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AN OVERVIEW OF PACKAGING TECHNOLOGIES FOR SEED SPICES: A REVIEW

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ABSTRACT

The present paper reviews the different packaging technologies for seed spices in India. Seed spices comprise fragrant products of plant origin used for flavouring food and beverages. Among different groups of spices, seed spices encompass the single largest group of spices with over 17 items coming under it. The important amongst this group are coriander, cumin, fennel, fenugreek, celery, ajowan, dill, aniseed and caraway. India is the largest producer of seed species with a production of about 5 lakh tonnes annually from an estimated area of about 9 lakh hectares. This group has a prominent place in our national economy because of its large domestic consumption and growing demand for export. Being annual crops these are grown extensively in rotation with food crops and also as inter or mixed crop under rain-fed or irrigated conditions. The research area has primarily concentrated on developing packaging solutions to increase yields, enhance the quality of produce and ensure consumer safety. The ongoing compilation provides concise information about the achievements accomplished by the country's scientific and developmental team in supporting the sustainability of these crops.

Ke ywords : Export, Food, India, Packaging, Quality, Spices.

Introduction

The seed spices is a group that denotes all those annuals whose dried fruits or seeds are used as spices (Purseglove, 1981). Seed spices, originating from tropical regions, are aromatic vegetable products primarily utilized in their ground form for seasoning or enhancing the flavor of food and beverages. They are characterized by pungency, strong odour, sweet or bitter taste (Pruthi, 1987a). They are well known appetizers and often contain essential oils, which yield the aroma and add flavour to food relieving a monotony of staleness of the food materials and increasing the pleasure of eating. Spices possess several other properties such as medicinal as anti-oxidants or antibiotics and as preservatives in pickles and chutneys. Cumin, coriander, fennel, fenugreek, ajowan, dill, celery, anise, caraway and kalongi are among the significant seed spice crops. They thrive in regions with low rainfall or limited water resources, earning them the designation of "arid land spices". This paper focuses on the status and production potential of seed spices under low rain areas (Malhotra and Vijay, 2000).

In India, spice exports have been consistently moving up during the last decade. The Ministry of Commerce entrusts the Spices Board with the responsibility of overseeing spice exports from the country. Spices make up approximately 16% of the total horticultural exports from India in terms of quantity and 19% in terms of value. India's share of the world spices trade is estimated as 40- 50% by volume and 25% by value. According to the estimates of the Spices Board, during 2015-16, a total of 8,43,255 tons of spices and spice products valued Rs.16238.23 crore have been exported from the country as against 8,93,920 tons valued Rs. 14899.68 crore in 2014-15, registering an increase of 9% in rupee terms and 2% in dollar terms of value (Pruthi, 1987b). The total export of Spices during 2015-16 has exceeded the target in terms of both quantity and value. Compared to the target of 8,08,000 tons valued Rs. 14014.00 crore for the

financial year 2015-16 the achievement is 104% in terms of volume and 116% in rupee and 110% in dollar terms of value (Sharma *et al*., 2017).

Scope and importance of packing in spices

Packaging is defined as enfolding of food to protect it from tampering or contamination from physical, chemical and biological sources. Packaging plays a vital role in preserving the advantages of food processing even after the manufacturing process is finished. It ensures that food products can be transported safely over long distances from their place of origin and remain in a wholesome condition when consumed. The primary purpose of food packaging is to protect the food against attack from oxygen, water vapour, ultraviolet light, and both chemical and microbiological contamination (Pruthi *et al*., 1962).

