lilliciaceae	Star Anise
14.	Capparidaceae	Caper
15.	Myrtaceae	Clove and allspice
16.	Myristicaceae	Nutmeg and mace
17.	Papaveraceae	Poppy seed
18.	Cupressaceae	Juniper berry
19.	Asteraceae	Tarragon
20.	Caesalpiniaceae	Tamarind

C. On the basis of Economic importance		
1.	Major spice	Black pepper, chilli, small cardamom, ginger and turmeric
2.	Minor spice	Except the above 5 spices all other spices are grouped under minor spices.
D. On the basis of origin & flavor		
1.	Pungency spice	Pepper, ginger, chilli, mustard, garlic, oregano and onion
2.	Aromatic fruit	Cardamom, fenugreek, cumin and nutmeg
3.	Aromatic bark	Cinnamon and cassia
4.	Phenolic spices	Cloves and allspice
5.	Colored spices	Paprika, Saffron and Turmeric
E. On the basis of degree of taste		
1.	Hot spices	Capsicum, black and white peppers, ginger and mustard
2.	Mild spices	Paprika and coriander
3.	Aromatic spices	All spice, cardamom, cassia, cinnamon, clove, cumin, dill, fennel, fenugreek, mace and nutmeg
4.	Herbs	Basil, bay, dill, leaves, marjoram, tarragon and thyme
5.	Aromatic vegetables	Onion, garlic and celery
F. On the basis of growth habits		
1.	Herbs	Coriander, cumin, tenet, fenugreek, chilli and parsley
2.	Shrubs	Rosemary and chilli
3.	Trees	Nutmeg, clove, cinnamon, tamarind, garcinia and Japanese pepper
4.	Climbers	Black pepper, tailed pepper and vanilla
5.	Perennial herbs/ rhizomatous herbs	Cardamom, ginger, turmeric, mango ginger, Japanese ginger, galanga and asafoetida.
G. On the basis of season of growth		
1.	Annual spices	Coriander, cumin, fennel, fenugreek, ajowan and black cumin, aniseed, mustard and chilli
2.	Biennial spices	Onion and parsley
3.	Perennial spices	Cardamom, turmeric, ginger, black pepper, saffron, clove, nutmeg, asafoetida and cinnamon
H. On the basis of parts used		
1.	Leaf	Coriander, celery, curry leaf, mint, parsley, hyssop, bay leaf, lovage, marjoram, basil, rosemary, sage, savory, thyme, oregano and tarragon
2.	Bark	Cinnamon and cassia
3.	Rhizome	Ginger, turmeric, sweet flag and greater galangal
4.	Fruit	Pepper, cardamom, chilli, coriander, cumin, fennel, celery, aniseed, ajowan, caraway, dill, pepper long, star anise, allspice and tamarind
5.	Seed	Cardamom, fenugreek, mustard, nutmeg and, poppy seed
6.	Rind	Kokam and camboge
7.	Bulb	Garlic and onion

8.	Stem	Celery and lovage
9.	Pod	Vanilla
10.	Stigma	Saffron
11.	Root	Horse radish, angelica and lovage
12.	Flower bud	Caper
13.	Unopened flower bud	Clove
14.	Berry	Juniper berry
15.	Aril	Mace

Table 1: Classification of spices (Chhetri et al., 2018)

4. HEALTH BENEFITS OF SPICES

Spices have been a staple of global cuisine for centuries, adding flavor, aroma, and depth to various dishes. However, beyond their culinary applications, spices possess a wealth of health benefits, making them a valuable addition to a healthy lifestyle. The various health benefits of spices include:

4.1. *Antioxidant properties*: One of the most significant health benefits of spices is their antioxidant properties. Spices like turmeric, ginger, and cinnamon are rich in polyphenols, which combat free radicals and reduce inflammation in the body. This can lead to a reduced risk of chronic diseases like heart disease, cancer, and neurodegenerative disorders (Kaur et al., 2020).

4.2. *Anti-inflammatory properties*: Spices also possess anti-inflammatory properties, which can alleviate symptoms of conditions like arthritis, muscle soreness, and digestive disorders. Capsaicin, found in chili peppers, has been shown to reduce pain and inflammation by blocking the production of prostaglandins (Patel et al., 2022).

4.3. *Antimicrobial properties*: Spices have been found to have antimicrobial properties, making them effective against harmful bacteria and fungi. Cumin, coriander, and cinnamon have been shown to inhibit the growth of E. coli and Staphylococcus aureus (Raghavan, 2006).

In addition to their individual health benefits, spices can also enhance the bioavailability of nutrients in food. Piperine, found in black pepper, has been shown to increase the absorption of curcumin, a polyphenol found in turmeric (Patel et al., 2022).

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Development of Modern Spice Oil and Oleoresin Industry in India

Dr. Mathew (A.G.) Attokaran
Cochin

Spices with their attractive aroma and flavor have been a fascination for man from ancient times. Many daring expeditions were undertaken for locating the source of these fascinating food ingredients. However, with the growth of modern food industry, demand for a precisely standardized extracts having all the properties of the spice (Fig 1), grew.

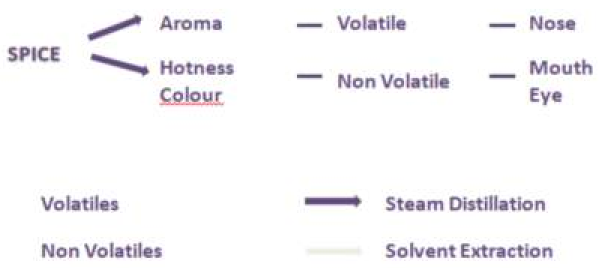


Fig. 1 Organoleptic properties of spices

After the World War II, in the Western world, production of extractives like either spice oils by steam distillation or spice oleoresin by solvent extraction only could be made. They were unable to produce both the extractives at the same time from raw material. This is very wasteful and the prices of products were high. The
flow diagram of production of spice oleoresin is shown in Fig 2.

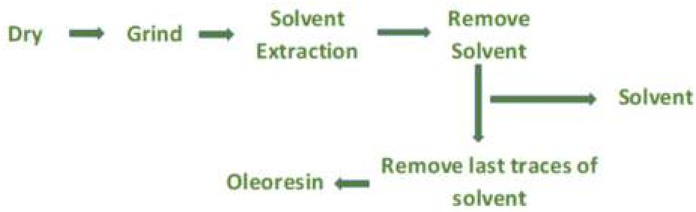


Fig. 2 Traditional method of producing Oleoresin Black Pepper

A successful attempt to produce both oil and oleoresin in a two-stage single process was made by scientists of CSIR Central Food Technological Research Institute, Mysuru. In this process, first stage is steam distillation to produce spice oil and second stage is extraction of resinous matter containing all non volatile ingredients like pungent and other taste giving constituents along with colour if any. (Fig 3) Finally these two fractions could be blended in appropriate proportions as required by the buyer.

Development of this two stage process has been one of the most significant efforts in food technology in the independent India. For spices which have essential oils, first stage therefore will be recovery of the oil. For this dry spice is size reduced. During the grinding cell walls will be ruptured enabling oil to vaporize and escape out in volatile form. Oil is then obtained when the mixture of oil vapors and steam is cooled with the help of a cold water circulating condenser.

Very fine grinding will encourage channeling of steam and therefore coarse grinding is employed. It also helps in avoiding channeling during passing of solvent in second stage.

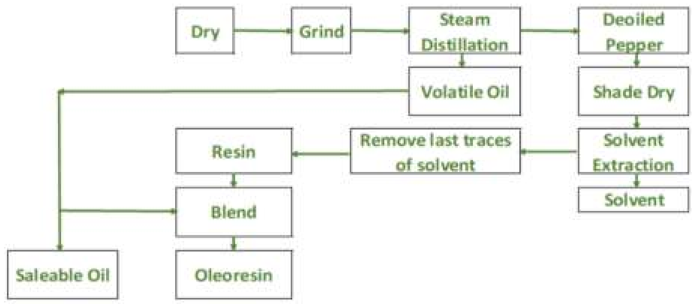


Fig.3 Improved Indian method of two stage extraction of Black Pepper.

Black pepper is one of the most important spices with valuable spice oil and oleoresin. (Fig 4). Highest level of oil and piperine, the pungent principle, are found in slightly immature pepper. At this stage outside colour will be dark green due to chlorophyll. During drying due to enzyme action outer skin gets a very dark colour. Because of slightly early harvesting Sri Lankan pepper is the best raw material for making of oleoresin. It gives high yield of oleoresin and high levels of piperine. In India, best raw material is produced in Nedumangad and Pulpully regions. Immature pepper of Indonesia and Vietnam are also used in India especially when the demand for pepper oil and oleoresin are high. Vietnam raw material is generally regarded as inferior. Dried slightly immature pepper is passed through a roller mill when berries flatten into flakes. This is then steam distilled to obtain the pepper oil.

The deoiled pepper is then shade dried if needed and passed on to stainless steel percolators. Piperine containing resinous fraction is extracted with a suitable solvent. Ethylene dioxide, ethyl acetate and mixture of acetone - hexane are the widely used solvents. The miscella so obtained is then freed of the solvent by distillation.

The next most important step is removal of the last traces of solvent residue. When organic solvents are used, there are strict limits usually in parts per million (ppm) level for residual solvent. For achieving this, use of stirring, vacuum and letting in of steam to virtually steam distil the traces of solvent are resorted to. Removal of last traces of solvent residue is a standard procedure in all oleoresins.

Finally required quantity of pepper oil is blended with resin fraction to obtain oleoresin of the specification of the buyer. Not all the chlorophyll of the skin disappears on drying.

Therefore pepper oleoresin will have a dark green colour, with the right amount of piperine for hotness and pepper oil for aroma. The most popular grade of oleoresin black pepper is 40% piperine and 20% volatile oil. Other grades with more or less content of both piperine and oil are also demanded by buyers all over the world.

It may be noted that resinous fraction and oil do not blend into a homogenous oleoresin in the case of black pepper. There is a tendency for piperine to sink to the bottom and oil to float on top. To get a fine homogenous product, the use of an emulsifier like polysorbate 80 and passing through a mechanical homogenizer are required. Production of a finely blended pepper oleoresin is as much a good technology as is a fine art.

Fig. 4 Pepper berries on vines ready for harvest.

Ginger is another spice with valuable spice oil which gives the spice and oleoresin the characteristic rich aroma. Cochin ginger is a highly valued raw material for extraction.(Fig 5). To hasten removal of moisture, the skin of ginger rhizome is scraped with a knife on both sides.

Fig. 5. Dried Cochin peeled ginger.

Another important raw material is the Nigerian split ginger. A cheaper raw material is Shimoga dry ginger of Indian origin. This gives inferior ginger oil and oleoresin. However due to lower price of the products, there is some demand for Shimoga ginger products. In the case of ginger also, as in all spices with spice oil, two stage operations of steam distillation of oil and extraction are resorted to. But unlike in pepper, oil and resin blend well. The main pungent principle of ginger is gingerol. Celery seed and nutmeg are two important spice oils and oleoresins. Celery seed is mostly obtained from Punjab and nearby areas. Selinine is an important ingredient of celery oil. Important chemical ingredient of nutmeg oil is myristicine. India and Sri Lanka are good sources of nutmeg; however myristicine content of oils from these two countries are low. Best quality raw material with high content of myristicine is obtained from Indonesia. Since raw material is not seen by the consumers, appearance of seed is not important. For cost effectiveness the most sought after grade of raw material is BWP (Broken, Wormy and Punky). A considerable quantity of nutmeg oil is used for flavouring of cola drinks.

In these as well as in most minor spices oil blends easily with resinous fraction. Among the minor spices, an important spice for processing into oils and oleoresins, is coriander. India, Russia and Morocco are the main producers of coriander seed. Raw material for cumin and fennel oils and oleoresins are also available in India.

It may be noted that in all cases of spices which have spice oils, considerable quantity of oils are produced. Only about 50% of oil obtained is needed for blending to produce oleoresin. Rest is saleable spice oils. This is one the major advantage of two stage process developed in India.

There are a few spices which have no spice essential oil. Prominent among these is chili. Therefore the extraction can be carried out in one stage. There are two types of chilis. The one with high pungency is used for making oleoresin capsicum. (Fig 6). Pungent constituent of chili is capsaicin. The major raw materials are available in India. Earlier traditional varieties like Sanam and Mundu were used. Later Indian researchers produced a high pungent variety known as Jwala. But in recent time better varieties like Namdhari and Teja with higher content of capsaicin and colour were developed. Extraction is usually carried out after removing of the seed, which has a steady market in chili grinding industry.

Most popular oleoresins of capsicum sold are those with 6.6% and 10% of capsaicin. There is demand for oleoresin with 3.3% and even 40% capsaicin also. There is no specific level of colour. But in special cases buyers specify required range of colour content. For use in light coloured and white products there is demand for decolorized oleoresin capsicum. Activated carbon is used to decolorize oleoresin.

High coloured low pungent chili known as paprika gives on extraction the very valuable oleoresin paprika. Colour is expressed in terms of colour units (cu). India has a major variety of raw material known as Byadege. It has high colour, but the disadvantage is it has a rather moderate amount of capsaicin. Because of this it is unsuitable for making oleoresin paprika. Indian researchers of CSIR National Institute of Interdisciplinary Science and Technology, Trivandrum, have found ways to separate capsaicin from paprika by using liquid- liquid fractionation. Industry also contributed significantly to standerdize the process of deheating of oleoresin from Byadege. The separated capsaicin can be added to oleoresin capsicum, and thus reducing the price of sweet paprika made from Byadege chili.

This innovation made Indian paprika oleoresin produced from Byadege chili very popular. Today India has become a big producer and exporter of oleoresin paprika. The most popular grades of oleoresin are the ones with 100,000 cu and 40,000 cu.

The colour constituents of paprika are xanthophylls, which are oxygenated carotenes. Xanthophylls of chili and paprika are red in colour. Out of these major ones are capsanthin and capsorubin.

Fig 6. Hot chili after drying.

Even though turmeric has an essential oil it has not got a market, so much so oil is not produced. There is a very small demand in Ayurvedic preparations. Solvent extracted oleoresin has small demand. But the main demand is for pure curcumin, which is the yellow pigment separated from oleoresin by crystallization. Turmeric is the dried rhizome of the turmeric plant. (Fig 7) The best raw material is Alleppey turmeric. A trade variety that is abundantly available is Erode turmeric. Because of presence of large amount of starch, rhizome requires a boiling step for gelatinization of starch, before sun drying.

Powdered dry turmeric is then extracted with a suitable solvent. Ethylene dichloride, ethyl acetate and mixture of acetone and hexane are all satisfactory solvents. Oleoresin is obtained after removal of solvent. To obtain curcumin in pure form, it is separated from oleoresin by crystallization. Ethyl acetate, acetone and isopropyl alcohol are all good solvents for crystallization. The separated crystals are collected by filtration using a basket centrifuge.

