

Future prospects

Challenges, thrust areas and research support and highlights:

- Low productivity of spices is the major issue to be addressed in the country. In black pepper, our national average is only 316 kg/ha whereas, in Thailand it is 3,352 kg/ha. Guatemala produces cardamom at the rate of 250 kg/ha as compared to 135 kg/ha produced in India. Ginger is about 3391 kg/ha in India as against 8,116 kg/ha in Indonesia. At present we do not have high yielding varieties, appropriate production technologies and a highly conducive climate for spices production.
- Quality is the key to good marketing of spices. Our motto should be 'clean spices' rather than 'cleaned spices'. In order to compete and retain our position in the world spices market, our ability to meet the quality expectations in the areas of pesticide residues, mycotoxins and microbial load should be strengthened.
- Broad-basing the spices export basket by product diversification to meet global quality standards.
- Price competition in the global market is another major challenge for the Indian spice industry. A realistic price reduction to offer healthy competition to our major competitors like Vietnam (for black pepper), Guatemala (for cardamom). etc., should be seriously considered.
- Challenges with respect to the WTO regime and IPR issues.
- Many Indian spices are much valued in the world market because of their intrinsic qualities. However, the import of low grade spices to India and re-export under the Indian label should be regarded very seriously.
- Promotion of organic spices production, so as to cash in on the growing demand for organic produce in the world market. The huge expense involved in the process of certification remains a major challenge to be addressed.

Research Support:

Research schemes on spices were initiated in limited number during 1940s. Research on spices was initially restricted to formulate cultural practices for major spices like black pepper, cardamom, ginger and turmeric at a few centres under the Department of Agriculture in the Southern states comprising Kerala, Karnataka, Tamil Nadu and Andhra, Pradesh. Since 1949, there have been organised attempts to conduct spices research in the country and to formulate specific programmes for the development of spices. The Government of Madras

initiated the first pepper research scheme at Panniyur, Kerala. It was followed by cardamom research schemes at Mudigere (Karnataka) and Pampadumpara (Kerala) in 1951. The Spices Enquiry Committee set up by the Government of India in 1953 made recommendations to commence specific research activities and the opening of new research centres on spices. Accordingly, research centres were set up at Chethalli (Karnataka), Dergaon (Assam) and Sirsi (Karnataka) for black pepper; Kandaghat (Punjab), Targaon (Maharashtra) and Thodupuzha, Ambalavayal (Kerala) for ginger and turmeric; and Burliar (Tamil Nadu) for minor spices. The pre-plan period included research schemes for cardamom in Chennai (Tamil Nadu), ginger in Kerala and Orissa and turmeric in Orissa. These programmes came to a natural end with the termination of their respective schemes. The first five year plan stressed research on pepper, cardamom, clove, nutmeg and minor spices. During the second and third plans, research on spices spread to a number of states including Orissa, Andhra Pradesh and West Bengal. Schemes for minor spices and were also initiated during this period.

To increase the production and productivity of spices, adequate research support is needed. The research and development work in spices is carried out by Indian Council of Agricultural Research (ICAR), State Agricultural Universities (SAUs), Spices Board, Directorate of Arecanut and Spices Development, Council of Scientific and Industrial Research (CSIR) and a few other agencies. The Indian Council of Agricultural Research is the apex body that conducts, coordinates, manages and funds various crop research programmes. The research and development of spices received new impetus and vitality when ICAR commenced concerted research through the All India Coordinated Research Project on Spices. The establishment of the All India Coordinated Spices and Cashew Improvement Project (AICSCIP) by the ICAR in 1971 (IV Plan) was a major step in spices research in the country.

During the fifth plan period, ICAR recognised the need to initiate concerted research on major spices like black pepper, cardamom, ginger, turmeric and tree spices. A regional station under CPCRI (ICAR) was started on 10th November, 1975 at Calicut, Kerala, to carry out research exclusively on spices. The Cardamom Research Centre at Appangala, Coorg, Karnataka, originally established by the Mysore Government to initiate research on cardamom, was taken over by CPCRI in 1974 from the Indian Institute of Horticulture Research, Bangalore. This was followed by the setting up of the Indian Cardamom Research Institute in 1976 by the Spices Board to work exclusively on cardamom, with four regional stations.

The CPCRI (RS), Calicut, was upgraded and designated as National Research Centre for Spices (NRCS) in April 1, 1986, by merging the CRS, Appangala, Karnataka. The AICRPS, functioning from 1971, was bifurcated into two independent projects, one on spices and other on cashewnut, in September 1986. Based on the recommendations of the QRT and the parliamentary committee (Rajya Sabha), the NRCS was upgraded to a full-fledged institute and called the Indian Institute of Spices Research from July 1, 1995.

The AICRPS is the largest spices research network in the country, providing the much needed R & D base. Research on 12 mandate crops is carried out under the AICRPS in 20 coordinating centres, located in 15 states with the respective Agricultural Universities, representing the major agro-climatic regions.

Highlights of spice research:

- The IISR & AICRPS centres hold more than 10,500 germplasm accessions in black pepper, cardamom, ginger, turmeric, tree spices, seed spices and vanilla.
- The concerted efforts made during the last three decades resulted in the release of many high yielding varieties.
- Production technologies have been developed with respect to propagation, density of planting, manures and fertilizers, irrigation, cropping systems, harvesting, processing, grading and development of value added products.
 - Integrated plant nutrient management systems are being evolved, weed management and water requirement have been standardised for a few spices.
- Advances have been made to locate sources of resistance/tolerance to biotic and abiotic stress.
- Technology for management of pests and diseases has been developed.
- Integrated disease management has been developed against major diseases.
- High quality lines in black pepper, cardamom, ginger and turmeric have been identified.
- Advances have been made in biocontrol of diseases in major spices.
- The production of planting materials have been undertaken.

Research attainments:

A considerable increase in productivity has been reported in research stations especially in pepper, ginger, turmeric and coriander.