Packaging spices is a more intricate task compared to packaging other products, primarily because various spices have unique and specific packaging requirements. The different forms of spices such as Seed spices (celery, fennel, cumin, fenugreek), Powdered or ground spices, Spice mixes (curry powders and masalas), Oils and oleoresins and different distribution channels need design and development of suitable packaging material to enhance the shelf life. Continuous quality monitoring should be implemented to remove substandard materials, contaminants and foreign matter throughout the processing and final stages of packaging. Processed plant materials must be packed in clean, dry containers such as boxes, sacks, bags, or other suitable packaging, following established standard operating procedures and adhering to the regulations set by both the producer's and the end-user countries' national and/or regional guidelines (Ramanathan *et al*., 1974). Packaging materials should meet certain criteria, including being non-polluting, clean, dry, undamaged and they should meet the quality standards for the specific plant materials being packaged. In the case of reusable packaging materials like jute sacks and mesh bags, they should be properly disinfected and completely dried before reuse to prevent contamination from previous contents. Additionally, it's important to store packaging materials in a clean and dry environment that is free from pests and inaccessible to livestock, domestic animals and other potential sources of contamination.

Varieties of Packaging Materials and Formats in the Food Industry

In the fresh and processed food industry, a diverse array of packaging materials and formats are employed to manage, store and transport fresh and processed food items, spanning from the farm to the consumer. Various materials, including glass, plastic, metal and cardboard are utilized to create packaging containers in the food industry. The choice of material is contingent upon the specific characteristics of the food product. This is because different packaging materials possess a spectrum of performance attributes that can greatly influence the product's shelf-life. (Robertson, 2011). Liquid food products are frequently packaged in bottles and glass jars, whereas solid food items are primarily packed in plastic and cardboard containers. Processed fruits and vegetables are typically enclosed in hermetically sealed metal containers to inhibit the passage of oxygen, which could otherwise result in product spoilage due to microbial growth and lipid oxidation (Robertson, 2010). According to the World Packaging Organization (2008), the most important consumer packaging are made of paper and board (38%), followed by plastic (30%) with rigid plastics alone taking an 18% share, metal (19%), glass (8%), and others (5%). Moreover, approximately 70% of overall consumer packaging are used in food industry where 48% of all the packaging are made from paperboard

Packing of seed spices

Spices and spice products are hygroscopic in nature, and being highly sensitive to moisture, their absorption of moisture may result in caking, discolouration, hydrolytic rancidity, mould growth and insect attack. Furthermore, they contain volatile aromatic principles, and the loss of these principles and the absorption of foreign odours as a result of inefficient packaging, may pose serious problems, especially in ground spices (Pruthi, 1980a). In addition, heat and light accelerate deterioration, especially with oxygen-sensitive products. The packaging standards for seed spices are given in Table 1.

As previously detailed, the packaging of spices is tailored to specific needs and may involve the use of various materials and formats. These include gunny bags/ jute bags, polywoven bags, poly pouches, cloth bags, glass bottles of different sizes and shapes, each equipped with labels and metal or plastic caps, as well as flexible pouches like pillow pouches, gusseted pouches and stand-up pouches. These flexible pouches come in various laminated compositions such as Polyester/metallised polyester/LDPE, BOPP/LDPE, BOPP/metallised polyester/LDPE, Polyester/Al foil/LDPE, and aluminum foil laminate, depending on the specific packaging requirements (Sharma *et al*., 2017).

Uses of packing materials

Spices exported to developed foreign countries are

Table 1 : Agmark Packaging Regulations for Whole and Ground spices.

Common Spice and Spice product	Criteria for Packaging Quality
Fenugreek, Fennel, Cumin, Coriander and Ajwain	Clean, sound and dry containers like jute bags, cotton bags, polywoven bags, paper bags and polyethylene laminated pouches, cardboard cartons, tin, grass, plastic container and wooden cases options shall be used for packaging the graded article.
Caraway	1) Whole items should be enclosed in containers that are clean, dry, and in good condition, such as jute or cloth bags, polyethylene, polypropylene, or food-grade plastic pouches. 2) Caraway powder should be placed in newly manufactured, clean, dry containers composed of tin, glass, or notches made from laminated/ extrusioned metallised/multilayer food-grade plastic materials. 3) Caraway, whether in whole or powder form and placed in containers, will be available in the following net weight options: 25g, 50g, 100g, 500g and 1kg. 4) Each package must exclusively contain either whole or powdered Caraway of a single grade.
Poppy seeds	1) The graded article shall be packed in clean, sound and dry containers using lining of polypropylene, in jute bags, cloth bags, polywoven bags, paper bags only.For consumer packs, the packaging material should consist of polyethylene or polypropylene with a minimum thickness of 100 microns, along with metallised polyester or any other suitable packing materials.

typically consumed in three primary segments: industrial, institutional and retail. The choice of packaging materials varies according to consumer preferences. Various packaging media such as plastic films, aluminum foils, laminations, and flexible pouches are employed. Exporting spices in consumer-ready packaging allows for the potential of earning a higher unit value for the same quantity of product (Thankamani *et al*., 2017).

