Development of garam masala powder using organic seed spices and its storability under different packaging materials

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Summary

In the current study garam masala powder from organically produced seed spices was developed and to retain its quality for a longer time, a storability study was carried out using different packaging materials. The garam masala was first standardized with the combination of key ingredients *i.e.* coriander seeds, cumin seeds, dry ginger powder, black pepper, cardamom pods (green), bay leaves, cinnamon, nutmeg, shah jeera and asafetida. The prepared garam masala was tested on *dhal* and *dum aloo* curry based on the hedonic score for sensory evaluation. The best masala was again compared with the commercial brands available in the local market. Hedonic scores were recorded and acceptability comparisons were performed with the popular brands available. The standardized garam masala was assessed for essential oil and total oil content and microbial load under different packaging materials (100gauge polythene bag, 200gauge polythene bags, aluminium foil bag, vacuum packing and paper bag) for 18 months with a 6-month interval. The maximum essential oil content (2.58 %, 2.51 % and 2.5 %, respectively) at 6, 12, and 18 months of storage was recorded in the garam masala packed in vacuum packing (polythene 100 gauge). The highest total oil per cent was recorded in vacuum packing (1000gauge polythene) which was 11.96%, 11.6% and 10.1% respectively for 6 months, 12 months and 18 months of storage. The bacterial count in different packaging materials was within the safer limit of consumption. The fungal count was absent during the storage period. The garam masala was found acceptable in quality parameters *i.e.* essential oil, total oil and microbial load till 18 months of storage. The findings showed that the packaging materials had a marked effect on the concentration of essential oil and total oil of garam masala and the garam masala may be packed in vacuum packaging and aluminium foil packaging for 18 months for longer shelf life.

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INTRODUCTION

Spices and herbs are flavour-enhancing aromatic culinary ingredients. Most of the time, crushed or powdered dried roots, bark, or seeds are utilized as spices. Typically, herbs are the young leaves, stems, or blooms of herbaceous plants, although spices are more potent than herbs.[7] India, which is renowned as the origin of spices, has a long history of commerce with the prehistoric civilizations of Rome and China. Given their excellent aroma, texture, flavour, and medicinal potential, Indian spices are currently the most sought-after worldwide. The world's largest domestic spice market is in India.

The majority of the 109 varieties of spices classified by the International Organization for Standardization (ISO) are produced in India, which also consumes and exports the most spices in the world. India also accounts for half of the allspice trade worldwide. The antioxidative, chemopreventive, antimutagenic, anti-inflammatory and immunological modulatory effects of dietary spices on cells via action on the gastrointestinal, cardiovascular, respiratory, metabolic, reproductive, neurological, and other systems have been demonstrated to be beneficial to human health.[16, 18].

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They serve a vital function as supplemental, complementary, and synergistic ingredients, and they do more than only improve the taste and flavour of food.[12, 1] Despite the separate addition of spices, India has a long tradition of combining processed spices. A mixture of ground spices known as garam masala is widely used in Indian cooking. Garam masala's ingredients are typically toasted to enhance flavour and aroma before being pulverised. Garam and masala both simply mean "hot," respectively. It is thought that garam masala, which is particularly common in classic Mughal recipes, has its roots in Northern Indian cuisine. A mixture of common ground spices known as garam masala is frequently employed as an antioxidant in Indian cuisine.[19]

The frequency of gastric emptying time was also linked to garam masala.[8] The ancient theory behind the use of garam masala was that it promotes "digestive fire," which is another way of saying that it appears to have something to activate the digestive enzymes. Various curry dishes can be infused with garam masala. Garam masala does not have a set recipe in India. The components vary according to the geography and personal preferences of each chef. Only processed spices are utilized in restaurants, hotels, military facilities, food production facilities, etc.

The volatile oil and aroma of the spices are lost as a result of improper handling and packing at processing plants, thus degrading the quality. Due to rising consumer awareness and a highly competitive market, it is essential to produce high-quality spices, clean and grade them following international standards, and package them attractively to extend their shelf life. Temperature and relative humidity are the main factors influencing food quality during storage, which causes a significant decline in product quality.