The critical need is effective transfer of technology. Attempts are being made to identify main production constraints and work out appropriate and economic strategies.

An exclusive nucleus seed multiplication programme to supply quality planting materials to farmers is under implementation. Research results are available on the rapid multiplication through tissue culture of black pepper, cardamom, clove, nutmeg, cinnamon, ginger and turmeric.

Biotechnology research has great potential in spices *Potential applications of plant biotechnology in spices*

- Micro-propagation and rapid clonal multiplication of high yielding, elite genotypes to generate adequate good quality and disease-free planting materials. E.g. cardamom, vanilla, black pepper.
- Exploiting somaclonal variation and utilisation of techniques like somatic cell hybridization, anther culture, embryo rescue, etc., for crop improvement. E.g. bold rhizome types in ginger.
- In *vitro* selection for resistance to biotic and abiotic stresses. E.g. soft-rot resistant lines in ginger.
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- In *vitro* conservation and safe exchange of germplasm.
- Production of flavour and volatile constituents in culture.
- Synseed technology available for many spices.

Spices	Constrains	Research attainment
Black pepper	Phytophthora foot rot	Management of the disease through package of practices is standardised. Tolerant lines to the disease are developed (P24), biocontrol is being recommended
	Stunt disease	No effective control measures except uprooting of diseased plants. Causative organism is virus/mycoplasma, insect, micronutrient deficiency
	Slow decline	Effective management method(s) are available except on source of resistance to <i>Radopholus similis</i> nematode.
	Low productivity	High Production Technology (HPT) is demonstrated
Small cardamom	Katte disease, Vein clearing (Kokke Kandu) virus diseases	Virus etiology is established. 'Katte' escapes are identified. *Katte'-tolerant lines are multiplied
	Low productivity	Removal of diseased plants is advocated. No effective management measures are available. The spread has been checked by social action.
Ginger Turmeric	Rhizome rot	High Production Technology (HPT) is demonstrated. <i>Pythium</i> sp. involved, soil solarisation
	Bacterial wilt	Causitive organisms are identified. Solarisation of soil prior to planting is effective. Biocontrol is being tried out.
	Nematode infestation	<i>Ralstonia solanacearum</i> is the causal organism. No resistant variety is available. <i>Meloidogyne</i> sp. and <i>Pratylenchus</i> sp. identified.
	Low curcumin	High curcumin lines have been identified.
	Low productivity	Integrated plant nutrient management (IPNM) has been developed.

Table 1 Improved variety and hybrid released so far

Spices		Hybrids /varieties released
Black pepper	16	Panniyur-1 (H); Panniyur-2 (V); Panniyur-3 (H); Panniyur-4 (V); Panniyur-5 (V); Panniyur-6 (V); Panniyur-7 (V); Subhakara (V); Palode-2 (V); Sreekara (V); Panchami (V); Pournami (V), IISR Thevam (V), IISR Malabar Excel (H), IISR Girimunda (H), IISR – Shakthi (V).
Small Cardamom	14	Mudigere-1 (V); Mudigere-2 (V); PV-1, PV-2 (V);, CCS-1 (Suvasini) (V); ICRI-1 (V); ICRI-2 (V); ICRI-3, TKD – 4 (V), IISR Vijetha (V), IISR Avinash (V), Njalani green gold (V), SKP-14 (V); ICRI-4 (V)
Cinnamon	8	IISR Navasree (V); IISR Nithyasree (V), YCD-1 (V), Konkan Tej (V), Sugandhini, PPI (C)-1 (V), RRL (v) C-1 (V).
Ginger	9	Suprabha (V); Suruchi (V); Surabi (V); Varada (V); Himgiri (V), V ₃ S ₁ -8, V ₁ E ₈ -2 (V), IISR Rejetha (V), IISR Mahima (V)
Turmeric	24	Co-1(M); Krishna (V); Sugandham (V); BSR-1 (V); BSR-2 (V); Suvarna (V); Roma (V); Suroma (V); Rajendra Sonia (V); Suguna (V); Sudarshana (V); Ranga (V); Rasmi (V); IISR Prabha (V); IISR Prathibha (V); Megha Turmeric-1 (V), Pant peethabh, Suranjana (V), Alleppy Supreme (V), IISR Kedaram (V), Kanthi (V), Sobha (V), Sona (V), Varna(V).
Coriander	21	Gujarat Coriander-1 (V); Co-1 (V); Co-2 (V); Co-3, (V); Gujarat Coriander 2 (V); Rajendra Swati (V); RCr-1 (V); RCr-41 (V); Sadhana (V)' Swathi (V); CS-287 (V); Sindhu (V); UD 20 (V); DH-5 (V); CIMPO S-33 (V); Hisar Anand (V); Pant Dhania (V); Sadhana, CS-2 (V),
Cumin	12	RS-1, S-404 (V); MC-43 (V); Gujarat Cumin-1 (V); Gujarat, Cumin-2 (V); RZ-19 (V), GC-3 (V) GC-4 (V) Selection – 3 (V), CJS- 182 (V), VC-19 (V), VC-198 (V).
Fennel	7	S-7-9 (V); PF-35 (V); Gujarat Fennel-1 (V); Co-1, (V), Gujrat Fennel-2 (V); Rajendra, Saurabh (V), UF-32 (V),
Fenugreek	14	Co-1 (V); Co-2 (V) Rajendra Kanti (V); RMt-1 (V); Lam Selection-1 (V), RMt 303 (V), RMt 143, Hisar Sonly (V) Gutarat Methi-1 (V); Rajendra Khushba (V), Pusa Early Bunching (V), Kasuri Selection (V), Prabhat (V)

H-Hybrid, V-Variety, M-Mutant (*Source: Spice Board, Cochin*)

Source: Spice Board, Cochin)