Over the last couple of years, demand for fresh coriander herbs in India and overseas has increased rapidly with a potential for further market expansion both at domestic as well as export. Just like many other food products, which are perishable by nature, it requires protection from spoilage during their preparation, storage and distribution to give them desired shelf-life (Pruthi, 1980b). Approximately 85% of growers and distributors have very little knowledge of handling the fresh leaves particularly during transport. Even in developed countries, when refrigerated vans are used, poor handling and temperature management practices may still occur during the marketing chain. With very little control over the temperature during distribution and lack of proper handling protocols fresh herb quality suffers and wastage is high. The principal causes of such degraded quality and wastage are physical injuries, shrivelling due to excessive moisture loss, high respiration rates, microbial infection and in some cases, chilling injuries. Preserving the freshness of coriander leaves over an extended period under typical conditions presents a significant challenge. The primary factors contributing to the limited shelf life of fresh-cut coriander leaves are the oxidation process triggered by enzymatic activity in the cut leaves, moisture loss, and the growth of spoilage and pathogenic microorganisms (Gimenez *et al*., 2003).

The dehydration processes not only affects the colour and other pigments but also the sensory attributes like colour, appearance, texture, aroma and overall quality to a varying degree. Although, visual quality could be maintained for up to 22 days, typical cilantro aroma decreased notably after 14 days, regardless of storage conditions (Loaiza and Cantwell, 1997).

In order to select a suitable packaging material for spices, it is essential to know the factors which affect the quality of spices *viz*., moisture content, loss of aroma / flavour, discolouration, insect infestation, microbial contamination, etc. Selecting appropriate packaging materials for spices is crucial to preserving their quality throughout the entire process of handling, transportation, storage and distribution. It's essential to choose packaging materials carefully, considering both functional aspects, such as preservation and protection, as well as marketing requirements to effectively present and market the spices to consumers. (Del Nobile *et al*., 2006). Previous research works explored the influence of low environmental impact, packaging materials on the respiration rate of minimally processed lettuce (Del Nobile *et al*., 2008).

Herbs can also be placed in specialized bags designed to reduce moisture loss and can be stored in refrigerated conditions for extended freshness (Bhide, 2006). Jaggi *et al*. (2005) studied on acceptability of coriander and fenugreek stored in flexible consumer packages showed that non-perforated packets are significantly more acceptable than stored in perforated packets. It also reveals that low temperature helped to improve the shelf life of leafy vegetables up to six days.

Fig. 1 : Various packing materials used for spices packing.

In terms of respiration rate, coriander leaf may be categorized as moderately high. In order to maintain the quality of coriander leaves during handling, transportation, storage and distribution, the packaging material has an important role. Most traditional materials used earlier like paper, tinplate containers and jute bags are being replaced by plastic materials for packaging due to their properties viz., light weight, easy availability, compatibility, hygienic nature machineability, printability, heat sealability and selective barrier properties (Hardenburg *et al*., 1986).

A high level of oxygen reduces the nutritional value of food and reduces its shelf life. The presence of oxygen in the headspace gases within the packaging can interact with sensitive food products, hastening the degradation of many items such as meats, sausages, milk powder and spices. This oxygen exposure can also lead to the breakdown of vitamins, the development of rancidity in oils, nuts, and fatty foods, and it can promote the growth of microorganisms. (Mohan *et al*., 2008).