Fig 7. Turmeric plant with turmeric rhizome.

Curcumin with at least 95% purity has demand both as a natural food colour and as nutraceutical. It has excellent antioxidant property which is helpful in preventing onset of cancer, correcting cardiovascular problems, treatment of inflammations etc. India is the major supplier of curcumin to the world.

India and Guatemala are the main producers of cardamom. While there is a small demand for oleresin, cardamom oil is the main product from this spice. The first step is separation of seeds, which has all the valuable volatile oil, from the husk. For this cardamom pods are passed through a plate mill, with plates loosely fitted. Seeds are then separated from husk by sieving. Cardamom oil is obtained by steam distillation of the mildly crushed seeds. Cardamom oil has a pleasing aroma and has a great demand in various sweet preparations.

In recent years spice oils and oleoresin industry has been recording a healthy growth as can be seen from Table 1. In 2021-22, total export has shown an export figure of nearly Rs 4500 crores corresponding to over $4000 millions.

Table 1 EXPORT OF SPICE OILS AND OLEORESINS FROM INDIA

	2017—18	2019—20	2021—22
Total Quantity in M. tones	17,200	13,000	21,000
Value in Rs Crores	2661.72	2446.83	4478.38
Total Spice Export in $ millions	2789.35	3110.63	4102.29

Table 2 represents export figures of individual items of spice oils. It can be noted that volatile oils of ginger, pepper, garlic and mustard have performed well.

Table 2 EXPORT OF INDIVIDUAL ITEMS OF SPICE OILS – 2021-22

	Quantity in m tonnes	Value in Rs Crores		Quantity in m tonnes	Value in Rs Crores
Aniseed	81.21	9.78	Dill seed	2.26	0.59
Caraway seed	1.18	0.41	Fennel seed	2.30	0.59
Cassia	4.07	0.57	Garlic	176.33	35.55
Celery seed	26.12	16.00	Ginger	73.81	57.78
Cinnamon leaf	14.22	2.40	Mustard seed	288.24	30.36
Cinnamon bark	12.77	3.43	Nutmeg	72.62	25.84
Clove leaf	101.97	13.14	Pepper	133.40	43.08
Clove bud	25.02	4.85	Turmeric	25.67	8.39
Coriander seed	17.55	7.24	Other spices	118.88	75.83
Cumin seed	14.22	3.99			

Export figures of individual items of various spices are presented in Table 3. Impressive performance comes from paprika, capsicum which is included in other spices, pepper and turmeric which mainly consists of curcumin.

Table 3 EXPORT OF INDIVIDUAL ITEMS OF SPICE OLEORESINS: 2021-22

	Qty. mt	Value Rs Crores		Qty. mt	Value Rs Crores
Cardamom	29.41	12.52	Garcinia extract	1151.00	109.00
Celery	329.96	25.19	Ginger	359.79	95.06
Clove bud	23.16	6.93	Nutmeg	231.44	41.68
Coriander	70.26	10.68	Paprika	6930.27	1449.57
Cumin	83.23	11.10	Pepper	1490.07	379.65
Fennel	11.34	1.46	Turmeric	2251.41	927.39
Fenugreek	168.82	15.32	Other spices	7579.28	1053.02

While oleoresins in small batches are produced, extraction is generally carried out using batch counter current method. However, when large batches are processed, especially in the case of major spices like black pepper, paprika, capsicum and turmeric, now-a-days it is customary to employ continuous plants for ease of handling and for

increased output.

Development of a innovative novel method of extraction, deheating of Byadege chili oleoresin and other appropriate improvements carried from time to time have contributed to the growth of spice oil and oleoresin industry in India. However, one significant factor that contributed to the growth of the industry has been the tremendous initiative shown by the pioneer entrepreneurs who started the industry, with their insistence on quality of the products and adherence to good business practices.

SPICES EXPORT- QUALITY AND FOOD SAFETY REQUIREMENTS

Dr. B.Jacob Meledom
Managing Director
TransSynergy Quali Systems (P) Ltd

Spices are intricately intertwined in the history of the world. Imagine the spices did not exists, then countries in Europe would not have launched expeditions of exploring sources of supply of spices, their ambition for colonial empires would have remained dormant.

Of course, lure of spices made them undertake adventurous expedition would lead to the discovery of unknown continents.

India, the land of spices was the dream destination of the seafarer. Of course there were other tropical countries which later became spice destination.

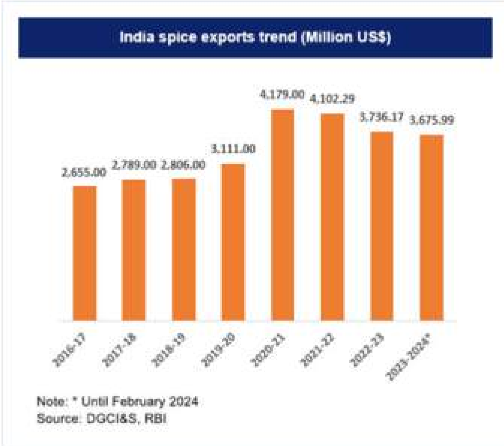
Jill Norman in 'The Complete Book of Spices' writes: "Spices have been used for thousands of years in throughout Asia, Arabia and the Mediterranean region. Once valued as highly as gold. They were such sought after in the west and the quest for spices influenced the course of history dramatically. Countries wide to win control over the production and navigators such sail to discover new sea route to east which eventually allowed small nations to build a large empires. Although the days of warring on spices are now over spices still play significant role in the economies of many countries. "

Port of Lisbon in 16th century was the most important centre of spice trade
Pic courtesy: 'The Book of Spices' - (Catz International B.V.)

The spices have a wide spectrum uses:

1. Culinary
2. Pharmaceuticals
3. Nutraceuticals
4. Cosmetics
5. Immunity enhancers
6. Natural colours
7. Traditional, Cultural and Religious uses
8. Confectionary
9. Perfumery

World trade in spices has grown substantially over the decade. India shares 75 % of the world production of spices. We are also the largest consumer of spices in the world. Major spices exports from India include Red chillies, Black Pepper, Turmeric, Ginger, Cardamom etc. During FY 2023-24 India exported 153,969 tonnes spices valued at INR 36,958.80 crores equivalent to US $ 4.46 billion.



Export of spices from India

The multiple uses of spices show a widening spectrum- Culinary, pharmaceutical, nutraceutical, cosmetic, immunity supplements, natural colours, confectionary, perfumery, cultural and religious uses.

Spices are exported primarily as whole spices, spice powders, Masala powders, spice extracts such as essential oil, oleoresin, natural colours etc.

Exports to USA

USA is the major buyer of Indian Black pepper, Exports of Black Pepper to USA have to meet the specifications of the AMERICAN SPICE TRADE ASSOCIATION (ASTA) and the requirements of FEDERAL FOOD, DRUG AND COSMETIC ACT (FFD & C ACT).

The Federal Food Drug and Cosmetic Act (FFD & C Act) of the United States is the most comprehensive legislation of its kind in the world. The US Food and Drug Administration (USFDA) is responsible for the enforcement of the provisions of the Act. The basic objective of the Act is to ensure the health and safety of the US citizens. It ensures the consumers that food are pure and wholesome, safe to eat and produced under sanitary conditions. Any food imported to USA which does not conform to these requirements is not allowed to enter the channels of distribution to the consumers. FDA has powers to detain such shipments and ask the importers to bring such shipments into compliance or else re-export or destroy them.

Black Pepper exports from India was brought under the purview of Quality Control & Pre-shipment Inspection with effect from 1st January 1963. Export Inspection and Certification of Black Pepper was done in accordance with the provisions under the Agricultural Produce (Grading & Marketing) Act 1937 and the rules made under the Act. The grade specifications based on physical characteristics such as colour, size, light berries, density, moisture content, presence of extraneous matter, damaged berries etc. For Ground Black Pepper the parameters include moisture content, total ash content, acid insoluble ash and crude fibre apart from freedom from admixture, mould growth, insect infestation and musty odour.

These specifications define the minimum requirements which Black Pepper for export from India should meet. But the importing countries my stipulate additional requirements based on the food laws and regulations prevalent in those countries. Black Pepper is considered as a food item and hence it becomes mandatory that the product meets the provisions of the food laws and regulations in these countries which reflect the concern of their government to protect the health and safety of their consumers.

In 1987 US-FDA imposed automatic detention on Indian Black Pepper as consecutive shipments were found to be contaminated with mammalian filth (rodent and other mammalian excreta) In the past, Black Pepper exports from India had encountered problems when Ethylene Dibromide (EDB) residues were detected. Consequent to the crisis in 1987 Govt. of India deputed a delegation to United States of America who held discussions with the US-FDA for resolving the problem. As a result of this, a Memorandum of Understanding (MOU) between the Ministry of Commerce and US-FDA was signed on the assurance that Govt. of India will provide a reliable inspection and certification services administered by the Export Inspection Council of India. The methodology of sampling and procedure of analysis were in consonance with US-FDA requirements. Relying on the credibility of the EIC's quality assurance system the US-FDA signed a MOU with the Ministry of Commerce, Govt. of India. Automatic detention imposed on Indian Black Pepper was later revoked by US-FDA after evaluation the performance of Indian shipments over a time span.

ASTA Cleanliness Specifications

The ASTA cleanliness specifications were evolved or compliance by the Spice importers of USA at the initiative of US Food and Drug Administration. The objective of the policy of the FDA was to reach a self-regulation understanding with Spice importers so as the shift most of the work of sampling and analysis of Spice importers from the FDA gave the industry the privilege of importing Spices under conditional release without formal FDA inspection. In exchange, the importers would guarantee the all Spice shipments found to be adulterated on sampling and microscopic analysis by on ASTA approved laboratory would be returned to the exporting country or would be properly cleaned or reconditioned before being put into consumer channels.

However, the ASTA Cleanliness Specifications for unprocessed Spices are a supplementary part of the ASTA's Import contract. Further, these specifications do not substitute the total requirements under FFD & C Act.

The ASTA specifications set limits only for extraneous matter which is removable by further processing under Good Manufacturing Practice (GMP) to place the product in condition for consumption.

A memorandum of understanding (MOU) between the Ministry of Commerce and US-FDA was signed on the assurance that Govt. of administered by the Export Inspection Council of India. The methodology of sampling and procedure of analysis were in consonance with US-FDA requirements.

Relying on the credibility at the EIC's quality assurance system the US-FDA signed a MOU with the Ministry of Commerce, Govt. of India. Automatic detention imposed on Indian Black Pepper was later revoked by US-FDA after evaluation the performance of Indian shipments over a time span.

ASTA's Cleanliness specifications for Spices, Seeds and Herbs

(Effective April 28, 1999)

For purpose of these Specifications, extraneous matter is defined as everything foreign to the product itself and included, but is not restricted to: stones, dirt, wire, string, stems, sticks, nontoxic foreign seeds, excreta, manure and animal contamination.

The level of contaminants permitted under these Specifications must fall below those shown on the following table, except for the column "Whole Insects, Dead" which cannot exceed the limits shown.

	Whole insects dead	Excreta Mammalian	Excreta other	Mold	Insect defiled/ infested	Extraneous foreign matter
Name of spice, seed or herb	By count	By mg./lb	By mg./lb	% by Wgt.	% by wgt.	% by wgt.
All spice	2	5	5.0	2.00	1.00	0.50
Anise	4	3	5.0	1.00	1.00	1.00
Sweet Basil	2	1	2.0	1.00	1.00	0.50n
Caraway	4	3	10.0	1.00	1.00	0.50
Cardamom	4	3	1.0	1.00	1.00	0.50
Cassia	2	1	1.0	5.00	2.50	0.50
Cinnamon	2	1	2.0	1.00	1.0	0.50
Celery Seed	4	3	3.0	1.00	1.0	0.50
Chillies	4	1	8.0	3.00	2.50	0.50
Cloves	4	5	8.0	1.00	1.00	1.00 *
Coriander	4	3	10.0	1.00	1.00	0.50
Cumin Seed	4	3	5.0	1.00	1.00	0.50
Dill Seed	4	3	2.0	1.00	1.00	0.50
Fennel Seed	SF(2)	SF(2)	SF(2)	1.00	1.00	0.50
Ginger	4	3	3.0	SF(3)	SF(3)	1.00
Laurel Leaves **	2	1	10.0	2.00	2.50	0.50
Mace	4	3	1.0	2.00	1.00	0.50
Marjoram	3	1	10.0	1.00	1.00	1.00n
Nutmeg (Broken)	4	5	1.0	SF(4)	SF(4)	0.50
Nutmeg (Whole)	4	0	0.0	SF(5)	SF(5)	0.00
Oregano ***	3	1	10.0	1.00	1.00	1.00n
Black Pepper	2	1	5.0	SF(6)	SF(6)	1.00
White Pepper ****	2	1	1.0	SF(7)	SF(7)	0.50
Turmeric	3	5	5.0	3.00	2.50	0.50

US-FDA DEFECT ACTION LEVEL

Defect Action Level represents the limit at or above which FDA will take legal action against a product to remove it from the market as 'adulterated'. (It is a regulatory requirement that food is prepared, packed, transported and held under sanitary and hygiene condition which would prevent contamination rendering it unfit for use).