Table 2 - Methods of plant propagation in spices

Spices	Method of propagation	Advantages
Black pepper	Single noded rooted cutting using bamboo method, Serpentine method, Pit method.	Multiplication rate of 1:40 per year. Good anchorage due to presence of two root systems The recovery percentage is higher compared to rapid multiplication technique. Simple, less costly, quick and ready for planting within 4 - 4 ½ months
Cardamom	Trench method of sucker production.	Multiplication rate of 1:20 per year
Clove	Inarching on clove seedling.	Earliness, dwarfness and high productivity
Nutmeg	Epicotyl grafting, top working.	Female plants are propagated conservation of male plants to female plants. Rapid multiplication of elite plants per unit area.
Cinnamon	Cottage, air layering (rapid multiplication techniques).	Earliness,. More plants per unit area
Cassia	Air layering, cottage.	True to type plants
Allspice	Cuttage, layering.	Management of rhizome rot
Ginger and turmeric	Rhizomes	Crop rotation, solarization and disease – free rhizomes.

(Source: Spice Board, Cochin)

Some of the salient achievements of biotechnology in spices include micro-propagation and clonal multiplication in cardamom, black pepper, ginger, turmeric, cinnamon and vanilla. *In vitro* selection for resistance to biotic and abiotic stresses especially rhizome-rot in ginger is in progress. Protocols are also available for direct regeneration through tissue culture in long pepper, chaba pepper, kaempferia, curry leaf, tamarind, coriander, fennel, cumin, dill, lavender, aniseed, thyme and large cardamom. Synseed technologies are also available for cardamom, ginger, turmeric and pepper.

Spice Pests/diseases Bio-control agent tried

Black pepper *Phytophthora capsici*, *Trichoderma* sp. in combination with scale insects, top VAM. Natural enemies viz., *Encarsia* shoot borer, lounsburyi, *Apanteles cypris*, an import-nematodes ant parasite, *Verticilliumchlamydospor- ium*, *Trichoderma* sp., VAM

Pollu beetle An entomophagous mite and

nematode

Cardamom Rhizome-rot and *Trichoderma* sp. and *Paecilomyces*

damping-off *lilacinus*

Root-knot nematode *Paecilomyces lilacines*

Ginger and Rhizome-rot *T harzianum*, *T hamatum*, *T.uiride*

turmeric

Coriander Wilt *T viride*, *T harzianum*, *Pseudomonas*

fluorescences

Fenugreek Root knot *T uiride*

Environmentally friendly spices culture

The use of plant protection chemicals has led to residual toxicity in spice products. Moreover, there is a high premium for organic spices. Biocontrol of pests and diseases is another area where useful information is being generated.

A fungus, *Trichoderma* sp, in combination with VAM suppresses *Phytophthora capsici*, the causative organism of foot-rot in black pepper. Biopesticides to manage pests of spices are also being developed. There has been a major break-through in the generation of new technologies.

Spice Oils and Oleoresins

As raw spices do not provide uniformity in flavour, strength and colour, spice oils and oleoresins are used in flavour formulations. The spice oleoresins and oils score over the respective raw materials in their flavour concentration, solubility, stability, uniformity and hygienic quality and are hence preferred in modern food industries. Spice oils are volatile substances which are mostly terpenic in nature and are obtained by the steam or hydrodistillation methods. Oleoresins are obtained by organic solvent extraction of the powdered spices and they contain essential oils fraction, bitter principles, colour and resinous matter.

Spice oils

In most spices, the odour or aroma factor is attributed to the volatiles (essential oils) present in them. This 'essential oil' can be obtained by steam distillation of the ground spice. The oil is made up of hydrocarbons like terpenes, sesquiterpenes and their oxygenated derivatives. Steam distillation is a gentle process, in which the oil components from the ground spices are entrained by steam at a temperature less than 100°C. With a rapid flow of steam, large quantities of oil can be collected.

Production

The spice is ground before distillation, using a suitable mill. The crushed material is distilled as quickly as possible to avoid any loss of oil. The distillation of oil should be carried out using stainless steel instruments to avoid metallic and other contaminations which are undesirable in materials used for food flavouring. The ground spice is kept in a cage with a perforated bottom. From an external source, steam is let in through the bed of the material. As the steam passes, it carries with it the volatile components of the spice by entrainment. The mixture of steam and oil passes through a water-cooled condenser, gets condensed and the mixture of water and oil enters the oil-water separator situated at the other end of the condenser. Since most of the essential oils are lighter or heavier than water, they are separated out and the oil can be collected easily.

Precautions have to be taken regarding the rate of flow of steam, condensate temperature, rate of distillation, etc., to ensure the best results. The distillation time should be sufficient to ensure complete recovery of all the important constituents of the oil.

The oil collected from the separator is filtered and dried over anhydrous sodium sulphate. The oil is packed in brown glass or tinned metal containers. The containers are filled to the brim to exclude air, since oxygen can cause deterioration. The oils are then stored in a cool place.

Supercritical fluid extraction technology (SCFE):

The SCFE system is the modern technology of making oils and oleoresins through carbon-dioxide processing. This system provides a modern cost-effective technology for value addition in the processing of various agricultural commodities like spices. The CO₂ extraction of essential oils utilises liquid carbon dioxide at low temperature (0 to + 10°C) and high pressure (8 to 80 atm) as a selective solvent. Under these conditions, CO₂ liquifies to become a non-polar solvent which is odourless, tasteless, colourless, easily removed without residues and non-flammable. Selectivity is demonstrated by the extraction of the under-graded essential oil plus the lighter molecular weight fractions of the resin, imparting the character of an 'absolute' to the extract. The liquid and supercritical gaseous extraction of spices and other aromatic plants offers many interesting and novel products to the food product developer. This technology is preferred worldwide for commercial-scale extraction because it offers a:

Superior product

- Delicacy and freshness is close to natural

- High potency of active components
- Excellent blending characteristics
- Longer shelf life
- Free of biological contaminants

Super technology

- Simultaneous fractionation of extract
- Pollution-free process
- Provides solution to international concerns
- No residual solvent
- No residual pesticide

Yields

The volatile oil content of different spices varies widely. It may be as low as 0.1% and as high as 18%.