In addition, the main cause of quality degradation is due to bacteria associated with stored goods. It is a well-known fact that the material chosen for storage, packaging procedures, and storage environment all have a favourable impact on the quality of internationally stored goods. To effectively resist these variables, storing the product in "vapour permeable" containers like cloth bags and gunny bags is not as effective as storing it in vapour-proof containers such as vacuum aluminium packaging, polybags, paper bags, tins, or any other sealed containers.[20, 2]

Food packaging serves many important functions, including safeguarding food products from outside influences and damage, containing the food, and providing consumers with ingredient and nutritional information.[5, 14] There is virtually little research on post-harvest treatment and packaging for improved quality and shelf life in the spice industry. Taking these factors into account, this study aimed to standardize garam masala utilizing organic seed spices (such as coriander, and cumin), as well as to look into acceptable packaging materials for garam masala preservation for longer shelf life.

Materials and Methods

The current study was carried out in 2018 and 2019. The key ingredients such as coriander seeds and cumin seeds were collected from the farm of ICAR-NRCSS, Tabiji, and Ajmer, which were grown under an organic production system. The rest ingredients *i.e.* dry ginger powder, black pepper, cardamom pods (green), bay leaves, cinnamon stick, nutmeg, shah jeera and asafetida were purchased from the local market of Ajmer, Rajasthan, India. All the materials were cleaned to remove dust, dirt and other foreign material.

The development process of garam masala powder

The blend of different key ingredients supposed to be added to the garam masala was weighed followed by individual roasting on low flame for 60 seconds to 90 seconds and then allowed to cool. After cooling the ingredients were mixed and ground with the help of a domestic grinder. Prepared powder was sieved through 52 mesh sieves and analyzed for sensory parameters *viz.* colour, taste, appearance, texture, and flavour through *dhal* and *dum aloo* curry.

Flow chart of development of garm masala powder

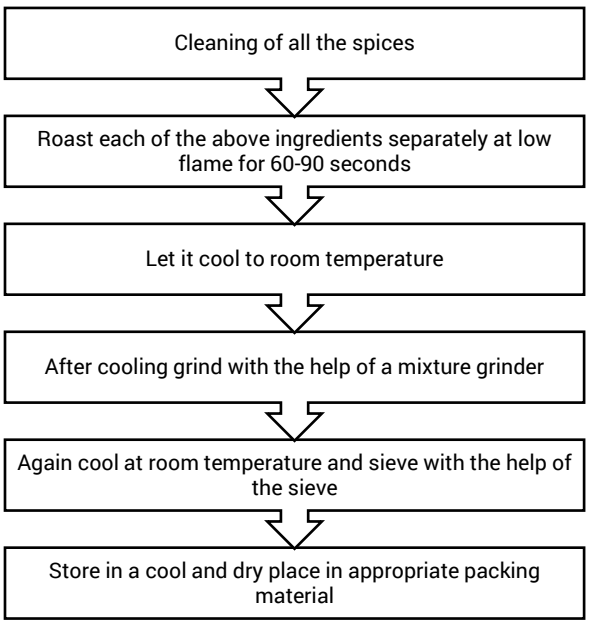

Fig. 1: Processing of garam masala

Sensory and microbial evaluation

A panel of judges and six members evaluated the prepared garam masala's organoleptic acceptability using a nine-point Hedonic scale. A semi-trained panel used observations to determine the finest garam masala recipe or formula. Garam masala (A) was tested on dhal and dum aloo curry and got compared with commercial brands (B, C, and D) available for garam masala in the local market of Ajmer via sensory evaluation after choosing the optimum recipe/formula. This time, the panel was chosen at random, and the hedonic rating/score was determined for each category panelist.

In microbial studies, plate count agar (PCA) and potato dextrose agar (PDA) media were utilized for the bacterial load/count and fungal load/count, respectively, Garam masala samples for microbial load preparation were made with 10 g of freshly prepared masala, 90 ml of blank water, and 5 drops of tween twenty. The freshly made solution was put in the shaker for 90 minutes (180 rpm). After shaking, the homogeneous mixture was left to stabilize for 30 minutes. Using the pour plate technique, the bacteria were isolated. The Meynell & Meynell (1970)[11] serial dilution approach was applied.

As stock solutions, 1 ml of each sample was put into test tubes containing 10 ml of sterile water. To make a 10-1 dilution, 1 ml of each stock solution was aseptically taken out and transferred to a different set of test tubes that each held 9 ml of sterile water. Repeating similar transfers created a 10-4 decimal dilution. Following this, sterile molten agar was added to the 0.5 ml of the 10-4 decimal dilutions, which were then gently spun three times clockwise and three times counterclockwise for proper mixing.