PRODUCT	DEFECT (Method)	ACTION LEVEL
Ginger, Whole	Insect filth and/or mold (MPM-V32 (/food/laboratory-methods/mpm-v-8-spices-condiments-flavors-and-crude-drugs#v32))	Average of 3% or more pieces by weight are insect-infested and/or moldy
	Mammalian excreta (MPM-V32 (/food/laboratory-methods/mpm-v-8-spices-condiments-flavors-and-crude-drugs#v32))	Average of 3 mg or more of mammalian excreta per pound
	DEFECT SOURCE: *Insect infestation - post harvest and/or processing, Mold - post harvest and/or processing infection, Mammalian excreta - post harvest and/or processing animal contamination* Significance: *Aesthetic, Potential health hazard - may contain mycotoxin producing fungi*	
Pepper, Whole (Black & White)	Insect filth and/or insect-mold (MPM-V39 (/food/laboratory-methods/mpm-v-8-spices-condiments-flavors-and-crude-drugs#v39))	Average of 1% or more pieces by weight are infested and/or moldy

PRODUCT	DEFECT (Method)	ACTION LEVEL
	Mammalian excreta (MPM-V39 (/food/laboratory-methods/mpm-v-8-spices-condiments-flavors-and-crude-drugs#v39))	Average of 1 mg or more mammalian excreta per pound
	Foreign matter (MPM-V39 (/food/laboratory-methods/mpm-v-8-spices-condiments-flavors-and-crude-drugs#v39))	Average of 1% or more pickings and siftings by weight
	DEFECT SOURCE: *Insect infested - post harvest and/or processing infestation, Moldy - post harvest and/or processing infection, Mammalian excreta - post harvest and/or processing animal contamination, Foreign material - post harvest contamination* Significance: *Aesthetic, Potential health hazard - mammalian excreta may contain salmonella*	
Pepper, Ground	Insect filth (AOAC 972.40)	Average of 475 or more insect fragments per 50 grams
	Rodent filth (AOAC 972.40)	Average of 2 or more rodent hairs per 50 grams
	DEFECT SOURCE: *Insect fragments - post harvest and/or processing insect infestation, Rodent hair - post harvest and/or processing contamination with animal hair or excreta* Significance: *Aesthetic*	

European Spice Association Specifications of Quality Minima for Herbs and Spices

SUBJECT	
Sampling	ISO 948 For mycotoxins: See the relevant Commission Regulation at: www.esa-spices.org
CHEMICAL/ PHYSICAL ANALYSIS	
Ash	For values see appendix I; for analysis see appendix II
Acid Insoluble Ash	For values see appendix I; for analysis see appendix II
Moisture	For values see appendix I; for analysis see appendix II
Volatile Oil	For values see appendix I; for analysis see appendix II
Water Activity	Water activity is a key parameter that affects microbiological growth. Therefore ESA recommends a target value of max. 0.65.
Bulk Density	Due to methodology variability both method and value should be agreed between buyer and seller.
Microbiology	The product shall be free from microorganisms at such levels which may represent a hazard to health. If the product is treated to reduce microbial loads before being imported into destination country the treatment will be such as to render/ensure the microbiological safety of consumers. Specific requirements to be agreed between buyer and seller.
CONTAMINANTS/ RESIDUES	
Pesticides	Shall be utilised in accordance with good agricultural practice. Application and residue limits must comply with existing EU and/or national legislation.
Heavy Metals	Must comply with national / EU legislation (e.g. cadmium, lead).
Mycotoxins	Herbs and spices must be grown, harvested, handled and stored in such a manner as to prevent the occurrence of mycotoxins. If found, levels must comply with existing national and / or EU legislation.
Allergens	Refer to ESA Position Statement

Appendix I Chemical / physical parameters; dry base for ASH, AIA, V/O

PRODUCT[1)]	**ASH % W/W MAX ***	**AIA % W/W MAX ***	**H_20 % W/W MAX ***	**V/O ml/100g MIN ***	**NOTES**
ANISE	9.0	2.5	12	1.0	
BASIL	16	2.0	12	0.5	
CARAWAY	8.0	1.5	13	2.5	
CARDAMOM	9.0	2.5	12	4.0	
CELERY SEED	12	3.0	11	1.5	
CELERY LEAVES	20	1.0	8.0	Traces**	
CHERVIL	17	2.0	8.0	Traces**	
CHILLI	10	1.6	11	-	
CHIVES	13	2.0	8.0	Traces**	
CINNAMON (CEYLON) (CASSIA)	7.0	2.0	14	0.7 – 1.0 (ISO 6539 ISO 6538) Depending on botanical species	The use of SO_2 is only permitted for Ceylon cinnamon, Annex III part B Directive 95/2/EC Styrene off notes can be prevented through the control of moisture content throughout the supply chain.

CLOVES	7.0	0.5	12	14	
CORIANDER SEED Microcarpum Macrocarpum	7.0	1.5	12	0.6 Traces**	
CORIANDER LEAVES	15	1.0	8.0	Traces**	
CUMIN	14	3.0	13	1.5	
DILL SEED	10	2.5	12	1.0	
DILL TOPS	15	2.0	8.0	Traces**	
FENNEL	10	2.0	12	1.5	
FENUGREEK	7.0	1.5	11	Traces**	
GALANGAL (ground)	9.0	4.0	10	Traces**	
GARLIC PRODUCTS	6.0	0.5	6.5	-	Due to the hygroscopic nature of these products lower moisture content may be required

Appendix II **Recommended analytical methods**

Unless otherwise agreed between buyer and seller, ESA recommends the following methods:

1. Spices and condiments – Sampling EN ISO 948 – 2009
2. Spices and condiments – Preparation of a ground sample for analysis ISO 2825 - 1981
3. Spices and condiments – Determination of extraneous matter and foreign matter content ISO 927 – 2009 *(see definition chapter 5)*
4. Spices and condiments – Determination of total ash ISO 928 – 1997
5. Spices and condiments – Determination of acid insoluble ash ISO 930 – 1997
6. Spices and condiments – Determination of moisture content – (Entrainment method) ISO 939 - 1980
7. Spices and condiments – Determination of volatile oil EN ISO 6571 2009
8. Analysis of spices and condiments – Determination of loss in mass of capsicum and allium species and of dried vegetables by vacuum oven drying – DIN 10236 (German standard)

These methods are available at the national standardisation bodies or at www.iso.org (click on ISO store)

Appendix III **Other documents for information**

To help suppliers meet the requirements of the ESA quality minima the following documents may be beneficial:

1. Code of hygienic practice for spices and dried aromatic plants CAC/RCP 42 – 1995, Codex Alimentarius Commission
2. Manual on the Packaging of dried herbs and spices – prepared by the International Trade Centre, ITC, Geneva 1999, ISBN 92-9137-114-9
3. With respect to cleaning and reconditioning, ESA supports the principles of Section 8 "Cleaning and Reconditioning" of the Clean Spices Booklet issued by ASTA, October 2000
4. Guidelines for the application of the Hazard Analysis Critical Control point (HACCP) system Alinorm 93/13 A App. II Codex Alimentarius

FOOD SAFTEY AND STANDARDS AUTHORITY OF INDIA (FSSAI) SPECIFICATIONS

BLACK, WHITE & GREEN (BWG) PEPPERS. - (1) Black, White & Green (BWG) peppers are the berries of *Piper nigrum L.* of the Piperaceae family having reached an appropriate degree of development and/or maturity for the intended product purpose. Berries are treated in an appropriate manner to obtain the above products, by undergoing operations such as threshing, sieving and sifting, soaking, washing, blanching, drying or dehydrating, decorticating, grading, crushing and grinding. The product shall be free from foreign odors, and flavors and free from any other harmful substances and added colors.

a) *Black pepper* –It shall be dried berries having unbroken pericarp. The product shall be whole with a globular shape and wrinkled pericarp and shall have diameter of a minimum 2.0 mm. It shall be brownish to dark brownish or blackish in color. The flavors shall have a penetrating odor and hot, biting pungent taste characteristics of black pepper excluding mouldy and rancid odors.

(b) *White pepper* – It shall be dried berries after removing the pericarp. The product shall be whole with globular shape with smooth surface, slightly flattened at one pole and a small protuberance at the other, and shall have a diameter of minimum 1.8 mm. It shall be matt grey to brownish to pale ivorya white. The odour and flavor shall be characteristic of white pepper, slightly sharp and very aromatic, excluding mouldy and rancid odours.

(c) *Green pepper* –It shall be obtained from green berries by removal of moisture under controlled conditions. The product shall be whole with globular shape with or without wrinkled pericarp and shall have diameter of minimum 2.0 mm. It shall be characteristic green, greenish or dark greenish. The product shall have pungent odour and flavour characteristic of green pep-per, free from rancidity, mustiness, Bitter taste and extraneous flavor.

(2) BWG peppers can be of any one of the following forms:

(a)Whole

(b)Cracked/crushed –broken into two or more pieces.

(c)Ground–processed into powders.

(3) The product shall confirm to the following requirements, namely: -

For Whole Peppers

S. No.	Requirements	Black	White	Green
1.	Moisture content, percent by mass (*Maximum*)	13.0	12.0	12.0
2.	Total Ash, percent by mass on dry basis, (Maximum)	7.0	4.0	5.0
3.	Acid-insoluble ash, percent by mass on dry basis, (*Maximum*)	1.5	0.3	0.3
4.	Volatile oil content, ml/100g, on dry basis (*Minimum*)	1.0	1.0	1.0
5.	Non-volatile ether extract, % (m/m) min, on dry basis.	6.0	6.0	0.3
6.	Piperine content, % (m/m), min, on dry basis.	2.0	3.0	NA
7.	Bulk density, (g/l), min.	400	550	NA
8.	Light berries, % (m/m) max.	10.0	2.0	NA
9.	Extraneous vegetable matter,% (m/m), max.	2.0	2.0	1.2
10.	Foreign matter, % (m/m), max.	0.5	0.5	0.5
11.	Black berries/corns % (m/m), max.	NA	10.0	5.0
12.	Broken berries, % (m/m), max.	NA	3.0	10.0
13.	Mouldy Berries, % (m/m), max.	3.0	3.0	2.0
14.	Insect defiled berries /Corns, % (m/m), max.	2.0	2.0	2.0
15.	Mammalian or/and other excreta, (mg/kg), max.	2.0	2.0	2.0
16.	Pinheads for black pepper, % (m/m), max.	4.0	NA	NA

For Ground/powdered/crushed pepper

S. No.	Requirements	Black	White
1.	Moisture content, % (m/m), max.	12.0	13.0
2.	Total ash by mass, % (m/m), on dry basis, max.	6.0	3.5
3.	Non-volatile ether extract, % (m/m) ,on dry basis, min.	6.0	6.0
4.	Volatile oil*, % (ml/100g), on dry basis, min.	1.0	0.7
5.	Crude fibre, insoluble index, % (m/m)on dry basis, max.	17.5	6.5
6.	Piperine, % (m/m), on dry basis, min.	2.0	3.0
7.	Acid insoluble ash, % (m/m) on dry basis, max.	1.2	0.3

Explanations: for the purpose of this clause,

a) **Light berries** (in Black and White peppers only) -Generally immature berries without kernel with an apparent density lower than 0.30g/mL or300 g/L.

b) **Extraneous vegetative matter**-Vegetative matter associated with the plant from which the product originates -but is not accepted as part of the final product. Light berries, pinheads or broken berries are not considered as extraneous matter.

c) **Foreign matter**-Any visible objectionable foreign detectable components of the spice plant; such as sticks, stones, burlap bagging, metal

d) **Pinheads**–Developed from unfertilized flowers, berries with a diameter of less than 2 mm with more angularity than normal berries, they have soft texture (collapse under heavy pressure) and have less odour and flavour than pepper berries.

e) **Insect defiled berries:** Berries or corns damaged by insects.

(4) The product covered under these standards shall be labelled in accordance with the Food Safety and Standards (Labelling and Display) Regulation, 2020. In addition, the forms of the product shall also be mentioned on the label. The name of the product shall be "Black Pepper" (pepper corn), "White Pepper" or "Green Pepper".]

[Dried Ginger (Sonth, Dried Adrak)

1. **Dried Ginger (Sonth, Dried Adrak)] whole** means the dried rhizome of Zingiber officinale Roscoe in pieces irregular in shape and size, pale brown in colour with peel not entirely removed and washed and dried in sun. It may be bleached with lime. It shall have characteristic taste and flavour free from musty odour or rancid or bitter taste. It shall be free from mould, living and dead insects, insect fragments, and rodent contamination. The product shall be free from added colouring matter.

It shall conform to the following standards:—

(i)	Extraneous matter	Not more than 1.0 percent by weight
(ii)	Moisture	Not more than 12.0 percent by weight
(in)	Total ash on dry basis	
	(a) Unbleached	Not more than 8.0 percent by weight
	(b) Bleached	Not more than 12.0 percent by weight
(iv)	Calcium as Calcium oxide on dry basis	
	(a) Unbleached	Not more than 1.1 percent by weight
	(b) Bleached	Not more than 2.5 percent by weight
(v)	Volatile oil content on dry basis	Not less than 1.5 percent by v/w
(vi)	Insect damaged matter	Not more than 1.0 percent by weight

[Dried Ginger (Sonth, Dried Adrak)] Powder means the powder obtained by grinding rhizome of Zingiber officinale Roscoe. It shall have characteristic taste and flavour free from musty odour or rancid or bitter taste. It shall be free from mould, living and dead insects, insect fragments, and rodent contamination. The powder shall be free from added colouring matter.

It shall conform to the following standards:—

(i)	Moisture	Not more than 12.0 percent by weight
(ii)	Total ash on dry basis	
	(a) Unbleached	Not more than 8.0 percent by weight
	(b) Bleached	Not more than 12.0 percent by weight
(hi)	Calcium as Calcium oxide on dry basis	
	(a) Unbleached	Not more than 1.1 percent by weight
	(b) Bleached	Not more than 2.5 percent by weight
(iv)	Volatile oil content on dry basis	[Not less than 1.0 per cent]
(V)	Water soluble ash on dry basis	Not less than 1.7 percent by weight
(vi)	Acid insoluble ash on dry basis	Not more than 1.0 percent by weight
(vii)	Alcohol (90% v/w) soluble extract on dry basis	Not less than 5.1 percent by weight
(viii)	Cold water soluble extract on dry basis	[Not less than 10.9 per cent]

2.9.18: Turmeric (Haldi)

1. **Turmeric (Haldi) whole** means the primary or secondary rhizomes commercially called bulbs or fingers of Curcuma Longa L. The rhizomes shall be cured by soaking them in boiling water and then drying them to avoid regeneration. The rhizome be in natural state or machine polished. The product shall have characteristic odour and flavour and shall be free from mustiness or other foreign flavours. It shall be free from mould, living and dead insects, insect fragments, rodent contamination. The product shall be free from Lead Chromate added starch and any other extraneous colouring matter.

It shall conform to the following standards:—

(i)	Extraneous matter	Not more than 1.0 percent by weight
(ii)	Defective Rhizomes	Not more than 5.0 percent by weight
(iii)	Moisture	Not more than 12.0 percent by weight
(iv)	Insect damaged matter	Not more than 1.0 percent by weight
(v)	Test for lead chromate	Negative

Explanation :- Defective rhizomes consist of shrivelled fingers and or bulbs internally damaged, hollow or porous rhizomes scorched by boiling and other types of damaged rhizomes.

2. **Turmeric (Haldi) powder** means the powder obtained by grinding dried rhizomes or bulbous roots of Curcuma Longa L. The powder shall have characteristic odour and flavour and shall be free from mustiness or other foreign odour. It shall be free from mould, living and dead insects, insect fragments, rodent contamination. The powder shall be free from any added colouring matter including Lead Chromate and morphologically extraneous matter including foreign starch.

It shall conform to the following standards:—

(i)	Moisture	Not more than 10.0 percent by weight
(ii)	Total ash on dry basis	Not more than 9.0 percent by weight
(iii)	Ash insoluble in dil. HCl on dry basis	Not more than 1.5 percent by weight
(iv)	Colouring power expressed as	Not less than 2.0 percent by weight
	curcuminoid content on dry basis	
(v)	Total Starch	Not more than 60.0 percent by weight
(vi)	Test for lead chromate	Negative

The requirements of importing countries keep on changing from time to time because discovery of a new pathogen or a contaminant would compel these countries to review the existing quality parameters and set new limits. The consumer awareness in these countries has also great influence on such decisions. This explains the enormous challenges that an exporting country has to face. The success depends upon our capability to meet the emerging challenges and ensure that spices exports from India conform to the requirements of the consumers and by meeting the regulatory requirements of importing countries.