Quality evaluation:

Ideally, the quality of spice oils should be assessed organoleptically by experienced, well-trained panels. But this method is slow and impractical when quick evaluations are needed by industry.

Physico-chemical properties like density, solubility, refractive index and optical rotation are used to characterise essential oils, but they do not provide complete information on the quality. Thin-layer chromatography, gas liquid chromatography, infrared spectroscopy, mass spectrometry, etc., are modern methods used for the objective assessment of quality of essential oils.

Spice oleoresins:

The oleoresins represent the total flavouring components of spices in a very concentrated form. They are very close to the flavour of the whole ground spice. Spice oils only give the aroma of the spice, whereas spice oleoresins represent the total flavour of the spice. Oleoresins are prepared by extracting the ground spice with solvents like alcohol, acetone, hexane, methylene chloride, ethylene dichloride and ethyl acetate. Care should be taken to use pure solvents (food grade) that do not leave behind high boiling residues, which affect the flavour adversely. The major advantages with oleoresins are: flavour stability, less storage space requirement and uniformity in flavour strength. The main steps involved in the oleoresin process are:

1. Grinding the spice

2. Extraction
3. Distillation of the miscella (extract)
4. Blending the finished product

The ground spice is placed in extractors, which are preferably made of stainless steel. The bed of material rests on a perforated false bottom. The solvent is let in at the top. It percolates down the bed of material, carrying with it the solubles like volatile oil, fatty oils, colours, resins and pungent principles. The contact time between the solvent and the spice particles should be sufficient to ensure diffusion and extraction of the flavour constituents. About 4 to 5 volumes of the solvent are required to get most of the solubles out of the ground spice. This volume can be reduced by using countercurrent extraction, where dilute extracts can be used for extracting fresh material.

The concentrated extract (miscella) is distilled to remove the solvent. A vacuum is used towards the end, to prevent damage by heat and to ensure the complete removal of the solvent. Since food laws require the oleoresin to contain not more than 30 to 60 ppm of solvent residue, the final traces of solvent have to be removed carefully.

For obtaining a standard quality oleoresin, it is important that the choice of the solvent, particle size of the spice and the ratio of solvent to spice are properly determined. Attempts have been made to prepare oleoresin by using the super-critical extraction technique. The process is yet to be commercialised.

The finished product (oleoresin) is a dark viscous liquid. The flavour or colour strength of the oleoresin can be adjusted to the required standard by dilution with permitted diluents. It can be fortified with separately distilled essential oils to achieve a balance between pungency and aroma. The yield of oleoresin and the main constituent present in them, from some spices, are given in Table 13

Table 11 - Yield of oleoresin and the principal constituent

Spice Yield of oleoresin (%) Principal constituent in oleoresin

Pepper	10-12	Piperine (35-60%)
Ginger	4-7	Gingerene (25-30%)
Chillies	12-16	Capsaicin (2-4%)
Turmeric	6-9	Curcumin (20-30%)
Coriander	18-20	D-linalool (1.5-2.0%)

(Source: Spices Board, Cochin)

As mentioned earlier, the oleoresins are too viscous and concentrated to be used as such in flavour blends or food products. It is customary to disperse them on solid or liquid media to dilute them and make their use more easy.

Standards for spice oleoresins have been given by the Essential Oil Association of America. Other organisations like the Indian Standards Organisation and the International Standards Organisation have also prescribed such standards.

Applications of spice oils and oleoresins:

Spice oils and oleoresins can be used to advantage wherever spices are used, except in those applications where the appearance of the filler aspect of the spice is of importance. In addition to the benefits of standardisation, consistency, and hygiene afforded by spice oils and oleoresins, there is a huge potential in their use for new product development. New flavours and fragrances are constantly being sought to entice the consumer. This applies equally to food products, medications, as well as other non-food products.

Food:

Processed meats:

The use of spices, particularly pepper, in the manufacture of meat products, is traditional for imparting flavour and maintaining the quality of the products. The typical seasoning mix for fresh sausages, for example, consists of pepper, capsicum, ginger, nutmeg, plus herbs. For dry sausages and pickled meats, cardamom and coriander are also used.

The move to use oleoresins has been accelerated by the increasing size of manufacturing plants, where the use of spice extracts benefits production quality, as well as easy handling and cost savings.

The above-mentioned spices are used in the dispersed form of their oleoresin, while cardamom and coriander are used in the form of their oils.

Fish and vegetables:

The seasoning mix for both fish and vegetables, and particularly pickled or brined products such as herrings, contain a wide range of spices and herbs. The use of oleoresins, particularly dispersed oleoresins on a soluble base, will provide a means of easier preparation, reduced handling and costs.

Soups, sauces, chutneys and dressings:

The increasing demand for convenience products available in the form of a dry mix for ready reconstitution, has caused a rapid move from conventional seasoning towards dispersed or encapsulated oleoresins and oils.

Oleoresins of celery, pepper, capsicum, etc., are used in conjunction with the oils of onion

and garlic. Coriander and ginger extracts are used in barbeque sauces. The use of the lesser known but highly useful spices, such as fenugreek, broaden the new product opportunities.

Cheeses and dairy products:

The use of spices in cheeses is established in Germany, including 'Quark'. Spice extracts are unlikely to be used in these products as spices provide the flavouring and visual impact.

However, spice oils and oleoresins have significance in processed cheeses and savoury spreads.

Baked foods:

The use of cardamom baked goods in Scandinavia and Germany is traditional. The baking industry generally uses ginger, cinnamon and nutmeg. The move from the spice to their oleoresin has been effectively taking place for many years for ease of handling and simplicity in manufacture. The use of spice extracts in cake fillings, biscuits, and snack products is also steadily increasing.