Antimicrobial packaging encompasses various systems, including the incorporation of a sachet within the packaging, the dispersion of bioactive agents within the packaging material, the application of bioactive agents onto the surface of the packaging material and the utilization of antimicrobial macromolecules that can form films or be integrated into edible matrices (Coma, 2008). A wide array of antimicrobial agents, including ethanol, carbon dioxide, silver ions, chlorine dioxide, antibiotics, organic acids, essential oils and spices, among others, are employed to prevent the growth of microorganisms that can lead to the spoilage of food products. It's worth noting that bacteria can also impact the functionality and properties of packaging materials.

Some packaging systems utilize volatile antimicrobial substances such as chlorine dioxide, plant extracts, sulfur dioxide, essential oils (Skandamis and Nychas, 2002; Rodriguez *et al*., 2007; Lopez *et al*., 2007), carbon dioxide and allyl isothiocyanate (Pires *et al*., 2009; Winther and Nielsen, 2006; Plackett *et al*., 2007) for their antimicrobial properties. The theoretical advantage of volatile antimicrobials is that they can penetrate most of the food matrix and the polymer not necessarily in direct contact with food. Active packaging of this nature is well-suited for situations where there is no direct contact between the food portions and the packaging material. This is particularly applicable in scenarios like ground beef, as discussed by Appendini and Hothkiss (2002) and Nadarajah *et al.* (2005).

Many preservatives (ascorbic acid, benzoic acid, propionic acid and its salts, or bacteriocins such as nisin, natural spices, silver ions, chelators, etc.) are added to plastic films and materials and are used as antimicrobials.

Table 2 : The limits of the various contaminations permitted under these specifications are shown here.

Cleanliness	Whole insects dead	Excreta rodent	Excreta others	Mould	Insect defiled	Extraneous matter
Coriander	4	4	10.0	1.00	1.00	0.50
Fennel	**S.F	**S.F	**S.F	1.00	1.00	0.50
Cumin	4	2	5.0	1.00	1.00	0.50
Caraway	4	2	10.0	1.00	1.00	0.50

** Fennel seed: In the case of fennel seed, if marc thon 20% of the sub samples contains only rodent or other excreta or whole insects, the lot must be reconditioned.

But these non-volatile antibacterial require direct contact with the food to be active (Ouattara *et al*., 2000).

Cleanliness specifications of spices

For purposes of these specifications (Table 2), extraneous matter is defined as everything foreign to the product itself and includes, but is not restricted to; stones, dirt, wire, string, stems, sticks, non-toxic foreign seeds, excreta, manure and animal contamination (Pruthi, 1991a).

Conclusion

Packaging is an essential component of seed spices and plays a critical role in containing, protecting and preservation food and other agro-industrial raw materials from field to the end user. Research has demonstrated that the adoption of suitable packaging plays a pivotal role in mitigating food losses and waste while preserving product quality and safety. To tackle the challenges related to safety and sustainability, cost-effective and resource-efficient packaging design becomes paramount. The integration of emerging technologies into packaging design opens up exciting possibilities for enhanced quality monitoring through electronic devices that can provide real-time information on the nutritional quality and safety of food products. Additionally, the convergence of recent advancements in biotechnology, nanotechnology, and materials science presents new opportunities for the development of innovative packaging materials and designs. These advancements can address critical industry concerns, including product safety, environmental impact, and the sustainability of packaging practices.

Maintaining good manufacturing practices, employing optimal processing conditions and ensuring high-quality packaging for spices, whether in bulk, institutional, or consumer packages can lead to better prices for both ground and whole spices. Inadequate packaging, on the other hand, can result in spice spoilage, a decline in quality, and infestations by pests and diseases. Despite various initiatives undertaken by the Spice Board and other organizations, spices have often been packaged in an unscientific manner, particularly at the farmer's level. Spices procured from primary producers are subsequently exported to foreign countries for value addition and other product development. There is an urgent need to raise awareness among primary producers and traders regarding the use of modern packaging materials and value addition practices. This can help establish geographically specific brand identities for the various spices produced in India, ensuring their quality and competitiveness in the global market.

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