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ESSENTIALS OF OLEORESINS

Dr.N.Ramachandra Sharma

Former Principal Scientist,
Export Inspection Agency laboratory

Oleoresins are the concentrated extract obtained from different parts of plants, spices, and herbs. Oleoresins have a liquid, semi-liquid, or solid consistency. They are usually produced by solvent extraction of the various parts of the plants. They are endowed with the full characteristics of natural spices.

Chemically oleoresins are mixtures of terpenes and terpenoids (or flavonoids), which may contain both steam volatile or nonvolatile components. They may be solid or semi-liquid, although always water-insoluble. If the percentage of volatile components is high, the substance will be more liquid and may be labeled as oleoresin. Volatile terpenoids and related compounds are termed Essential (aromatic or volatile) Oils.

Oleoresins thus consist of volatile Essential Oils and nonvolatile compounds. The nonvolatile compounds contribute to the color and pungency of the oleoresins. In short, oleoresins are chemically more complex. As they exhibit a more complete flavor profile of the species, these products can be used in smaller quantities than essential oils and raw spices. These extracts are rich in compounds capable of providing aroma, taste, color, and pungency. These properties make oleoresins the chosen and selected additives in the food industry.

<u>Essential Oils and Oleoresins</u>

The characteristics of both the components are described below.

<u>Essential oils</u>, being steam volatile are extracted from the raw material by steam distillation or hydro distillation, releasing the floral top notes of a flavor. They are considered to provide the essence of the spices' raw material. For example, ginger essential oil can be described as pungent, floral, and aromatic, characteristic of the ginger itself.

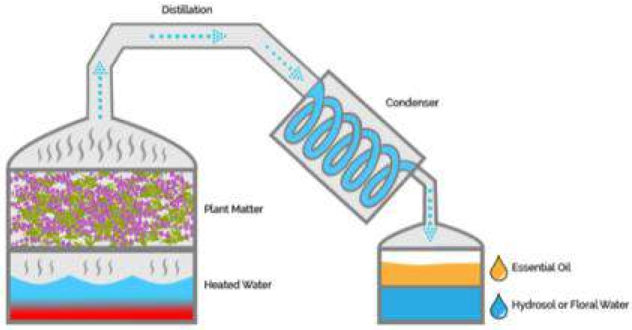
<u>Oleoresins</u>, not steam volatile, are extracted from the raw material by solvent extraction, obtaining the rich, earthy base notes of the flavor including the active ingredient compounds which cannot be extracted by steam distillation e.g. capsaicin found in capsicum, or piperine found in black pepper. Essential oils also get extracted in the solvent extraction technique. The main components of an oleoresin are essential oils, fixed oils, pigments, pungent constituents and natural antioxidants.

<u>Extraction process</u>

The extraction methods for both essential oils and oleoresins are described in brief:

<u>Essential Oils - Steam Distillation</u>

Steam Distillation is used for distilling volatile components from various raw materials, like spices, seeds, leaves, roots etc. As the steam rises through the apparatus, it releases the aromatic, top-note compounds. The steam is then passed into a condensation chamber, where the vapour is condensed into a liquid. The essential oil naturally separates from the water-soluble compounds due to the difference in viscosity, allowing for easy collection.



<u>Oleo Resins - Solvent extraction</u>

Solvent extraction is used to recover the oleo resin from the raw materials. Organic solvents are used as the medium for extracting the active components. The solvent is then evaporated off, leaving behind an oil-based, viscous and resinous liquid with an intense flavour, providing a good base-note of the starting material. The solvents used are acetone, ethyl acetate, ethylene dichloride or alcohol.

Oleo resin Extraction Plant

Exact procedures may differ between various spices and herbs. The yield of oleoresins and the main constituent present in them, from some spices, are given in table below.

Table 1: Yield of oleoresin and the principal constituent

Spice	Yield of oleoresin (%)	Principal constituent in oleoresin
Pepper	10-12	Piperine (35-60%)
Ginger	4-7	Zingiberene (25-30%)
Chillies	12-16	Capsaicin (2-4%)
Turmeric	6-9	Curcumin (20-30%)
Coriander	18-20	D-linalool (1.5-2.0%)

Oleo Resins -SUPERCRITICAL FLUID EXTRACTION

Supercritical fluid extraction is an efficient separation method of active ingredients from plant materials. Supercritical solvent extraction is one of the gentle, flexible, dynamic, and nature-friendly techniques used for the extraction of spices, herbs, and flowers using CO_2. These products are extracted at ambient temperature and high pressure to avoid loss of aroma and degradation of active compounds.

Apart from being solvent residue-free, supercritical fluid extraction is a green process that is highly rated for its eco-friendliness. The low viscosity and high diffusivity of supercritical fluid enhance the penetrating power and results in a high mass transfer of solutes into the fluid. Supercritical extraction using CO_2 is widely used in the manufacturing of organic-certified products.

Microencapsulation of Oleoresins for Shelf Life Enhancement & Quality Improvement

Oleoresins have greater heat stability and uniform flavor compared to essential oils. However, they are susceptible to degradation and have a short shelf life when stored not properly. Oleoresins show a tendency to get oxidized when exposed to oxygen, light, and heat. Microencapsulation techniques have been used to overcome this problem and to facilitate application in foods. Microencapsulation techniques are employed mainly to protect bioactive compounds from degradation and to improve their shelf life and stability. This technique also promotes a better release of the active principles.

Spice Oleoresins as a Value-Added ingredient for food industry

With the increasing health concern, consumers are increasingly looking for natural products that have nutritional characteristics too. The use of Oleoresins as substitutes for synthetic additives is in line with this trend. The flavor, aroma, and color properties are responsible for most uses of oleoresins. Additionally, oleoresins can be standardized for flavor with high stability in storage, as long as oxidation is prevented. Physically, their appearance ranges from a viscous oil to a thick, paste that dissolves in fats and oils, but generally requires a carrier to apply to food.

Oleoresins have broad spectrum functional properties - antioxidant, anti-inflammatory, antimicrobial, anticancer, and insect repellent properties. No doubt they find applications in various sectors such as gastronomic, nutritional, and pharmaceutical. Essential oils and oleoresins are widely used in food applications at industrial level. They can be used in all applications where whole spice or any other forms of spices cannot be directly used. A few examples of their use are given. They are being used in dairy products (yogurt, curd, cheese), confectionary, beverages and bakery products . Paprika and turmeric oleoresins are examples for coloring applications, while oleoresins from ginger, mustard, and chili peppers are typically used for their pungency . Clove, nutmeg, and cinnamon oleoresins have a great antimicrobial activity, demonstrating its potential as an alternative food preservative .

Application	Main oleoresin
Aroma & taste	Black pepper, chilies and capsicum, turmeric and ginger, cinnamon,
Colour	Capsicum,paprika and turmeric
Pungency	Chili peppers, black pepper, ginger
Preservative	Cinnamon, ginger, nutmeg and clove

Other than food, essential oils and oleoresins are used in cosmetics, cleaning and hygiene products, air fresheners and medicines .

Global Market at a Glance

The global market for oleoresins was valued at US$1.43 billion in 2021, according to Grand View Research. The market is expected to grow at a Compound Annual Growth Rate of (CAGR) 6.9% from 2022 to 2030. Specifically, the European region led the market with a revenue share of more than 30% in 2021, which goes back to the growing demand for natural flavour and colouring agents like oleoresins in the food and drinks industry. The region is regarded as a significant market as it is one of the essential ingredients consumed in food & beverages applications by the region's elderly and middle-aged consumers. Suppliers of oleoresins from developing countries will find many opportunities on the European market, as demand will continuously rise due to more food and beverage companies exploring natural alternatives for synthetic ingredients.

In North America, the Oleoresin Market experiences significant regional growth, especially in the United States. The robust food and beverage industry in the US contributes to the market's share, with a strong emphasis on natural ingredients. Canada and Mexico also play vital roles, collectively contributing to the regional market share.

European Market

According to the European Flavour Association (EFFA), the European flavour industry is responsible for about one-third of the global market share. The main share of the European flavour companies comes from Small and Medium Enterprises(SMEs) and family-owned businesses. European flavouring companies have set up projects for direct sourcing of oleoresins. The major end user in Europe is the food sector, which takes more than half of the European market for oleoresins.

According to European buyers, the most popular oleoresins in Europe are black pepper, paprika and turmeric. Black pepper oleoresin is mainly used in the meat industry, while paprika is used in processed foods because of its colour and taste, and Turmeric is used mainly in foods due to its health benefits.

The large European food and drink industry offers interesting opportunities for suppliers of oleoresins from developing countries. Europe's demand for oleoresins , other flavourings and colours is growing steadily, as the world's leading manufacturers are located in Europe (Givaudan, Symrise,

Mane). The demand for oleoresins is driven by the rising consumer awareness for healthier and natural food products.

Summing Up- Quintessential

Oleoresins are natural extracts rich in bioactive compounds. They are extracted from natural sources by different techniques. The solvent extraction technique is widely used in the industry. This method leaves solvent residues in the product which raises food safety concerns. But new technologies such as Super Critical Fluid Extraction (SCFE) Methods considered as Green Technology are now being adopted by the industry. No organic solvents are used in this method. SCFE methods enhances the yield and also improves quality of the product as it leaves no solvent residue . Also, the microencapsulation of the extracts has been explored as a way to enhance the stability and shelf life and to facilitate the better release of active compounds. Oleoresins are potential substitutes for synthetic additives. They can promote antimicrobial, antioxidant, anti-cancer, and anti-inflammatory qualities to products. The chemical diversity of the compounds present in oleoresins bestows all these properties. The most commonly used oleoresins in the food industry are black pepper, cinnamon, ginger, paprika, and turmeric. In addition to color and flavor, different biological properties arouse the industry's interest in these extracts.

Coming to the global market scenario ,it is observed that more than thirty percentage of the market revenue is cornered by European Union countries. There is huge demand for natural food additives globally , which makes the manufacture of Oleoresin more promising and challenging. India being one of the prominent manufacturer and exporter of oleoresins can no doubt , climb more heights in this sector.

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Vanilla: The Elegance of the World's Most Expensive Spice

Bridget Scaria
Assistant Professor, Dept of Food Technology
Indira Gandhi College of Arts & Science, Nellikuzhi

In the realm of spices, where every exotic flavor tells its own story, vanilla beans shine as the second most expensive spice, enchanting the senses with their unmatched aroma and taste. Hailing from the lush tropical regions of Mexico, vanilla boasts a history as rich and flavorful as the spice itself. In the 15th century, traders and explorers introduced vanilla to Europe, where it swiftly became a symbol of luxury and sophistication.
In India, the vanilla essence industry primarily relies on synthetic alternatives, but natural vanilla essence is widely preferred worldwide for its superior quality. Vanilla pods undergo a curing process to develop their distinctive aroma. Vanillin (C8H8 03) is the primary compound responsible for the unique fragrance and flavor of vanilla beans. Recognized globally for its exotic flavor and unmistakable scent, vanilla is highly valued in culinary applications. Vanilla essence is extracted from the pods of the Vanilla plant, particularly from the species *Vanilla Planifolia* of the Orchidaceae family, which is the most commonly used variety.
Vanilla flavor is universally cherished, symbolizing indulgence, elegance, and comfort. In fusion cuisine, trends in vanilla flavor lean towards creative pairings, blending traditional vanilla with exotic ingredients such as lavender, matcha, or chili to create distinctive taste sensations. Whether in desserts, savory dishes, or beverages, the adaptable nature of vanilla flavor continues to inspire culinary innovation and captivate adventurous tastes. Its timeless appeal and subtle aroma have made it a favored flavoring across diverse industries for centuries, showcasing its limitless versatility in enhancing sweetness and depth of flavor in every application.
The unique sweet and floral characteristics of vanilla have established it as a fundamental ingredient in kitchens around the globe. Whether enhancing desserts or savory dishes, vanilla brings richness and intricacy to a diverse array of culinary endeavors. Embraced by the culinary community for its versatility, vanilla has transcended its role as a mere flavor enhancer to become a standout ingredient in its own right.

<u>Vanilla Beans</u>
Indian vanilla beans, known for their sweet, aromatic, and delightful flavor, undergo a curing process lasting 5 to 6 months. They are esteemed comparably to Bourbon vanilla beans from Madagascar. Some regions in India produce vanilla beans of the highest global quality.

<u>Vanilla Powder</u>
The natural vanilla powder is crafted from carefully selected seasoned bourbon vanilla beans, without any added dextrose. It boasts a rich aroma and imparts a deep, dark brown color. Vanilla powder can effectively replace alcohol-based vanilla extract in recipes that involve baking, blending, toasting, or sprinkling.
This aromatic vanilla powder is widely favored for enhancing pastries, confections, desserts, and has industrial applications in chocolate manufacturing and ice cream production. Available in 60 mesh and 80 mesh fine powder forms. It contains no preservatives or artificial additives, offering a completely alcohol-free, 100% natural product that dissolves easily in hot liquids.
Unlike vanilla extract, vanilla powder retains its flavor well during baking and cooking processes. To substitute for liquid vanilla extract, use an equal amount of vanilla powder. It is also popularly used to flavor coffee, tea, or sprinkled on French toast for added enjoyment.

<u>Vanilla Paste</u>
Vanilla Paste is created from premium bourbon-like Vanilla beans, which are ground into a paste and mixed with sugar syrup. This convenient form is widely favored by bakers, households, and in products such as ice creams and pastries.

<u>Vanilla extract: A Traditional Choice</u>
Vanilla flavor plays a pivotal role in the dairy industry, enriching a variety of products from creamy ice creams to indulgent milkshakes. Its adaptable characteristics bring richness and sweetness, enhancing the enjoyment of dairy products enjoyed by consumers globally.
Vanilla is an essential component in bakery items, imparting richness and warmth to a diverse range of baked goods such as cakes, cookies, pastries, cream biscuits, and beyond. Vanilla beans stand out in the world of spices as the second most expensive, renowned not only for their price but also for the sensory delight they provide. From their storied cultivation history to the meticulous craftsmanship involved, vanilla beans embody a legacy of culinary excellence and luxury. As we enjoy the unique aroma and flavor of this exceptional spice, we gain a deeper appreciation for the artistry and dedication that make vanilla beans truly incomparable.

Enhancing Spice Flavor and Stability: Techniques and Innovations

Emlin Seles Soshi [a], Nandana Nair [a], and Sherin Mary Simon [b*]

[a] III UG Student Dept of Food Processing Technology, St. Teresa's College, Ernakulam

[b, *] Corresponding Author-Assistant Professor, Dept of Food Processing Technology, St. Teresa's College, Ernakulam

INTRODUCTION

India has numerous supremacies over other nations in terms of production and consumption of spices, including a wide range of agro-climatic conditions for production, each spice being available in plethora of variations that are suited to different climates, cost-effective labor, a considerable domestic market, a long history of inculcating spices and their derivatives in cooking, pharmaceutical, and cosmetics (Shinoj and Mathur, 2006). The production and export of spices is a significant part of India's economy. India is the largest manufacturer of spices in the world. People use spices like pepper, nutmeg, ginger, turmeric, garlic, cinnamon, and cardamom, among others, all throughout the world (Shambharkar and Ghormare, 2017).