Confectionery:

The use of spices and spice extracts in the confectionery area is rather rare, but the demonstration of the use of such material as cardamom oil and other extracts in toffees, chocolates, and others, has shown that they provide a very novel and pleasing confectionery ingredient which is new to the market.

Snacks:

Flavouring is an essential component of the appeal of snack products, and unusual because the flavour is often applied on the surface, either by spray coating or dusting. For this purpose, the seasoning mix has to be capable of being applied in spray form or powder. Oleoresins of pepper, chilli and celery, are widely used. Turmeric and chilli extracts are used to provide colour.

Beverages:

Spice oils are used for the preparation of soft beverages, for example, ginger oil in the preparation of ginger beer, etc. Some of the less well-known spice extracts can be used to produce very pleasing soft drink products. But, these are not yet widely known outside of the countries in which they originate

Cosmetics:

The use of spice oils in the preparation of creams, soaps, shampoos, lacquers, lipsticks, etc., is well known. However, some of the materials available from India are not yet widely used, nor are they recognised as providing a new dimension to cosmetic products.

The growing preference for herbal, spicy and spicy coniferous products like shampoos and hair tonics are noted, yet such extracts as those of cardamom and fenugreek are little heard of. The use of lesser known spice extracts can provide new product appeal.

Perfumes:

The perfumery industry uses a wide range of essential oils and oleoresins from sources far and wide, yet some of the lesser known oils and oleoresins are hardly used. An examination of the wide range of those available from India could well provide a new basis for products of appeal.

Hygiene products:

Products like toothpastes, mouthwashes, etc., depend on essential oils to provide their pleasing flavour, making them not only acceptable, but pleasant to use.

In cleansing materials, detergents, etc., spice oils provide the aromatic appeal in otherwise uninteresting sometimes offensive notes associated with some of the base products.

Aerosols:

The use of aerosols worldwide is increasing at a significant rate in products such as air fresheners, polishes, lacquers, and many cleansing agents, and waxes, etc. All of these are perfumed with essential oils for pleasant and fresh aroma.

Pharmaceuticals:

Both oils and oleoresins are widely used in pharmaceutical products, to provide either a pleasant taste or aroma to render them pleasing and easy to use, which would otherwise be difficult to accept. These include medications, skin creams, cold remedies, etc.

Most staple foods are bland, although they provide important sources of nutrition and are essential for growth and maintenance. Food is made palatable and enjoyable by using spices and herbs which are valued for their flavour and colour. The use of whole spices in food processing is limited to the extent of providing 'eye appeal' to the final product and not imparting full characteristic flavours. The flavour moiety is well protected from evaporators and in whole spices by the cells. Whole spices release flavour slowly; ground spices release the flavour more quickly.

Need for value-added products

- Ground spices have a limited shelf-life and the flavour loss/ modification is considerable during grinding/storage. They are of poor hygienic quality and hence find restricted use in processed foods.
- Dispersed spices are prepared by blending spice oils and oleoresins with carriers like dextrose, salt, rusk, etc. They tend to lose flavour during storage due to the large

internal surface area on which the aromatic components are spread.

- The characteristic flavour (fresh)/aroma is absent in dried/ dehydrated spices like ginger, green chilli, garlic, curry leaf, etc.
- Spice oils do possess good flavour but are often incomplete and unbalanced. Some flavour components are readily oxidised. They are quite concentrated and hence difficult to disperse in product mixes.
- Spice oleoresins represent the total flavour profile of the spice being concentrated (10-50 times the spice). They are viscous and difficult to incorporate in to the end product. Solvent residues (high boiling fractions) contribute to off-odours and off-flavours. Doubts have also been raised regarding the safety-in-use of residual organic solvents in spice extractives.
- Processing steps like ultra-high temperature and microwave demand stable flavours.
- The growing demand for convenience foods needs suitable stable flavouring materials.
- Better flavour quality can be obtained by suitable blending of naturals and synthetics.

Irradiated spices

Whole or ground spices are unhygienic since they are contaminated with a heavy load of saprophytic and thermophilic bacterial spores, moulds and yeasts (10^2 - 10^7 /g). Gamma irradiation serves as an effective means of reducing bacterial load in natural spices. A dose of 3 to 10 KGY can reduce the viable cell count to an acceptable level of $<10^4$ /g and the flavour quality remains unaffected.

Liquid water-soluble emulsion

The oil or oleoresin can be extracted in glycerol, isopropanol, propylene glycol, etc. Although the extraction is poor, the shelf-life of the emulsion is generally better. Solubilised spices are prepared by mixing them with a polysorbate ester (Tween 80) or by emulsifying them with plant gums.

Encapsulated flavours

One way by which the loss of volatiles can be obviated is to encapsulate the flavouring components by using an impermeable shell, which locks in the aromatics and thereby considerably increases their shelf-life. Encapsulation is essentially a method of providing a 'wall' material around the 'core' flavour, thus protecting the flavour from deterioration/oxidation. In this technique liquid droplets/particles are trapped in a continuous film of a polymer-celled wall material. The selection of the wall material is governed by its final end use. There are several methods of encapsulation like spray drying, molten extrusion,

molecular inclusion, gelatin coating, spray cooling, etc. Encapsulated flavours are particularly useful in dry mixes and convenience foods.

Spray drying

This is the most widely used method for the encapsulation of flavours. The method involves two unit operations, viz., emulsification of the spice flavour with an aqueous solution of plant gum/modified starch and dehydration in a suitable drying chamber. The 'core' flavour is homogenised with gum/starch solution and the emulsion is pumped in controlled amounts to the spray dryer's centrifugal atomiser. The dried particles are carried away in the stream of air and separated in a cyclone collecting chamber. There are several processing parameters which decide the product quality. These are viscosity of the emulsion, flavour load, degree of homogenisation, in-feed temperature, in-feed flow rate, operating variables of the spray dryer, etc.