To prevent the culture from being harmed by condensation on the plate cover, the infected plates were allowed to be set and incubated inverted. The infected agar plates (for bacterial culture) were incubated at 25°2 for 48 hours, whilst the PDA plates (for fungal culture) were incubated at 23°C for 72 hours before being treated the same way. Following incubation, the number of colonies formed on each media was counted.

$$\text{Colony forming unit } (cfu/g) = \frac{\text{Number of colonies} \times \text{dilution factor}}{\text{Weight of sample}}$$

Oil extraction

The Accelerated Solvent Extraction System was used to extract the oil content. Using a solvent under high pressure and temperature speeds up the conventional extraction procedure. The heated solvent is kept in a liquid state during the extraction process by maintaining pressure inside the sample cell. After heating, the extract is drained into a collection vessel from the sample cell. Oil was produced when the solvent was evaporated in a rotating evaporator. Three replications of each treatment (packing material) were taken from each 30-gram fresh sample at 6-month intervals and used for oil measurement.

To extract the essential oil, 30 grammes of fresh garam masala were utilized in three replications, and during the storage research, thirty grammes of a sample were taken from each treatment and used to hydro-distil the essential oil for seven hours using a Clevenger apparatus.[4] The appropriate mildly yellowish oil was extracted and its percentage was determined following decanting and drying of the oil over anhydrous sodium sulphate. The oil tastes warm and delicious and has a distinct smell. Every six months, the procedure was carried out again for various packing materials.

Storability study

For the storage study, garam masala powder was subjected to various storage treatments (packaging) materials *i.e.* 100 gauge polythene bag, 200 gauge polythene bags, aluminium polythene bag (stored at 4°C), Aluminum foil bag, and vacuum packing (1000 gauge polythene) and paper bag collected from a local market for studying the shelf life of the product. All the quality parameters *i.e.* essential oil, total oil, microbial load and fungal load were analyzed within 6 months intervals to 18 months.

Data analysis

Statistical analysis all the data were statistically analyzed by using one-way analysis of variance (ANOVA) and analysis was carried out using OP STAT software.[17]

Results and Discussion

Organoleptic/sensory evaluation

The sensory evaluation reveals that mean hedonic scores for overall acceptability were recorded high in masala C (8.26) followed by A (8.0) according to the sensory response like colour, appearance, aroma, texture, taste and overall acceptability (Table 1). A, B, C, and D were four different garam masalas of which three belong to different popular commercial brands, were bought from a

local market and one was standardized at the post-harvest laboratory of ICAR-NRCSS which was coded as A. The garam masala was evaluated through *dum aloo* curry. Garam masala standardized at ICAR-NRCSS, Ajmer had the mean score of 8.0 which means 'like very much on the hedonic scale. Garam masala was evaluated for sensory evaluation tested also on dhal (Table-2). The highest overall acceptability was found in masala 'A" which scored 7.87. Garam masala standardized at post-harvest laboratory of ICAR-NRCSS, scored 7.82 in overall acceptability which indicates "like very much" on the hedonic scale.

Table 1: Organoleptic evaluation of garam masala (*Dum aloo*)

Treatment	Color	Appearance	Aroma	Texture	Taste	Overall acceptability
A	8.00	8.00	7.86	8.14	8.0	8.0
B	7.86	7.71	7.21	8.00	7.14	7.59
C	8.43	8.36	8.21	8.14	8.14	8.26
D	7.43	7.57	7.93	8.14	7.71	7.76

Table 2: Organoleptic evaluation of garam masala (*Dhal*)

Treatment	Color	Appearance	Aroma	Texture	Taste	Overall acceptability
A	7.93	7.86	7.93	7.79	7.86	7.87
B	7.75	7.86	7.64	7.71	8.34	7.86
C	7.39	7.29	7.29	7.46	7.43	7.37
D	7.75	7.61	7.86	7.71	8.11	7.82

Effect of packaging material on essential oil and total oil content of garam masala