Cardamom, ginger, and garlic, among other 63 spices are produced in India. India, renowned as the origin of spices, has a long trade history with the prehistoric civilizations of Rome and China. Indian spices are the most in-demand worldwide owing to their distinctive scent, texture, medicinal properties, and flavor. Spices contain essential oil and oleoresins that are rich in flavor molecules. They are in small amounts, are in a concentrated form, and have a characteristic flavor that depends on the essential oil's composition. Flavors of spice are due to a blend of different components such as alcohols, phenols, esters, terpenes, organic acids, resins, alkaloids and sulfur-containing compounds. All of these constituents give each spice's particular flavor, color, nutritional, health, or preservative effect.

The cytoplasm of cells create essential oils, which are tiny droplets located between cells. The flavor elements (volatile and non-volatile) are enclosed within a matrix of carbohydrate, protein, fiber, and other cell components. They are a mixture of fragrant substances. A fragrant material is a chemically pure component that is volatile under normal conditions (Sonwa, 2000).

Essential oils are rich in numerous bioactive components with antioxidative and antibacterial properties. In addition to this, essential oils have shown promise as a natural alternative to synthetic preservatives (Juana and Manuel, 2018). The combination of oils and small amount of resins are known as oleoresins.

PROCESSING OF SPICES

It is important to treat or process spices before using or marketing them. Whole or ground spices are subjected to heat treatment. Treating spices as whole is easy process. Strict hygiene treatments are taken in order to prevent contamination of spices during processing, storage and packing. To avoid this issue spices are packed as soon as possible after treating them. (Dini I., et al., Sharif M., et al., 2018, Yashin A., et al., 2017). Roasting, frying, and powdering are some traditional methods of treating spices (Sharif M., et al., 2018).

MEANING OF FLAVOR

Flavour is a property sensed by olfactory system while tasting food. (UNE 87-001-86 AENOR, Madrid, 1986). Flavour of spices result in more flavourful and tastier food in addition with increasing palatability and health benefits. Flavour is defined as a combination of odour and taste. It is influenced by factors such as temperature, texture, appearance, etc.(British standards institution London, 1975).

BIOACTIVES OF SPICES

Spices have various functions such as lowering cholesterol levels, balancing sugar levels, and improving overall health. Phytochemicals are present in spices which protect in from insects and fungus (Sreenivas K., et al., 2005). Major spices are mostly used for cooking and household purposes. They include chilly, turmeric, garlic and pepper. Therefore, increased spice use increase quality of food and reduce hunger and malnutrition. Not a single compound but a combination of different compounds such as alcohols, phenols, organic acids, esters, terpenes, resins, etc. are responsible for the overall flavours of spices (Yashin A., et al., 2017).

ESSENTIAL OILS IN SPICES

Essential oils (also known as volatile or ethereal oils, as they evaporate when exposed to heat) are odorous and volatile compounds found and stored in plants in special brittle secretory structures, such as glands, secretory hairs, secretory cavities or resin ducts (Ahmadi et al., 2002; Bezić et al., 2009; Ciccarelli et al., 2008; Gershenzon et al., 1994; Liolios et al., 2010; MoroneFortunato et al., 2010; Sangwan et al., 2001; Wagner et al., 1996). They are mostly liquid at room temperature, but a few are solids. Most essential oils are clear but some oils are amber, yellow, brown, green or red in colour.

Essential oils can be obtained from all parts of a plant such as leaves, stem, root, seed, bark, etc (Bassolé and Juliani, 2012). For example, Cinnamon is obtained from tree bark, cardamom is a seed and leaves in the case of eucalyptus (Bassolé and Juliani, 2012). The total essential oil content of plants is generally very low and rarely exceeds 1% (Bowles, 2003), but in some cases, for instance clove (Syzygium aromaticum) and nutmeg (Myristica fragrans), it reaches more than 10%.

In addition, with providing flavour, essential oils also have therapeutic benefits such as antioxidant and antimicrobial activities. Essential oils add flavour to food which enhances the overall quality of the food. There are large numbers of natural essential oils but only some are used in flavouring industry while some are used in fragrance or perfume industry. Various methods are used in production of essential oils: fermentation, expression, extraction steam distillation, or other mechanical methods (Burt, 2004).

Essential oils are hydrophobic, are soluble in alcohol, non-polar or weakly polar solvents, waxes and oils. Most of the essential oils are colorless or pale yellow, with the exception of the blue essential oil of chamomile (Matricaria chamomilla) and have lower density than water (Gupta et al., 2010; Martín et al., 2010). Due to their molecular structures (presence of olefenic double bonds and functional groups such as hydroxyl, aldehyde, ester); essential oils are readily oxidizable by heat, light and air (Skold et al., 2006; Skold et al., 2008).

OLEORESINS IN SPICES

Oleoresins are the concentrated extract obtained from different spices. Different to essential oils, oleoresins comprise, in addition to volatile composites, non-volatile composites (pigments, pungency), making them more complex excerpts (Sowbhagya, 2019). Oleoresins can be used in smaller quantities than essential oils and raw spices, as they show a more complete aromatic and flavor profile. These extracts are abundant in compounds capable of producing aroma, taste, color, and pungency making oleoresins additives of interest to the food industry (Shahidi & Hossain, 2018).

Oleoresins have also awaken interest because of their various functional properties, such as antioxidant, anti-inflammatory, antimicrobial, anticancer, and insect repellent, including applications in the gastronomic, nutritional, and pharmaceutical sectors (Habashy et al., 2018). The marketing of spices in the form of oleoresins and essential oils add value to the product.

Oleoresins have greater heat stability and uniform flavor compare to essential oils (Shahidi & Hossain, 2018; Sowbhagya, 2019). However, they are susceptible to degradation and have a short shelf life if not stored properly. Some approaches have been used to overcome this problem and faciliatate oleoresins and essential oil's applications, such as microencapsulation (Ribes et al., 2017). Microencapsulation techniques are employed to prevent degradation of bioactive compounds found in oleoresins and promote a better release and enhance their shelf life and stability (Jayanudin et al., 2019; Oriani et al., 2018).

PROCESSING-INDUCED CHANGES OF SPICE FLAVOR

Factors influencing spice flavor

Factors influencing spice flavor can be classified into intrinsic and extrinsic factors. The intrinsic factors include the variety and maturity of spices. For instance, when pepper is getting riper, its color changes from green to orange and red. In such a process of transformation, the fruity flavor of esters and ketone decrease, while the content of limonene rises; this is followed by an increase in the pungency of pepper (J. Pino., et al., M. González.,2007). Spices should therefore be harvested when the contents of flavor ingredients are at the highest (S. Balasubramanian., et al., P. Roselin., et al; 2015). Major extrinsic factors affecting the flavour of spices include planting environment (temperature, humidity, soil moisture, fertilizer, rainfall, etc. (U. Schweiggert et al., R. Carle et al., 2007) and processing means, with drying, grinding, extraction, packaging and sterilization being the key steps in spice processing. Oxygen, light and temperature are known to exhibit significant influences on the flavor of spices during processing.

Drying

Generally employed drying ways for spices include sun drying, shade drying, hot air drying, infrared-assisted drying, microwave-assisted drying and freezing drying. Among these drying techniques, hot air drying and microwave-assisted drying are most widely used. While shade and sun drying can better maintain the taste of spices, the required drying time is long, the required space is large and production efficiency is low; making these processes unsuitable for industrial production. Furthermore, shade and sun dried spices are easily contaminated by bacteria. Hot air drying is currently the most widely used technique for spices. Nevertheless, hot air drying has several disadvantages as the spices need to be exposed to high-temperature for an extended period of time. This might lead to changes in chemical composition and sensory characteristics (color, flavor, aroma, texture) of spices (A.N. Yousif et al., C.H. Scaman et al; 1999).

Among advanced technologies, microwave and infrared drying has emerged as an alternative technique for spices, but is rarely used due to uneven heating and may have a destructive effect on heat-sensitive flavour compounds of spices (Y. Wang et al., M. Zhang et al; 2013). Finally, although freeze drying is known to be able to well preserve the flavor of spices (R.Wang et al., M. Zhang et al; 2009),it is not too attractive as it uses a lot of energy. Furthermore, the differential pressure exerted during freeze drying can have a negative impact on spice flavor. This phenomenon is called the expansion effect (R. Huopalahti et al., R. Kesälahti et al; 1985).

Extraction

Spice flavor composites are substantially in the form of essential oils or oleoresins. Major components of essential oils are terpenoids and their derivatives (F.S. Martins et al., L.L.Borges et al; 2015). Oleoresins are a combination of spice flavor compounds, but these flavor components are less volatile; these include such compounds as capsaicin and turmeric. The higher the concentration of flavor substances in essential oils or oleoresins, the stronger the smell and taste of spice.

Conventional methods for essential oils extraction include distillation (water distillation, steam distillation), solvent extraction, cold pressing and sublimation. Although these techniques have been widely used, they have many disadvantages such as low extraction rates, possible toxic residues and decomposition of some volatile compounds (D.W. Li et al.,I.W. Bi et al; 2010). In contrast, ultrasound is considered a green technology that can compensate for many of the aforementioned short-comings.

Ultrasound-assisted extraction of non-volatile flavor compounds

Ultrasound assisted extraction can be used to extract volatile and non-volatile compounds from spices as an alternate extraction method. This method results in higher extraction yield (J. Martínez, J. Rosas, J. Pérez, Z. Saavedra, V. Carranza, P. Alonso, 2018). Studies were conducted based on different extraction methods and among all, ultrasound assisted extraction yielded the most flavourful extract in high concentration.

Ultrasound-assisted extraction of volatile flavor compounds

During extraction, ultrasound provides energy to break oil glands to release essential oils and to function as an emulsifier (H. Sereshti, A. Rohanifar, S.P Lu, J.H. Wang, 2012,2006). Yield is much higher and the obtained fragrance is of high purity (Z.G. Lu, 2006). Extraction ability of support critical CO_2 can also be improved by Ultrasound method. Ultrasound-assisted extraction along with vacuum distillation is a promising technology for extracting flavour compounds from spices.

Microencapsulation

Essential oils have lower heat stability and higher volatility. (Z. Zhang, X. Liu, H. Li, P. Liu, X.Zhang., 2011). There will be alterations in flavour compounds of essential oils during processing, transport, storage and final application in food. (L. Vijayastelar, I.J Jismy, A. Joseph, 2017). These flavour losses can be prevented by Microencapsulation. It also helps to mask undesirable flavour of some bioactive compounds. Traditional methods may not be preferred as it shows low encapsulation efficiency. Ultrasound assisted microencapsulation is a good alternative to this issue. Therefore, due to emulsification, essential oils and wall material disperse uniformly in the solution. Defoaming action is very important in order to prevent deposition of essential oil and wall material in the bubbles of solution (M. Gallo, L. Ferrara, D. Naviglio, 2018). The process of microcapsule formation can be improved by ultrasound-assisted spray drying (F.T. Turan, A. Cengiz, D. Sandıkçı, M. Dervisoglu, 2016).

CONCLUSION

Spices are rich source for phytochemicals having precise health benefits. Spices are used individually or in combination as food adjuncts to impart flavor, color and aroma. Traditional knowledge has shown the medicinal properties of many spices. Some of the important compounds of spices which are shown to possess medicinal properties include curcumin from turmeric, capsaicin from red pepper, eugenol from cloves, allyl sulphides from garlic and onion. The essential oils and their components have many uses, both in pharmacology and in food. In addition, they are endowed with intriguing biological activities and have a therapeutic potential. For instance, essential oils exhibit antimicrobial activities, antiviral activities with broad spectrum. In the food industry, essential oils uses are an integral part, as they may play different roles. Therefore, economic importance of essential oils is indisputable.

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Exploring the World of Unusual Flavourants

*Meghna R, **Anna Aleena Paul
*PG Student, Department of Food Processing Technology
**Assistant Professor, Department of Food Processing Technology
St. Teresa's College, Ernakulam District

INTRODUCTION

From flavouring to preservations to therapeutics, spices and herbs have an integral part in our food culture for centuries. According to Global Health Estimates (GHE), 2019 by the World Health Organization (WHO), 74% of mortality is due to Non-communicable diseases (NCDs). In the past decade, the popularity of alternative therapies like Homeopathy, Ayurveda, Unani, and Siddha gained recognition for chronic illnesses and NCDs (Sahoo et al.,2023). Plant-based food culture, especially the role of essential oils, has been exponentially increasing among health-conscious consumers. Though various spices and herbs are used from our ancestral period, only a few have gained recognition in the food market, whereas the other majority are lesser known to the world. It is high time we explore the future of potential spices so that our upcoming generations can consume less adulterated expensive spices.

1. Black Garlic

Garlic, Allium sativum, has been a crucial element in our daily diet and traditional medicine. However, with unpleasant and pungent sensory attributes including taste and odor, consumers sometimes withdraw themselves from the consumption of raw garlic. Black Garlic is a novel processed food product having various distinct characteristics from that of the fresh garlic. The literature evidences show that the origin of Black Garlic is from Japan, Korea and Thailand, where it gained popularity among other countries like China, USA, and some parts of Europe due to its notable nutrient and bioactive profile, along with enhanced sensory attributes (Afzaal et al. 2021). Black Garlic is produced through fermentation process under controlled high temperature processing (60 to 90 C) and humidity in the range of 70% to 90%, making it as a functional food (Qiu et al. 2020).

Nutritional Profile of Black Garlic:

In the past decade, the influence of Black Garlic has been increasing in the food market; alcohol, candies, vinegar, white pan bread, beverages, ice-cream, tofu, sausages, jams, yoghourt, etc. are a few products that are popular in the USA and European region. Studies report that black garlic contains a remarkable amount of carbohydrates in the form of fructose (57.14%), sucrose (7.62%), and glucose (6.78%). The fructans present in black garlic decompose due to thermal-induced degradation. The enzymolysis is catalysed by garlic fructan exohydrolase. Fructooligosaccharides (FOSs) consisting of fructose moieties linked through β (1→2) glycosidic bonds have a prebiotic effect. It plays a major role in the growth and functional activity of various microorganisms in the gut region (Qiu et al. 2020). Garlic is known for its high protein content (19–14% dry matter), where lectin, a heterogeneous glycoprotein, is the most abundant. In addition to this, garlic contains all the essential amino acids; majorly - glutamic acid, arginine, aspartic acid, and tyrosine. On thermal treatment at 60°C, allicin production decreases as allinase is inactivated. However, the application of 70–80°C on fresh garlic decreases the allicin content by 80%. Various studies report that the allicin is converted to compounds like S-allylmercapto-cysteine (SAMC) and S-allyl-L-cysteine (SAC), which are water soluble and a other oil soluble compounds like diallyl sulphide (DAS), diallyl disulfide (DADS), diallyl trisulfide (DATS), and diallyl trisulfide (Afzaal et al. 2021).