Molten extrusion

Otherwise known as Sunkist fixation method, this was originally employed for the encapsulation of citrus flavours. Extrusion as applied to flavour encapsulation means that a flavour emulsion is forced through a die. A mixture of glycerol and corn syrup solids is heated to a molten state and cooled to a semiplastic mass when the essential oil is added and emulsified. The hot emulsion is extruded into a cold solvent when the filaments or standards harden. These filaments are impact-broken, separated from the solvent, dried under vacuum conditions and suitably packed after the incorporation of an anti-caking agent.

Molecular encapsulation

The encapsulation occurs on a molecular basis with beta-cyclodextrin. The reaction between beta-cyclodextrin and a suitable guest molecule takes place in a solution. Unlike spray drying, molecular inclusion techniques have the disadvantage that some of the chemical constituents cannot be encapsulated. The use of beta-cyclodextrin is approved of by some countries like Japan, Hungary and the Netherlands.

Spray cooling

A variant of the spray-drying process is known as 'spray cooling'. The product is prepared by blending an essential oil/oleoresin with a fatty carrier (hydrogenated fat). It is formulated for use in products such as mayonnaise, bakery, etc. In the hydrogenated fat, the product may be in the form of a solid block, which must be melted before use or it may be spray coated to obtain a free-flowing powder. To obtain a spray-cooled spice, the blend of spice oil/oleoresin and the fatty carrier is melted to 45-120°C and atomised in a stream of chilled inert gas (nitrogen) when minute fatty globules are formed and instantly 'set', thereby

protecting the entrapped flavour. An antioxidant may be added to delay the onset of rancidity on storage. The use is limited to fatty products such as dry cake mixes, potato chips, etc., since it is water insoluble. Other methods of encapsulation do not find use in food applications.

Organic Cultivation

In recent years, organic agriculture has been gaining considerable importance. Many farmers today show interest in organic cultivation. Several of them have begun switching to this traditional method of cultivation as a means to produce safe foodstuffs and preserve the environment. The concept of sustainable farming has finally caught on in India.

World demand for organic foods

The world demand for organically produced foods is growing rapidly in developed countries in Europe, in the USA, Japan and Australia. The current estimated share of organic foods in these countries is approximately 1 to 1.5 per cent which is expected to increase to 10 per cent in the next couple of pentinniums. The market size of organic spices in the US is 30,000 tonnes, Europe 21,000 and Japan 6,000.

The worldwide food trends are changing with a marked health orientation. Since organic foods are free from chemical contaminants, the demand for these products should steadily increase in the new millennium. According to the ITC, UNCTAD/GATT, more than a 130 countries produce certified organic foods. Many of them are from Asia and Africa. Internationally, there is a definite shift towards traditional/ethnic medicines. Since spices form part of many of these medicines, the demand for organically produced spices should grow.

Organic cultivation is nothing new to India. The country has always been practising the traditional ways of using indigenous technologies and inputs, mostly in line with modern organic farming principles. The per capita consumption of fertilisers and pesticides in India is far below that of the other developed countries. This means that it is very easy for Indian farmers to embrace organic spice farming in its true sense.

The Spices Board, India, has taken a major initiative in promoting the production and export of organic spices on a large scale.

The Indian initiative

The export of organic spices from India has started in right earnest. The country at present exports around 50 tonnes of different varieties of organic spices. These exports will get a significant boost in the coming years as more farmers are switching to organic methods. The Spices Board, India, has prepared a document on the production of organic species. It

features the organic concepts, principles, basic standards, production guidelines, documentation, inspection and certification. The document has been published after approval by the National Standards Committee constituted by the members of IFOAM in India.

Research programmes on the organic cultivation of important spices have commenced. The work is being carried out at the Spices Board's Indian Cardamom Research Institute at Idukki District in Kerala. Besides organising demonstrations to educate and motivate prospective organic spice growers, the Board is simultaneously involved in conducting training programmes for existing spice growers, on organic principles and practices.

Developing organic spices

The Spices Board encourages non-governmental organisations and farmers' groups to promote and adopt organic farming techniques. Infrastructure development for production of organic input is underway in prominent growing areas. The development of vermi-compost units and the supply of post-harvest aids for upgrading the quality of the produce at the farm level are also in progress.

Certification of organic spices

Certification for organic spice farms is an essential pre-requisite for marketing their produce, especially in the international markets. The Government of India is in the process of setting up indigenous certification programmes, since there is no domestic certifying agency in India. However, the offices of certain international certification agencies do operate in India.

For timely inspection at optimum cost, the Board has access to the services of trained inspectors from both governmental and nongovernmental organisations. These inspectors were trained in 1998 by the members of IFOAM in India. They will commence work once the domestic certification body is set up and approved by the competent authorities.

Help in sourcing organic spices

The Spices Board provides assistance to overseas buyers in sourcing organic spices from India. The country has the capability to produce and supply a variety of organic spices. If firm orders are placed well in advance, farmers can go ahead with confidence, cultivate squeaky-clean spices organically, and deliver them on time.

What follows is a list of agencies/farmers involved in the production and export of organic spices/spice products from India. The products covered are black pepper, white pepper, cardamom, clove, nutmeg, mace, ginger, turmeric, vanilla and seed spices. Many of these farms are certified, while others are either in the process of getting certification, or have initiated the necessary action.

Classification of Spices

Indian spices can be classified in different ways depending on the plantparts used, the economic importance, climatic requirements, origin and flavour, requirement of season and botanical description. But none of the classification is complete as each classification has got some lacuna or overlappings.

1. Based on plant parts used

Spices can be classified depending on the parts of the plant that are to be used. Different plant parts like leaf, root, bulb, fruit, seed, *etc.* are used as spice.