The essential oil content of garam masala was found to be decreased with the advancement of the storage period irrespective of the packaging materials used (Table 3). Before packaging it was recorded at 2.59 % which was reduced gradually with the advancement of the storage period and at the end of the storage period (after 18 months) the essential oil content in garam masala was recorded in the range of 0.31% to 2.5%. The essential oil content of garam masala was affected significantly by the different packaging materials, at all the stages of storage. The maximum essential oil content (2.58 %, 2.51 % and 2.5 %, respectively) at 6, 12, and 18 months of storage was recorded in the garam masala packed in vacuum packing (polythene 100 gauge). It was followed by aluminium foil (2.43%, 2.19%, 2.03%) which was at par with aluminium polythene packing in refrigerated condition (2.46 %, 2.31% and 2.0 %) at 6, 12, and 18 months of storage, respectively. The per cent essential oil in 200 gauge polythene bags was 1.93, 1.65 and 1.49 per cent at 6, 12 and 18 months respectively however for 100 gauge polythene bags the essential oil content was 1.36%, 1.16% and 1.03% for the time interval of 6 months, 12 months and 18 months as compared to minimum essential oil content (0.8%, 0.48 % and 0.31%), at 6, 12, and 18 months of storage, respectively in paper packing. The air-tight/vacuum packing restricts the volatile loss of essential oil in the aluminium vacuum and polythene. The effect of vacuum packing on essential oil content and shelf life was also reported by Rashidimehr et al. (2019)[13] and Lal et al. (2015)[9].

Table 3: Effect of different packaging materials on essential oil content of garam masala during storage

Treatments	Essential oil content (%)			
	0 Month	6 months	12 months	18 months
Polythene (100 gauge)	2.59	1.36	1.16	1.03
Polythene (200 gauge)	2.59	1.93	1.65	1.49
Aluminum polythene bag (4°C)	2.59	2.46	2.31	2.0
Aluminum foil	2.59	2.43	2.19	2.03
vacuum packing (polythene 1000 gauge)	2.59	2.58	2.51	2.5
Paper envelope	2.59	0.8	0.48	0.31
SE (m)	--	0.031	0.019	0.031
CD (P ≤0.05)	--	0.095	0.059	0.097

The total oil percentage declined slowly in each packaging material during the storage period. The highest total oil per cent was recorded in vacuum packing (1000 gauge polythene) which was 11.96%, 11.6% and 10.1% respectively for 6 months, 12 months and 18 months followed by 200 gauge polythene packing in the order of 11.43%, 10.88% and 10% and aluminium polythene (1000 gauge) 10.0%, 9.76%, 9.06% for 6 months, 12 months and 18 months. In polythene (100 gauge), paper envelops and aluminium foil packaging the total oil content was found at par for up to 18 months of storage. The vacuum packaging (1000 gauge polythene) is a superior technology in preserving the quality of whole chillies for up to 24 months. Changes in the essential components affected by packaging methods and storage duration have been reported by several other researchers. This phenomenon may be due to evaporation and oxidative reactions.[16] Various quality parameters *viz.,* total extractable colour, oleoresin extractable colour and capsaicin content were very high in vacuum packaging treatments.[10]

Bacterial and fungal load analysis

Microbial analysis of samples was carried out and given in table 4**.** The total plate count (TPC) of the product *i.e.* garam masala for the fresh was nil. Storage study for the microbial load was performed for various packaging treatments (100 gauge polythene bag, 200 gauge polythene bag, aluminium foil, aluminium polythene bag, vacuum packing in 1000 gauge thick polythene and paper envelope). Except for the aluminium polythene bag (stored at 4°C) others were stored at ambient conditions. After six months, each treatment was analyzed for its bacterial count. The records for 6 months bacterial count showed 1.3 x 10^4 cfu/10g, 1.0 x 10^4 cfu/10g, 1.0 x 10^4 cfu/10g, 0.66 x 10^4 cfu/10g, 0.33 x 10^4 cfu/10g and 2 x 10^4 cfu/10g for 100 gauge polythene bag, 200 gauge polythene bag, aluminum foil, aluminum polythene, vacuum packing (polythene 100 gauge) and paper envelope, respectively. Likewise same bacterial load evaluation was repeated after 12 months of storage of garam masala under different packaging materials the colony counted was 2.3 x 10^4 cfu/10g, 1.33 x 10^4 cfu/10g, 1.33 x 10^4 cfu/10g, 1.66 x 10^4 cfu/10g, 0.66 x 10^4 cfu/10g and 3.0 x 10^4 cfu/10g for 100 gauge polythene bag, 200 gauge polythene bag, aluminium foil, aluminium polythene, vacuum packing and paper envelope, respectively. Similarly, bacterial count was repeated after 18 months of storage in different packaging materials. The observations recorded were 4.3 x 10^4 cfu/10g, 3.0 x 10^4 cfu/10g, 2.3 x 10^4 cfu/10g, 2.6 x 10^4 cfu/10g, 1.3 x 10^4 cfu/10g, 6.33 x 10^4 cfu/10g in series of for 100 gauge polythene bag, 200 gauge polythene bag, aluminum foil, aluminum polythene bag, vacuum packing (polythene 100 gauge) and paper envelope, respectively. Observed microbial loads in the garam masala come under within the safety level and fit for consumption till 18 months of storage. The best performing packaging material was vacuum packing in followed by aluminium foil storage, 200 gauge polythene bags, 100 gauge polythene bags and paper envelopes. Vacuum packing (polythene 100 gauge) effectively retard the growth of microbial spoilage as compared to low-density polythene bags.[15] Clove, cinnamon, garlic, and oregano spices contain more phenol content. These spices act as antimicrobial agents. When compared to herbs and spices herbs have more phenol content than spices. Similarly, Das et al. (2012)[6] also showed that cloves and cinnamon oils were comparatively of superior quality than turmeric leaf and Japanese mint oil to kill food-borne pathogens for example pathogenic bacteria like *E. coli*., *Klebsiella* sp., *Enterobacter* sp., *Bacillus* sp., *Enterococcus* sp., *Micrococcus* sp., *Salmonella* Sp., *Micrococcus tetragenes*, *Salmonella paratyphi*, *Shigella dysenteriae* and *Vibrio* sp. Ochao et al. (2014)[19] revealed that cumin and clove with their essential oil and functional extract resulted in the decline of bacterial load. The higher concentration of essential oil and functional extract present in cloves and cumin showed better control of the bacterial load.