Inclusion of 1.5% black garlic in our diet helps to reduce epididymal fat and it regulates the transcription and enzymes, which ameliorate the diet-induced obesity. Also, the ageing process produces S-allyl-L-cysteine, which enhances antioxidant properties and reduces unstable and odorous compounds. In addition to these, black garlic is effective in reducing the hypercholesterolemia, hyperlipidemia, inflammations, hypertension, etc. (Afzaal et al.,2021).

2. Lichen

Lichen is the unusual organism that is mostly found in the natural world. It is a mutualistic organism composed of an algal (photobiont) (cyanobacteria or other microbial species) and fungal (mycobiont) that has a distinct and robust makeup. Examples of photobionts are cyanobacteria and chlorophyta. The three genera that are most prevalent among photobionts are Nostoc, Trentepohlia, and Trebouxia. Examples of Mycobionts are Ascomycetes, Basidiomycetes, Deuteromycetes and Phycomycetes fungi. Lichens come in three types according to their growth habits, range of sizes and shapes. The growth forms are fruticose lichen (shrubby or bushy structures), foliose lichens (leaf-like structures), and crustose lichens (strongly appressed to the substrate). Many countries, including China, Japan, Iceland, India, and Europe, have long used lichens in their traditional cuisines. there are many species of lichens throughout the world, only a few species of lichens have been reported for edible purposes. In China, Thamnolia vermicularis, Thamnolia subuliformis, and Lethariella cladonioides has been used as tea and other beverages. In India, the

Middle East, and Africa, Parmotrema tinctorum, Everniastrum cirrhatum, Ramalina conduplicans, Platismatia glauca, and Rimelia reticulata have been used as spices or food flavour enhancers. Cladina rangiferina, Cetraria islandica, Evernia prunastri were processed into the ingredients of a special bread, which used in times of food shortages in the Czech Republic, Norway, Iceland, and Estonia.

Nutritional Profile of Lichen:

Lichens have been proven to have theoretically rich nutritional value, and their extracts and active substances have also been shown to have multiple health benefits including anti-cancer, anti-inflammation, anti-oxidative stress, and anti-diabetes. Lichens comprise essential amino acids like isoleucine, leucine, methionine, phenylalanine, threonine, tryptophan, and valine. Fibre content is fairly high. The lichens are rich in minerals, such as calcium, sodium, potassium, zinc, and copper. The most important elements found in lichens are potassium and calcium. In terms of trace minerals, the lichens possessed a significant quantity of iron.

The black stone flower, or *Parmelia perlata*, is a foliose type of lichen that is used as a spice in India. It has a peculiar scent and is a member of the Parmeliaceae family. In southern and northern India, P. perlata's distinct scent is frequently utilized in the preparation of meat and fish dishes. It is also used in the Maharashtrian Goda Masala and is a dominant ingredient in Chettinad cuisine. The people of eastern Nepal have also used P. perlata as a seasoning. The Umbilicariaceae family includes rock tripe, which grows mostly on stone. Areas such as North America, New England, Asia, Japan, and Korea may have these lichens. There are numerous Umbilicaria species that are connected to traditional diets. Usnea lichen or *U. florida* is edible and healthy to eat. It is abundant in nutrients, with a high vitamin C content, and may be found throughout the southern and western British Isles (Thakur et al. 2023).

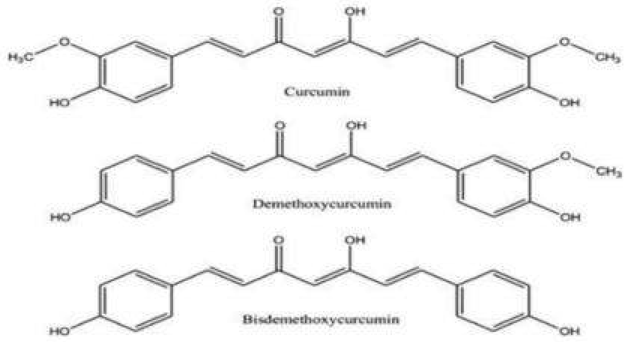
In India, a mixture of a few lichens (Physcia, Heterodermia, Pyxine and Parmelia) have been used as a special flavour in 'Biryani' - a dish made of rice. Also, Parmotrema and thallus of Heterodermia tremulans can be used as flavouring agents in vegetable and meat culinary (Sharma and Mohammad, 2020).

3. <u>Mango Ginger</u>

Curcuma amada (C. amada), commonly known as 'mango ginger', belongs to the Curcuma genus and Zingiberaceae family. This rhizomatous aromatic herb is said to have its origin in Eastern India. Mango ginger is known for its sweet, yet earthy floral - pepper flavour and similar to raw mango. Its root contains essential oil that can strengthen our digestive system, provide relief from constipation, loss of appetite, indigestion, bad breath; reduces and/or bronchitis, cough and asthma.

Nutritional Profile of Mango Ginger:

Curcuma amada contains numerous volatile oils (essential oils) having various medicinal properties. A pigment called Curcuminoids includes demethoxycurcumin, bisdemethoxycurcumin, and curcumin. Curcumin is the bioactive component present in turmeric. It has antioxidant and anti- inflammatory properties. Studies shows that the rhizome part of the plant contains various essential oils including Myrcene (80.5% - 88.8%), (Z)-β-Farnesene (21.9%), guaia-6,9-diene (19.8%), α-longipinene (14.8%), α-guaiene (14.5%), and camphor (5.5%). Given below is the structure of curcumin, demothoxycurcumin, bismethoxycurcumin present in C. amada. (Mahadevi and Kavitha, 2020).



Mango ginger is a potential therapeutic food ingredient due to its anticancer property. A comparison study reports that a supercritical CO_2 extract of C. amada exhibits more potent cytotoxicity than turmeric, temozolomide, etc. in human glioblastoma (U-87MG) cell lines. Also, antimicrobial property against *Bacillus subtilis*, *Staphylococcus aureus* and *Escherichia coli*. In addition to this, C. amada has the highest flavonoid content that can reduce the arthritis, inflammation caused by injury, rheumatism and liver inflammation. Mango ginger has shown properties like antiallergenic activity, cytotoxicity, antioxidant property, Hypertriglyceridemia activity, Antitubercular and Inhibitory action of Enterokinase (Sahoo et al. 2023).

4. <u>Kokum</u>

Kokum (*Garcinia indica Choisy*) is an indigenous tree spice crop found in the forest lands, riversides, evergreen and semi evergreen forests of Assam, coastal regions of Kerala, and Karnataka, Jantia hills, Khasi, etc. It originated and grown in the Western Ghats of India, including the Wayanad, Coorg, Goa and South Konkan region of Maharashtra. The tree is known in various names such as Biran, Bhinda, Bindin, Bhirand, Kokum, Panarpuli, Katambi, Ratamba and Amsol.

Nutritional Profile of Kokum:

The three major bioactive components present in the Kokum rind are: Hydroxycitric acid, Garcinol (a fat soluble yellow pigment) and anthocyanin pigment (Cyanidin-3-sambubioside, Cyanidin-3-glucoside). Hydroxycitric acid can be used as an acidulant, as well as a physiologically active chemical component; it plays a major role in reducing body weight through fat/lipid metabolism. Anthocyanins are known for their antioxidant, anti-carcinogenic activity and anti-inflammatory. Kokum butter or Kokum oil is a functional food ingredient that acts as the demulcent, astringent and emollient. Kokum butter is a better remedial medicine for treating diarrhoea and dysentery. Kokum majorly contains 20-30% of hydroxycitric acid (HCA) (1, 2-dihydroxypropane-1, 2, 3-tricarboxylic acid); giving its name as garcinia acid. Food products like wine and other beverages developed using kokum can attract the health conscious consumers as it purifies blood, reduces fat and cools the body down. The kokum fruit is considered as an Indian spice due to its pleasant flavour with sweet acidic (sour) taste.

In the world of spices, there are innumerous varieties of spice crops used across the world. Due to the popularity, functional and therapeutic properties, exotic varieties are costly and are mostly adulterated, nowadays. The application of local spices can ensure that our food habits are safe. Also, use of these spices may help us to develop novel food products and nutraceuticals. Thus, studies on these lesser known spice varieties open the platform for young scientists, as well as food industries.

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Spices and Health

Namitha U.M [a] and Sherin Mary Simon [b*]

[a] III UG Student Dept of Food Processing Technology, St. Teresa's College, Ernakulam

[b, *] Corresponding Author-Assistant Professor, Dept of Food Processing Technology, St. Teresa's College, Ernakulam

Introduction

Spices have been used globally for centuries, both in culinary traditions and for their medicinal properties. Their popularity is on the rise, especially as flavorings that enhance food's taste, aroma, and color. Spices are not only valued for their sensory contributions to cuisine but also for their potential protective effects against chronic diseases such as cardiovascular disease, neurodegenerative disorders, cancer, and type 2 diabetes (Yashin et al., 2017). While the medicinal benefits of spices are well-documented, their recognition and usage have seen a recent surge in the Western world (Barnes et al., 2007). Increasing awareness of the health benefits of ethnic spices is crucial for broader acceptance and use in these populations.

Health Benefits of Spices on Humans:

Extensive research has highlighted the numerous health benefits of spices. A significant body of evidence suggests that consuming spices is associated with a reduced risk of mortality from various chronic diseases, including cancer, ischemic heart disease, and respiratory diseases. For instance, a comprehensive observational study in China, involving 487,375 participants over a median follow-up period of 7.2 years, found that including spicy food in the daily diet was linked to improved health outcomes and a lower risk of death (Lv et al., 2015). This study underscores the potential health benefits of incorporating spices into one's diet to promote overall health and well-being.

A notable study published in the BMJ in 2015 further supports these findings, showing that regular consumption of spicy food is associated with a 10-14% reduced risk of death for individuals who ate spicy foods 1-7 days a week compared to those who consumed them less than once a week (Lv et al., 2015). Frequent consumption of spicy food was particularly linked to a lower risk of death from cancer, ischemic heart diseases, and respiratory diseases, with a more pronounced effect observed in women. Additionally, the consumption of fresh chili was associated with a lower risk of death from cancer, ischemic heart disease, and diabetes (Chopan & Littenberg, 2017;).

These findings highlight the importance of spices in not only enhancing culinary experiences but also in contributing to a healthier, longer life.

Chilli Pepper: Chilli peppers, particularly red pepper, are renowned for their pungent flavor and health benefits, primarily due to their bioactive components: capsaicinoids and capsinoids. Capsaicinoids are responsible for the heat sensation, while capsinoids offer similar benefits without the intense spiciness. Regular consumption of spicy foods, including hot red chili peppers, has been linked to reduced mortality rates. A significant study demonstrated that the total mortality rate among hot red chili pepper consumers was 21.6%, compared to 33.6% among non-consumers (Chopan & Littenberg, 2017).

Antioxidant and Anti-inflammatory Effects: Capsaicin, the most studied capsaicinoid in red pepper, exhibits potent antioxidant properties, effectively reducing oxidative stress in various tissues and organs. Research has shown that capsaicin can inhibit neutrophil migration, reduce vascular permeability, and decrease the production of proinflammatory cytokines (Anandakumar et al., 2008;) Moreover, capsaicin has potential anti-inflammatory effects, particularly in obesity-induced inflammation, by modulating the release of messenger molecules from fat cells and inactivating macrophages (Kang et al., 2007).

Cardiovascular Health: Capsaicin's beneficial effects on cardiovascular health are attributed to its antioxidant and antiplatelet properties and its ability to regulate energy metabolism. Animal studies have shown that capsaicin can lower LDL levels, reduce oxidative stress, increase HDL levels, and counter the adverse effects of high-fat diets on triglycerides and cholesterol (Manjunath &Srinivasan, 2007). Capsaicin also inhibits platelet aggregation and may enhance coronary blood flow (Guarini et al., 2012). In human studies, regular consumption of capsaicin has been associated with improved serum lipoprotein resistance to oxidation, lower resting heart rate, and better myocardial perfusion pressure (Ahuja et al., 2007). Additionally, capsaicin has been found to improve postprandial hyperglycemia and lipid metabolic disorders in women with gestational diabetes mellitus (Yuan et al., 2016).

Blood Glucose Control: Numerous human trials have consistently shown that consuming over 5 grams of chili pepper (Capsicum frutescens) can significantly lower blood glucose levels and help maintain healthy insulin levels (Chaiyasit et al., 2009;). Animal studies further support these findings, suggesting that red pepper can enhance insulin secretion, reduce liver glucose output, increase glycogen storage, and activate receptors involved in glucose and fat metabolism (Kwon et al., 2009;). Dietary capsaicin may improve glucose homeostasis through TRPV1 activation, highlighting its potential anti-diabetic effects.

Gut Health: Capsaicin, a prominent compound in chili peppers, has demonstrated gastroprotective effects, particularly in peptic ulcer disease. It inhibits acid secretion while stimulating the secretion of alkali and mucus, thus promoting ulcer prevention and healing (Satyanarayana, 2006). Additionally, capsaicin-rich red pepper sauce has been shown to improve swallowing by enhancing esophageal contractility and motility, especially in patients with ineffective esophagus motility (Grossi et al., 2006). These findings underscore capsaicin's potential benefits for gastrointestinal health.

Black pepper: Black pepper (Piper nigrum) is a well-known spice, rich in bioactive compounds, with piperine being the most abundant, accounting for 5-9% of its composition.

Piperine is a potent alkaloid that imparts the characteristic pungency and flavor to black pepper. Besides piperine, black pepper contains other significant compounds such as alkamides, piptigrine, wisanine, and dipiperamide, contributing to its pharmacological and culinary properties. These bioactive compounds have been extensively studied, with comprehensive analyses reported in the Journal of Agricultural and Food Chemistry (Kapoor et al., 2009).

Antioxidant Effect: Piperine, the primary active compound in black pepper, exhibits strong antioxidant properties. It has been shown to inhibit free radicals and reactive oxygen species in vitro, demonstrating potent antioxidant activity compared to other compounds (Kapoor et al., 2009;). Additionally, black pepper or piperine treatment has been found to reduce lipid peroxidation in vivo and improve cellular antioxidant status in various experimental models of oxidative stress (Vijayakumar & Nalini, 2006).

Digestion Aid: Black pepper significantly enhances the digestive process. It increases digestive enzyme activity, gastric acid, and bile acid secretion, and reduces food transit time (Srinivasan, 2007). In animal studies, piperine has been shown to enhance the activities of pancreatic enzymes, such as amylase, lipase, and chymotrypsin, by 87%, 37%, and 30% respectively, when consumed through the diet (Platel & Srinivasan, 2004).