- a) **Seed:** Cumin, black cumin, fenugreek, coriander, fennel, ajowan, poppy, aniseed and mustard.
- b) **Bulb:** Onion, garlic, leek and shallot.
- c) **Bark:** Cinnamon and cassia
- d) **Fruit:** Chilli, cardamom, allspice and kokam
- e) **Leaf:** Mint, curryleaf, bayleaf, chive, rosemary and savory
- f) **Rhizome:** Turmeric, ginger, and galangal
- g) **Pod:** Vanilla and tamarind
- h) **Kernel:** Nutmeg
- i) **Floral part:** Saffron, savory, caper and marjoram
- j) **Bud:** Clove and caper
- k) **Latex:** Asfetida
- l) **Aril:** Mace and anardana
- m) **Berry:** Black pepper, juniper and allspice

2. Based on economic importance

On the basis of economic importance of the spices grown in India they can be grouped into two viz, major and minor spices.

1. Major spices

The spices which contribute major share in the spice trade industry of the world are called major spices. The spices come under this group are small cardamom, black pepper, chilli, turmeric and ginger. These spices contribute about 75-90% of the total foreign exchange earned through spices.

2. Minor spices

Excluding all these five major spices, all other are called minor spices. Minor spices are further divided into five sub groups. They are mentioned hereunder:

1. **Seed spices:** Coriander, cumin, black cumin, fennel, aniseed, celery, mustard, poppy and caraway.
 2. **Bulbous spices:** Garlic, onion, leek and shallot
 3. **Aromatic spices:** Clove, cinnamon, allspice, aniseed and nutmeg
 4. **Leafy spices:** curryleaf, mint, rosemary, bayleaf, and parsley.
- v) **Acidulant tree spices:** Tamarind, kokam and anardana

3. Based on climate requirement of the crop

Depending on suitable climatic conditions like temperature, sunlight, humidity and air of a particular climatic zone, spices are grouped into three categories.

- i) **Tropical spices:** Spices of this category need high temperature, and abundant humidity. They are easily damaged by low temperature. Tropical spices are ginger, turmeric, black pepper, cinnamon, kokam, galangal, small cardamom and clove.
- ii) **Subtropical spices:** Sub-tropical climate is found where three distinct seasons like winter, summer and monsoon are found. Low temperature occurs in winter and high temperature during summer. Most of the spices require relatively low temperature during their vegetative or early growth stage and high temperature in reproductive stage. The examples of sub-tropical spices grown in winter are cumin, fennel, coriander, fenugreek, onion and garlic. Subtropical spices grown during summer are turmeric and ginger.
- iii) **Temperate spices:** Spices of this type can withstand low temperature and frosty weather but are damaged easily in hot weather. Examples of temperate spices are thymes, saffron, savoy, caraway seed and asfoetida.

4. Based on origin and flavour

Depending on the origin and flavour content of the spices, they can be classified as follows:

- i) **Aromatic spices:** Cardamon, aniseed, clery, cumin, coriander, fenugreek and cinnamon.
- ii) **Pungent spices:** Ginger, chilli, black pepper and mustard
- iii) **Phenolic spices:** Clove and allspice
- iv) **Coloured spices:** Turmeric, saffron and paprika

5. Based on season of growth

According to the requirement of season of growth, spices are grouped into following three classes:

- i) **Annual spices:** Spices which complete their life cycle in one growing season are called annuals. Example of this type of spices are coriander, cumin, fennel, fenugreek, ajowan and

black cumin.

- ii) **Biennial spices:** It needs two growing seasons to complete the life cycle. Examples of biennial spices are onion and parsley.
- iii) **Perennial spices:** Perennial spices are those which live for more than two years. Black pepper, saffron, -clove, nutmeg and cinnamon are example of perennial spices

6. Based on botanical description

Table 12: botanical description of some spices

Name	Botanical name	Family	Habit	of Parts
Onion	<i>All/urn cepa</i>	Alliaceae	Annual	Green
Garlic	<i>All/urn sativum</i>	Alliaceae	Annual	Green
Cumin	<i>Cuminum cyminum</i>	Apiaceae	Annual	Fruit
Coriander	<i>Coriandrum sativum</i>	Apiaceae	Annual	Leaf and
Aniseed	<i>Pimpinella an/sum</i>	Apiaceae	Annual	Fruit
Black cumin	<i>Nigella sativa</i>	Apiaceae	Annual	Fruit
Fennel	<i>Foeniculum vulgare</i>	Apiaceae	Annual	Fruit
Mustard	<i>Brass/ca juncea, B. nigra</i>	Brassicaceae	Herb, Annual	Seed
Chilli	<i>Capsicum annum</i>	Solanaceae	Annual	Fruit
Cinnamon	<i>Cinnamomum verum</i>	Lauraceae	Perennial Tree	Leaf a
Clove	<i>Eugenia caryophylus</i>	Myrtaceae	Tree	Flower
Black pepper	<i>Piper nigrum</i>	Piparaceae	Perennial	Fruit
Cardamom	<i>Elettaria cardamomm</i>	Zingiberaeeae	Perennial	Fruit
Cardamom	<i>Amomum subulatum</i>	Zingiberaeeae	Perennial	Fruit
Turmeric	<i>Curcuma longa</i>	Zingiberaeeae	Perennial	Rhizome
Ginger	<i>Zingiber officinale</i>	Zingiberaeeae	Perennial	Rhizome
Curry leaf	<i>Murraya koenigi</i>	Rutaceae	Shrub	leaf .

Table 12.1: Types of spices based on the useful part.

Wholefruit (Berries)	Juniper berry, allspice, black pepper, chilli, Zanthoxylum (Japanese pepper), seed spices like cumin, fennel,
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Bark	Cinnamon, cassia
Aril	Mace of nutmeg
Buds	Clove
Bulbs	Garlic, onion
Pistil	Saffron
Kernel / seed)	Nutmeg
Leaves	Basil, bay leaf, marjoram, sage, curry leaf, rosemary, etc.
Rhizome	Ginger, turmeric, mango ginger, Aplinia, etc.
Exudate	Asafoetida
Root	Angelica, horse radish
Seeds/fruits	Aniseed, caraway, coriander, dill, fenugreek, mustard etc
Fruit pulp/rind	Tamarind and Garcinia

Table 12.2: Spice based on morphology of aerial parts.