The fungal load was counted through potato dextrose agar. The freshly prepared garam masala showed a nil number of fungal colonies. At every 6 months, an interval garam masala stored under each packaging material was tested for fungal activity/growth but the fungal colony was absent which also indicates that the product is safe for consumption till 18 months after manufacturing. Roasting has a stabilizing effect on peanuts caused by both enzyme destruction and moisture reduction.[3]

Table 4: Effect of packaging material on total oil percent of garam masala during storage

	Total oil content (%)			
Treatments	0 Month	6 months	12 months	18 months
Polythene (100 gauge)	12.66	9.53	8.71	8.46
Polythene (200 gauge)	12.66	11.43	10.88	10.00
Aluminum polythene bag (4°C)	12.66	10.00	9.76	9.06
Aluminum foil	12.66	8.83	8.75	8.46
Vacuum packing (polythene 1000 gauge)	12.66	11.96	11.60	10.10
Paper envelope	12.66	10.90	8.83	8.40
SE (m)±	--	0.054	0.055	0.047
CD (P ≤0.05)	--	0.17	0.171	0.147

Table 5: Effect of packaging material on microbial (Bacterial & Fungal) load in garam masala during storage

	PCA-Bacterial 10^4				PDA- Fungal 10^4			
Treatments	0 Month	6 Months	12 months	18 months	Fresh	6 Months	12 months	18 months
Polythene (100 gauge)	Nil	1.3	2.3	4.3	Nil	Nil	Nil	Nil
Polythene (200 gauge)	Nil	1.0	1.33	3.0	Nil	Nil	Nil	Nil
Aluminum polythene bag (4°C)	Nil	1.0	1.33	2.3	Nil	Nil	Nil	Nil
Aluminum foil	Nil	0.66	1.66	2.6	Nil	Nil	Nil	Nil
Vacuum packing (polythene 1000 gauge)	Nil	0.33	0.66	1.3	Nil	Nil	Nil	Nil
Paper envelope	Nil	2	3	6.33	Nil	Nil	Nil	Nil
SE (m)±		0.333	0.561	0.694	Nil	Nil	Nil	Nil
CD (P ≤0.05)		N/A	N/A	2.162	Nil	Nil	Nil	Nil

Conclusion

Because they are believed to be functional foods that aid in the treatment of diseases and some metabolic abnormalities, dried food spices have gained popularity in recent years. As a result of the unique blend of spices used in their preparation, traditionally value-added spices have particularly distinguishing qualities. Because they improve the flavour and aroma of food products, spices are more commonly used on a commercial basis in the food industry.

Although packing happens last in the post-harvest processes, it is one of the factors that most significantly affect the product's value. Because international buyers expect the items to be received in good shape, it is crucial to the growth of exports. To ensure complete retention of the product's use value and to safeguard against loss, damage, and theft, it also protects the content from the environment and the other way around. Thus, the current study concluded that garam masala powder was made using organic seed spices and that it could be stored in vacuum packaging (polythene 100 gauge) followed by the aluminum foil for longer shelf life, i.e. until 18 months.

Declaration of interests

The authors have no conflict of interest to declare.

Data sharing

All relevant data are within the manuscript.

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