Cardiovascular Health: Piperine exhibits potential cardiovascular benefits in animal studies. It has been found to inhibit lipid accumulation in macrophages, thereby reducing fatty deposits in arterial walls (Matsuda et al., 2008). Additionally, piperine lowers plasma lipid and lipoprotein levels, inhibits vascular smooth muscle cell proliferation and migration, and reduces blood pressure in animals (Lee et al., 2015;). While these findings are promising, further research is necessary to confirm these effects in humans.

Mood and Cognitive Function: Black pepper has been found to possess antidepressant-like properties and cognitive-enhancing effects in animal studies. Piperine regulates neurotransmitter metabolism, leading to improved mood and cognitive function (Li et al., 2007). It increases levels of neurotransmitters such as serotonin, dopamine, and norepinephrine, which are crucial for mood regulation (Li et al., 2007). Additionally, piperine has been shown to improve cognitive function and memory in animal models, suggesting its potential as a cognitive enhancer (Wattanathorn et al., 2008). These findings indicate that black pepper may have a role in managing depression and cognitive impairment, although further human studies are required to confirm these effects.

<u>Cinnamon</u> : Cinnamon's composition includes essential oils and derivatives such as cinnamaldehyde, cinnamic acid, and cinnamate (60-80% in bark oil), eugenol (10% in leaf oil), and water-soluble polyphenols (4-10%) like catechin, epicatechin, and quercetin. It also contains flavonoids, mainly proanthocyanidins and oligomers of cinnamtannins, with type A polymers believed to be crucial for its glucose metabolism effects (Hariri & Ghiasvand, 2016).

Anti-inflammatory and Antioxidant Effects: Cinnamon polyphenol extract suppresses inflammation by regulating gene expression related to anti- and pro-inflammatory pathways (Cao et al., 2008;). Cinnamaldehyde inhibits COX-2 and iNOS, key inflammation pathways (Kim et al., 2007). A 12-week double-blind, placebo-controlled trial found that 500 mg/day aqueous cinnamon extract reduced oxidative stress markers in overweight subjects with impaired fasting blood glucose (Roussel et al., 2009).

Cardiovascular Health: Cinnamon and its extracts benefit cardiovascular health by reducing blood pressure and improving lipid metabolism. Studies have shown reductions in blood triglycerides and total cholesterol, and protective effects against metabolic syndrome complications (Maierean et al.,2017).

Neuroprotective Properties : Cinnamon shows potential in treating mild-to-moderate Alzheimer's disease by inhibiting tau protein aggregation and amyloid-β peptide formation, offering neuroprotective effects through antioxidant and anti-inflammatory pathways (Peterson et al., 2009;). However, further research is required to confirm its therapeutic efficacy.

Hepatoprotective Effects: Animal studies indicate that cinnamon has hepatoprotective properties. Its ethanol extract protects against carbon tetrachloride-induced liver injury and reduces liver lipid accumulation, demonstrating significant antioxidant activity (Moselhy & Ali, 2009).

<u>Turmeric</u>: Turmeric's major active constituents are curcuminoids, primarily curcumin, along with demethoxycurcumin, bisdemethoxycurcumin, and tetrahydrocurcumin. Curcumin is the most extensively studied for its health benefits.

Antioxidative and Anti-inflammatory Effects: Curcumin has strong antioxidant and anti-inflammatory properties, scavenging free radicals and inhibiting inflammatory mediators like TNF-α, NF-κB, and COX-2. A randomized controlled trial showed that 1 g/day curcumin supplementation significantly reduced proinflammatory cytokines in subjects with metabolic syndrome (Panahi et al., 2016).

Joint and Muscle Health: Curcumin's anti-inflammatory and antioxidant properties help maintain joint function and reduce inflammation. Clinical trials have demonstrated its efficacy in managing arthritis, with some studies showing pain relief comparable to ibuprofen (; Panahi et al., 2016).

Blood Glucose Control: Curcumin lowers blood glucose levels and improves glucose indexes. It suppresses liver glucose production, reverses insulin resistance, increases glucose uptake in muscle, and stimulates pancreatic beta-cell function (Kim et al., 2009). Turmeric supplementation also improves endothelial dysfunction and reduces inflammation in type 2 diabetes patients (Usharani et al., 2008).

Chemoprevention: Curcumin exhibits anti-cancer properties, inhibiting tumor cell proliferation and preventing carcinogen-induced cancers in animal models. High doses of oral curcumin have shown biological activity in pancreatic cancer patients (Kunnumakkara et al., 2008).

<u>Garlic</u>: Its biological effects are primarily due to organosulfur compounds like allicin, ajoene, S-allyl-L-cysteine (SAC), and alliin. Allicin is formed when garlic is crushed, but it rapidly breaks down into other sulfur-containing compounds.

Anti-inflammatory Activity: Garlic inhibits inflammation by suppressing NF-κB, iNOS, and COX-2 expression (Butt et al., 2009). Clinical trials have shown that garlic supplementation improves symptoms in women with osteoarthritis (Salimzadeh et al., 2018).
Cholesterol-lowering Effect: Garlic may reduce blood lipid levels by inhibiting enzymes involved in cholesterol synthesis. Meta-analyses have reported reductions in total cholesterol with garlic supplementation (Varshney & Budoff, 2016).
Brain Health: Garlic-derived products protect against ischemic brain injury and improve cognitive function in animal studies. Garlic may also protect neurons from neurotoxicity and apoptosis, suggesting a role in preventing cognitive decline (Gupta et al., 2009).
Immunomodulatory Activity: Garlic enhances immune function by stimulating lymphocyte proliferation and macrophage activity. It has shown immune-enhancing effects in both in vitro and in vivo studies (Ishikawa et al., 2006).

CONCLUSION :

The spices that add flavor and aroma to our meals have been revealed to possess a multitude of health benefits, backed by a plethora of scientific studies. From reducing inflammation and improving cardiovascular health to enhancing cognitive function and exhibiting anti-cancer properties, the advantages of spices are undeniable. Moreover, they have been shown to support the immune system, promote digestive health, and even lower mortality rates. As we continue to uncover the secrets of these ancient ingredients, it becomes clear that incorporating spices into our diets may be one of the simplest and most effective ways to improve our overall health and wellbeing.

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BOOK REVIEW

By

B. Jacob Meledom

President, AFSTI Cochin Chapter

Text book of Fish Processing Technology

The book is the revised and updated second edition authored by Dr.K.Gopakumar , former Deputy Director General , ICAR ,New Delhi and Dr.T.V.Sankar , former Principal Scientist , ICAR- CIFT, Kochi.

Dr.H.Pathak, Director General, ICAR has complimented the authors in his foreword to the book for their efforts in bringing out a comprehensive and revised second edition of the book 'Text book of fish processing technology'.

The publication would serve as a very valuable reference book for students and research scholars of universities and educational institutions the world over .

The book would also be a source of immense use for the fish processing industry in India and overseas .

The volume covers a wide spectrum of topics which include :

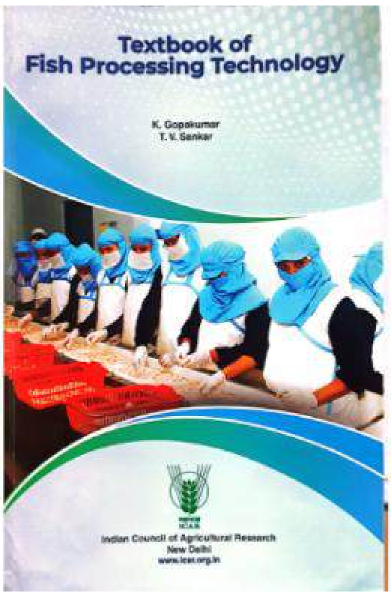
Biochemical composition of fish, Post-mortem changes in fish in quality assessment, fish and shellfish proteins and the changes during processing and preservation , bacteriology of fish and shellfish , technology of fish freezing , technology of fish canning , value added fish products, fishery products of commerce , utilization of fish wastes , recent trends in fish packaging , quality assurance of fish and fishery products , HACCP for enhancing food safety , sensory evaluation of foods , seaweeds and the industrial use and drugs of marine origin.

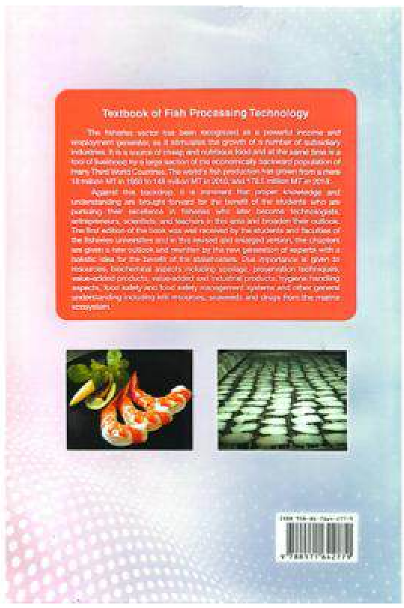
The Chapter on Fish freezing, Drying ,Canning, Irradiation gives comprehensive coverage of the different methods of fish preservation and processing. The Chapter on value added fishery products will be of particular interest to the fish processing and export industry. The domestic market has grown substantially over the years and is bound to register further impressive growth. Battered and breaded products coated fish fillets, fish minces, fish cutlets, burgers, sausage, surime, kneaded products. IQF products, fish sauce and fish salads, cured –and-dried products, pickled products all have immense domestic market potential as well as export market.

The Chapter on Quality Assurance of Fish and Fishery products is significantly important as the Indian Food Safety Regulatory body - FSSAI - and the regulatory bodies in the importing countries continuously upgrade quality requirements and specifications.

The Chapter describes in detail elements of quality systems, methods of quality evaluation and global perspective on food quality and safety. The Chapter "Hazard Analysis and Critical Control Point for enhancing food safety " gives valuable guidance on implementing HACCP based Food Safety Management System in fish processing units.

The book is an invaluable source of reference for industry and academia since it contains the knowledge and wisdom of many years of outstanding research and unique experience of Prof.(Dr.)K.Gopakumar and Dr.T.V.Sankar .





World Food Safety Day

World Food Safety Day was celebrated by AFST(I) Cochin chapter in association with Nitta Gelattin on 7 June 2024. The theme of World Food Safety Day for 2024 was "Prepare for the unexpected ".

Nitta Gelattin is an Indo Japanese joint venture which has been operating for the past several years maintaining a world class production unit and delivering products meeting stringent international standards. The event started at 10.30 am at the meeting hall of Nitta Gelattin at Kinfra Export Park at Kakkanad.

Sri. Sasikumar, Vice President AFST(I) Cochin Chapter welcomed the gathering.

Sri.K.Pradeep Kumar, Sr.General Manager, Nitta Gelattin inaugurated the event.

Dr.DD Nambudiri , National Vice President, AFST(I) made a presentation on the origin and a scope of activities of AFST(I) . He congratulated Nitta Gelatin for joining AFST(I) Cochin chapter to hold the commemorative event of World Food Safety Day at the facility of Nitta Gelatin.

Dr.T.V.Shankar, renowned expert on seafood and formerly of CIFT, ICAR delivered the keynote address. He covered a whole range of food safety issues which had occurred in the past and likely to recur and also emerging threats to food safety from unexpected sources. His presentation was exhaustive and informative .

Dr.Maya Raman , Associate Professor, KUFOS made a presentation on food safety issues of past, present and future. Dr. K.R.Chitra, AGM , Quality Assurance of Nitta Gelatin made a presentation on food safety and also emerging threats to food safety.

Dr.B.Jacob Meledom in his presidential address expressed his appreciation for the active association and hospitality extended by Nitta Gelatin for organizing World Food Safety Day. He mentioned that the theme 'Prepare for the unexpected' is the most appropriate for the current global situation in food safety. He also mentioned that the Nitta Gelatin the Indo Japanese joint venture, is the most ideal venue for holding this year's world food safety event as the theme is to 'Prepare for the unexpected' .

He mentioned Japan is the country frequently facing natural disasters like typhoon, earthquake and tsunami but they have been very successful and most effective in disaster prevention management. Japan would survive all the calamities successfully and mitigate the impact to the minimum . He narrated instances of quality concerns of Japanese to source seafood, cashews and spices from India ensuring utmost food safety .

Sri.Jayan Jacob, Secretary, AFST(I) expressed grateful thanks to Nitta Gelatin management for hosting the World Food Safety Day event and extending warm hospitality.

After the meeting Lunch was arranged at Nitta Gelatin. Later executive committee of AFSTI Cochin chapter was also held at the same venue.

Inauguration by Mr. K Pradeep Kumar, Nitta Gelatin

Presidential Address : Dr B J Meledom

Dr T V Sankar addressing Technical Session 1

Dr Maya Raman addressing Technical Session 2

Welcome address by Mr K Sasikumar, Vice President

Vote of thanks: Mr Jayan Jacob , AFSTI Secretary

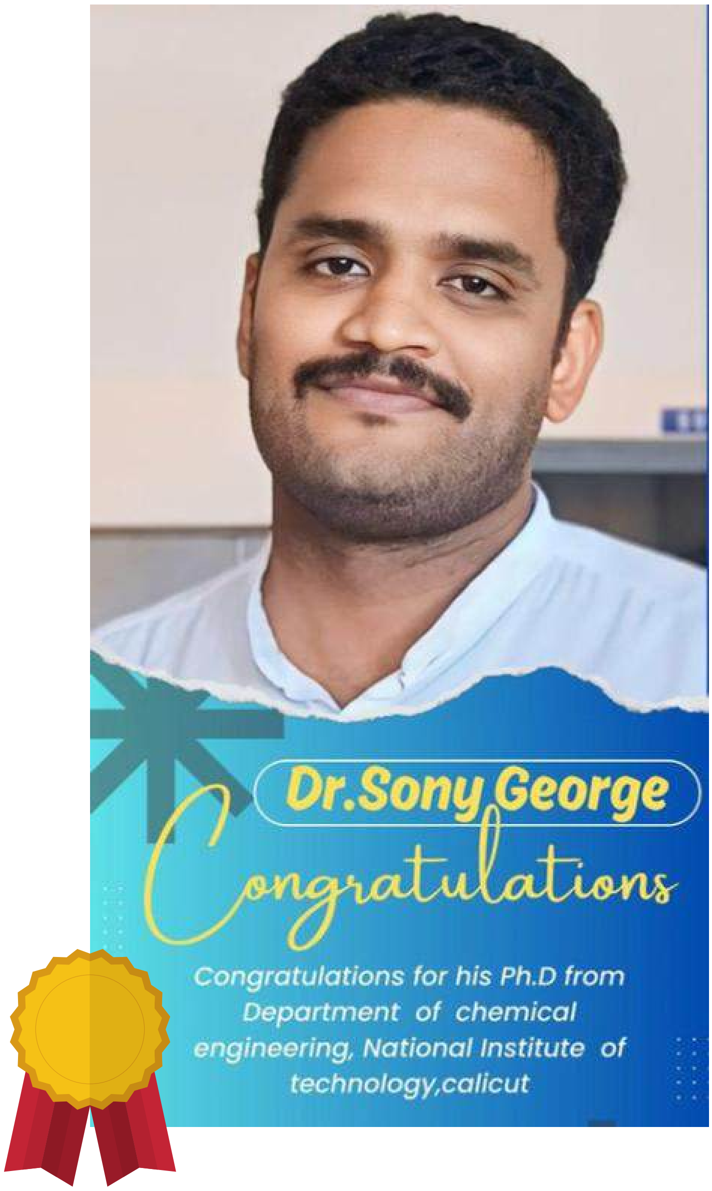
Dr. D D Nambudiri,National vice president,addressing the audience

Dr. DD. Nambudiri, National Vice president, AFSTI, has attended Dr.HAB Parpia memorial lecture held at Sant Longowal Institute of Engineering and Technology, Longowal, Punjab on 3 rd May 2024. The memorial lecture was delivered by Maneesha Sharma packaging expert. The central executive committee of AFSTI along with the senior members of local chapters interacted with the students and Faculty of Sant Longowal Institute of Engineering and Technology.