Herbs	Ajowan, coriander. Cumin, tenet, fenugreek, chillies, parsley
Shrubs	Rosemary, Chillies (perennial chillies), Pomegranate
Trees	Nutmeg, clove, cinnamon, tamarind, Garcinia, Japanese pepper
Climbers	Black peopper, tailed pepper, vanilla
Perennialherbs (rhizomatous herbs)	Ginger, turmeric, mango ginger, Japanese ginger, galanga, asafetida.

Table 13: Present a mixed combination of above classification is normally followed since none of the classification is complete as each classification has got some lacuna or over lappings, which is mentioned as below.

Mixed combination classification of spices.

Major spices	Black pepper, Chilli, ginger, turmeric, cardamom,
Major seed spices	Coriander, cumin, fennel, fenugreek

Minor seed spices	Ajowan, celery, parsley, dill caraway, black cumin, black caraway.
Major tree spices	Nutmeg, clove, cinnamon, tamarind, allspice, kokum, curry leaf.
Herbal spices (Herbs)	rosemary, thyme, parsley, etc.
Others (Miscellaneous)	Saffron, asafoetida, vanilla, garlic etc.

Value Added Spice Products

Value added products indicates that for the same volume of a primary product, a high price is realized by means of processing, packaging and upgrading the quality or other such be handled per unit area, also encourages the growth of ancillary industry and fetches increased foreign exchange. Majority of total spices trade (about 85%) is in the raw and bulk form. Thus there is a vast scope for exporting the processed and value added spice products in India. The value added spice products have certain advantages that are mentioned below:

1. It imparts their total flavour and keep intact the aromatic constituents.
2. It does not varies in flavour, strength and quality.
3. It is more hygienic than whole spice.
4. It fetches increased foreign exchange.
5. More volume can be handled per unit area.
- 6 It helps to encourage the growth of ancillary industries. 7. It is easy to store.

Therefore, emphasis should be given on the production of more value added spice products as there is a vast scope to export the processed and value added spices. The following are the different kinds of value added products in spices.

1. Spice oil

Spice oil is obtained by steam distillation of various parts of the spices. The essential oil thus obtained are endowed with the major part of the flavour and fragrance properties of the spices. Following are the various types of spice oils:

- (a)Pepper oil:** Oil is obtained by steam distillation of dried and crushed berries of black pepper. This oil is used for flavouring of food especially when anyone wants the pepper like aroma without pungency. The oil content varies from 2-4%.
- (b) Ginger oil:** Ginger oil is obtained from the ground dried ginger rhizomes by distillation. Usual yield of oil is 1.5-2.5%. But higher yield of about 4% has also been observed. Ginger

oil contains sesquiterpene, high carbon compound like gingerine and some oxygenated carbons also. Ginger is valued for its pungency, heat and flavour. The major pungent principle is due to the presence of gingerole.

(c) **Cardamom oil:** Cardamom oil is present in the seed and whole fruit *i.e.* the capsule. The ground powder of it is used to impart the aroma in the foods. To obtain the oil, the seeds are steam distilled. It yields oil of 6-8% in capsule and 8-12% in seed. The major constituents of cardamom oil are cineole and terpenyl acetate.

(d) **Nutmeg oil:** It has 2-15% oil. Bulk of which is composed of terpene hydrocarbons. The oxygenated derivatives consists of geraniol, linalool, terpinol, safrole and elemicin.

2. Oleoresin

Oleoresin is the concentrated product which is obtained by extraction of the dry spices. The extraction is done by using an organic solvent or solvent mixture like ethylene dichloride, acetone, alcohol and hexane. Oleoresin represents the complete flavour of the concentrated fresh spice. It contains volatile as well as non-volatile constituent of the spice. The residual solvent in the oleoresin should be below 30 ppm. Oleoresin can not be used directly because it is too concentrated and is difficult to dispense. But oleoresin can be used directly in the fatty products like processed meat, fish cheese, baked food and vegetables. Oleoresin has greater heat stability than essential oils.

3. Curry powder

It is the powdered blend of a number of spices. It has a good export potential. The number of spices vary from 5 to 20 depending on its end use. Different spices like turmeric, coriander, cumin, fennel, fenugreek, black pepper, chilli, *etc.* are used to prepare quality curry powder. The composition of curry powder changes according to different needs. The colour, form and taste of it varies in accordance to the custom of various nations and regions. Spices are ground and then mixed in a definite proportion to prepare curry powder. It generally contains 85% of spices, 10% farina and 5% salt. A wide range of products are generally covered under this category. This includes mixed power, straight powder, curry powder, curry mixture, masalas and curry paste. It is used to impart a distinct flavour to a variety of preparation like chicken, fish, meat, vegetable noodles and tea.

4. Ground spices

The spices which are milled to the degree of fineness like coarse grind, finegrind and cracked, *etc.* called the ground spices. There a considerable amount of heat is evolved during grinding operation] which results in loss of flavour. To over come this problem, spices are now milled at a low temperature.

5. Consumer packed spices

The spices which are exported to the developed foreign countries are consumed in three main segments *i.e.* industrial, institutional and retail. Various types of packaging media are used according to the consumer's preference or choice. Different types of packaging media like plastic films, aluminium foils, laminations, flexible pouches are used. By exporting consumer packed spices, higher unit value for the same quantity can be earned.

6. Organic spices

The awareness and growing concern of health and hazards through chemical residual toxicity led to the development of organic crops and organic spices also. The demand for organic spices is increasing. The organic agriculture has got tremendous importance in the international market. India has become a member of the countries exporting organic spices. Major consumer countries are USA, Europe and Japan. Organic products are more expensive than the conventional ones.