FOSTAC TRAINING

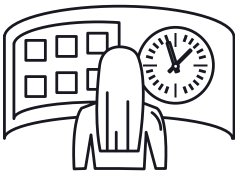
AFST(I), Cochin Chapter conducted FOSTAC training on Advanced Manufacturing for a total of 45 employees of NUTRICREAMS PRIVATE LIMITED and MERRIS FOOD INDUSTRIES in the month of June 2024.
39 participants from companies various factory locations participated in the training held on 12th June 2024 at the Nutricream's conference hall, Chelamattom. Rest 6 participants were trained on 15th June 2024. The participants included supervisors, food safety team members and factory managers.
The trainer for both the sessions was Ms. Rekha Menon Kuttath and Dr. B Jaocb was the assessor for the sessions.

Achievements of Our Member...



Sony George, AFSTI Cochin chapter Executive Committee Member, was awarded Doctoral degree in Chemical Engineering from the National Institute of Technology, Calicut in June 2024

Congratulations..... Dr. Sony George...!!!!!



Recent Updates...

Butter made from CO_2, not cows, tastes like 'the real thing', claims startup

FSavor, backed by Microsoft billionaire Bill Gates, says product has lower carbon footprint as it doesn't need cows. They have been experimenting with creating dairy-free alternatives to ice-cream, cheese, and milk by utilising a thermochemical process that allows it to build fat molecules, creating chains of carbon dioxide, hydrogen and oxygen. The company has now announced a new animal-free butter alternative. Reducing meat and dairy consumption is one of the key ways that humanity can reduce its environmental impact, as livestock production is a significant source of greenhouse gases, and Savor says its products will have a significantly lower carbon footprint than animal-based ones. The "butter" could potentially come in at less than 0.8g CO_2 equivalent per calorie. The standard climate footprint of real unsalted butter with 80% fat is approximately 2.4g CO_2 equivalent per calorie.

-The Guardian

FSSAI introduces bigger font & bold letters for nutrition labels of sugar, salt, & saturated fat

FThe Food Safety and Standards Authority of India (FSSAI) has approved a proposal to display nutritional information regarding total sugar, salt and saturated fat in bold letters and relatively increased font size on labels of packaged food items, putting an end to the proposed Front of package labelling (FoPL) Regulations in India for ultra-processed packaged foods.
Along with empowering consumers make healthier choices, the amendment would also contribute towards efforts to combat the rise of non-communicable diseases (NCDs) and promote public health and well-being.

- The Economic Times

The world's first microplastic-free cotton tea bags launched in Assam

IThe launch of Esah Tea comes in response to the revelation that conventional plastic tea bags release an astounding 11.9 billion harmful microplastic particles per cup.
Esah Tea, a direct-to-consumer (D2C) tea brand from Assam, has launched the world's first microplastic-free cotton tea bags. These innovative tea bags are 100% chemical-free, biodegradable, and handmade, reflecting the brand's unwavering commitment to sustainability and customer health. The price of the tea bag is just ₹5 per bag, making it one of the most economical products available in the market. The launch comes in response to the revelations from McGill University's researchers that conventional plastic tea bags release an astounding 11.9 billion harmful microplastic particles per cup.
The urgency of Esah Tea's innovation becomes clear considering the far-reaching implications of microplastic consumption. These minuscule particles, when ingested, inhaled, or absorbed through the skin, pose significant health risks. Scientific studies have indicated that microplastics can potentially cause cellular damage. In addition, regular exposure to microplastics has been linked to immune system disruption, neurotoxicity, reproductive issues, and even carcinogenic effects.

-Hotelier India

Mars leverages AI app predicting blood sugar responses to food

Acquiring data about consumers' blood sugar responses to certain foods is an expensive effort, but it is becoming much cheaper and easier through artificial intelligence (AI).
A collaboration between Mars, Inc., McLean, Va., and January AI, Menlo Park, Calif., is designed to unlock valuable information to guide product formulation and positively affect public health at the same time. The project will use January AI's tools and the company's R&D capabilities to predict responses to a wide range of different foods and formulations, explained Darren Logan, PhD, vice president of research, Mars.
For those who are prediabetic or who already have diabetes, it means being able to identify trends and patterns in the data and use them to determine healthier food options.

-Agro & Food Processing

India Aims To Promote Artificial Intelligence In Food Processing Sector: Report

Technology is possibly not the first thing that we consider while discussing issues in the food industry. But today, with the advancement of artificial intelligence (AI), automation has become an aspect that you just can't ignore while considering food production and distribution. And India is gearing up to boost the integration of AI in the food processing industry, reads a report in PTI. According to a Government announcement, this initiative aims to enhance the efficiency of the farmers, further improving their incomes and minimizing environmental impact. The announcement was made at a recent conference, organized by the National Institute of Food Technology Entrepreneurship and Management (NIFTEM), on using frontier technologies in the food and agriculture sector.
As per the PTI report, the senior bureaucrats and Government advisors, present at the conference, emphasized the need for a proper roadmap and strategy to deploy AI solutions, which are still at a very early stage when compared to the country's massive food processing industry.
The officials added that AI tools could also help improve overall sector efficiency as India aims to reach net zero emissions by 2070.

- The Economic Times

FSSAI Mandates Exclusive Use of Approved Test Methods for Fortificants' Testing

The Food Safety and Standards Authority of India (FSSAI) has issued a directive mandating the use of FSSAI-approved test methods for testing fortificants such as iron, vitamin B9, and vitamin B12 in fortified rice, fortified rice kernel, and vitamin-mineral premix for fortified rice kernel.
According to the recent order, all FSSAI-notified food testing laboratories approved for these tests must exclusively utilize the FSSAI-approved methods. These methods were originally published in orders dated September 8, 2022, November 7, 2023, and November 9, 2023.
Furthermore, laboratories currently employing Standard Operating Procedure (SOP) test methods based on FSSAI guidelines must update their accredited scope within four months from the issuance of this order to include the FSSAI-endorsed test methods. Failure to comply with these instructions will result in delisting or removal from the approved list of laboratories for testing fortificants in fortified rice and related products.
This regulatory step underscores FSSAI's commitment to ensuring the accuracy and reliability of fortificant testing across food products, aligning with stringent quality standards to safeguard public health.

GENERAL AWARENESS

1) Which country's name means "The Shallows"?
[a] Madagascar
[b] Argentina
[c] Bahamas
[d] Tasmania

2) Who was the first man to reach the South Pole?
[a] Tom Creen
[b] Robert Falcon Scott
[c] Edmund Hillary
[d] Roald Amundsen

3) Which of the Canary Islands is the largest and most populous?
[a] Tenerife
[b] La Palma
[c] Gran Canaria
[d] Lanzarote

4) Who ran against Bill Clinton in the 1996 US Presidential Election?
[a] George Bush
[b] Bob Dole
[c] Barack Obama
[John McCain

5) In what year did the Chernobyl nuclear disaster occur?
[a]1980
[b] 1978
[c] 1990
[d] 1986

6) B. C. Roy Award is given in the field of
[a] Music
[b] Journalism
[c] Medicine
[d] Environment

7) In which year was Pulitzer Prize established?
[a] 1917
[b] 1918
[c] 1922
[d] 1928

8) Who invented the BALLPOINT PEN?
[a] Biro Brothers
[b] Waterman Brothers
[c] Bicc Brothers
[d] Write Brothers

9) When was barb wire patented?
[a] 1874
[b] 1840
[c] 1895
[d] 1900

10)What invention caused many deaths while testing it?
[a] Dynamite
[b] Ladders
[c] Race cars
[d] Parachute

11) When was Milk Tray first introduced?
[a] 1915
[b] 1934
[c] 1923
[d] 1942

12) The landmass of which of the following continents is the least?
[a]Africa
[b] Asia
[c] Australia
[d] Europe

13) Who invented Automobiles using gasoline?
[a] Leo H Baekeland
[b] Karl Benz
[c] Evangelista Torricelli
[d] Kirkpatrick Macmillan

14) Who invented the battery?
[a] John Wilkinson
[b] Alessandro Volta
[c] James Hargreaves
[d] Thomas Edison

14) Who invented fuel cells in 1839?
[a] Buckminster Fuller
[b] Sir William Grove
[c] Sylvester Graham
[d] Joyce Hall

15) Who synthesized the first wholly artificial gene?
[a] Hargobind Khorana
[b] J.J. Thompson
[c] Benjamin Franklin
[d] Meghnad Saha

16) The National Anthem was first sung in the year
[a] 1911
[b] 1913
[c] 1936
[d] 1935

17) The head quarters of Sahitya Akademi is at
[a] Mumbai
[b[Chennai
[c] New Delhi
[d] Kolkata

18)Which of the following places is famous for Chikankari work, which is a traditional art of embroidery?
[a] Lucknow
[b] Hyderabad
[c] Jaipur
[d] Mysore

19) The hazards of radiation belts include
[a] deterioration of electronic circuits
[b] damage of solar cells of spacecraft
[c] adverse effect on living organisms
[d] All of the above

20) The great Victoria Desert is located in
[a] Canada
[b] West Africa
[c]Australia
[d] North America

1) Which of the following are not conjugated proteins?
[a] Glycoproteins
[b] Scleroproteins
[c] Phosphoproteins
[d] None of the above

2) --------- is an online portal developed by FSSAI that offers a centralised platform to the consumers to raise concerns related to food safety and hygiene
[a] FoSCoRIS
[b] FoSCoS
[c] Food Safety Connect
[d] None of the above

3) Agricultural & processed Food Products Export Development Authority was established by Government of India in?
[a] December 1985
[b] December 1980
[c] December 1986
[d] January 1980

4) As per the FSS Act, the sale of certain mixtures is prohibited. Which of the following is included in this?
[a] Condensed milk
[b] water mixed milk
[c] Coffee & chicory blend
[d] Curd from condensed milk

5) The primary function of the Spices Board include
[a] Production & development of small and large cardamom
[b] Production and development of cloves
[c] Production and development of cinnamon
[d] Production and development of star anise

6) The All India Cyclothon called "Swasth Bharat Yaatra", a key element of "Eat Right India Movement" was flagged of on:
[a] 16 January 2018
[b] 16 October 2018
[c] 16 March 2018
[d] 16 May 2018

7) "AGMARK" is related to
[a] Production
[b] Processing
[c] Quality
[d] Packaging

8) Principle method to dehydrate coffee beans extract
[a] Tunnel drying
[b] Drum drying
[c] Spray drying
[d] None of above

9) Bacterial growth is generally impossible when water activity reduces below
[a] 0.80
[b] 0.70
[c] 0.60
[d] 0.90

10) "Bitter pit" a storage disorder of apple is caused by any one of the following deficiency of the tissue
[a] Iron
[b] Calcium
[c] Nitrogen
[d] Potassium

11) Pre-cooling of fruit and vegetables is done at a temperature
[a] 5-10 °C
[b] 10-12 °C
[c] 15-17 °C
[d] 15-20 °C

12) Chilling injuries arising from the exposure of the products to a temperature
[a] Above the normal physiological range
[b] Below the normal physiological range
[c] Under poor ventilation condition
[d] In CA storage

13) ______________ is the example of antiripening agent
[a] 2, 4, 5 trichlorophenoxy acetic acid
[b] Maleic hydrazide
[c] Sulphur dioxide
[d] Sodium benzoate

13) ______________ is the example of antiripening agent
[a] 2, 4, 5 trichlorophenoxy acetic acid
[b] Maleic hydrazide
[c] Sulphur dioxide
[d] Sodium benzoate

14) ______________ is used to whiten the color of fresh whole for the production of some kinds of cheese
[a] Hydrogen peroxide
[b] Sulphurdioxide
[c] Sodium benzoate
[d] Potassium Sorbate

15) ADA (Azodicarbon amide), Potassium bromate, ascorbic acid, cystene are the example of________________ in flour
[a] Not Maturing
[b] Maturing
[c]Neutral
[d] None of above

16) Enzymes have ———— classes
[a] Two
[b] Six
[c] Seven
[d] Ten

17) Among the fatty acid ————- is used as nutritional additive
[a] Palmatic acid
[b] Stearic acid
[c] Capric acid
[d] Linoleic acid

18)__________ and __________ are the examples of Proteolytic enzyme
[a] Trypsin & Pepsin
[b] Trypsin & Amylase
[c] Lipase & Pepsin
[d] None of above

19) Vapors pressure of solution divided by vapors pressure of solvent is referred as:
[a] Density
[b] Solvent solution ratio
[c] Vapors
[d] Water activity

20) Fermentation is originated from:
[a] Spanish
[b] Roman
[c] Latin
[d] Greek

Cochin Chapter

Association of Food Scientists & Technologists, India (Cochin Chapter)

Invites

Articles for its 12th edition Newsletter

The Food Tech Times

On the theme

"AI in food processing"

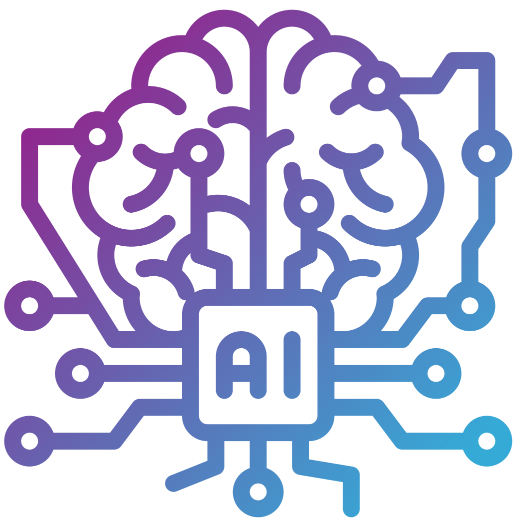
Instructions for the articles:

- The articles should can be written on the theme " AI used, companies involved, advantages, disadvantages," etc
- Give appropriate references.

Submit your articles to:

afsticochinnewsletter@gmail.com

Last date of submitting articles: 10 Oct 2024



Please send your valuable comments, feedbacks, queries, and complaints at afsticochinnewsletter@gmail.com