

Influence of storage period and packaging practices on essential oil and organoleptic quality of fennel (*Foeniculum vulgare* Mill) seed

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Abstract

An experiment on the performance of different packaging practices on the evaluation of essential oil, organoleptic quality with respect to seed colour, flavour, taste and seed texture under storage was carried out at ICAR-NRCSS, Tabiji, Ajmer, Rajasthan during 2012-13. The study was focused on common and available packaging practices with different material which could be reached by home makers and process marketers to elucidate its effects on fennel seed through its quality characteristic. The storage study was carried out for eight (08) months and it was discovered that storage irrespective of using different packages decreased significantly its essential oil content and organoleptic qualities like texture, flavour, taste and colour. Among different packaging practices used for packing, the performance of Aluminum vacuum packing (1000 μ) followed by polythene packing (200 gauge) was found best for the long term storage of fennel seed. The maximum essential oil content (1.20%), highest score for colour, flavour and taste (8.2 out of 10.0) and for texture (8.1 out of 10) was recorded for the produce packed in Aluminum vacuum packing (1000 μ) followed by polythene bag packing (200 gauge) packing (1.10%, 7.8 and 8.0, respectively) after 08 months of storage as compared to minimum essential oil content (0.85%), lowest score for colour, flavour and taste (6.2 out of 10.0) and for texture (6.3 out of 10.0) in Gunny bag packing (control).

Key words: Fennel, storage, packaging practices, essential oil, organoleptic quality.

Introduction

About one-third of food produced for human consumption is lost or wasted globally, which amounts to about 1.3 billion tons per year. This inevitably also means that huge amounts of the resources used in food production are used in vain, and that the greenhouse gas emissions caused by production of food that gets lost or wasted are also missions in vain (FAO, 4). Food losses take place at production, post-harvest and processing stages in the food supply chain (Parfitt *et al.*, 10). Inadequate preservation/protection, storage, and transportation have been cited as causes of food waste. packaging reduces total waste by extending the shelf-life of foods, thereby prolonging their usability. Rathje *et al.* (11) observed that packaged foods result in 2.5% total waste as compared to 50% for fresh foods. Therefore, Packaging may contribute to the reduction of total solid waste.

Fennel is one of the important major seed spices produced mainly in India. The total annual production of fennel is around 1.36 lakh tonnes from 0.94 lakh ha area (Spices Board, India, 2013-14). It is a vital adjunct to food, the quality and purity have to be of the highest level. Fennel seeds are brittle in texture and sweet in

taste has hence short shelf life and if subjected to various environmental stresses, affect the quality. The improper handling and packaging at the processing plants leads to loss of the volatile oil and aroma of the spices like fennel, which deteriorate the quality directly. Due to increasing awareness of the consumers and high competitive market, it is mandatory to produce the quality spices, clean and grade as per international specifications and pack them in attractive packets imparting better shelf life. The major factors affecting the seed quality during storage are temperature and relative humidity, which results in drastic deterioration of seed. Apart from this, fungi associated with stored grain are mainly responsible for deterioration of quality and reduction in germination potential. Moreover, deterioration of seed is associated with ageing phenomenon which is defined as an irreversible degradation change in the quality of a seed after it has reached stage. In order to prevent the quantitative and qualitative losses due to several biotic and abiotic factors during storage, several methods are being adopted such as plant products and storing in safe containers, besides sanitation of the storage place. It is well known fact that the choice of packaging practices and material selected for storing the seeds and storage environment exert a positive effect on the quality of

stored grain. To combat these factors effectively storing the seed in vapour proof containers like vacuum aluminum packing, polybags, paper bag, tins or any sealed containers is found to be more useful in maintaining the desired quality of produce for longer period, unlike those stored in "moisture pervious" containers like cloth bag and gunny bag (Yadav *et al.*, 14). Major roles of food packaging are to protect food products, from outside influences and damage, to contain the food, and to provide consumers with ingredient and nutritional information (Coles, 3). Research work on post harvest handling and packaging for better shelf life and quality is available very meagre in seed spices especially fennel. Keeping these facts into consideration the present study was conducted to investigate suitable packaging practices for long term storage of fennel seed with high quality.

Materials and methods

The present investigation on "Influence of storage and packaging practices on essential oil and organoleptic quality of fennel (*Foeniculum vulgare* Mill) seed" was conducted during 2012-13. The study comprised six treatments of different packaging practices viz., Aluminum vacuum packing (1000 μ), Polythene bag packing (200 gauge), Polythene bag packing (100 gauge), Paper bags packing (120 gsm), Cloth bag packing (muslin cloth), Gunny bag packing (control) collected from local market. The fennel seed harvested during the month of May was taken into consideration for experimentation. The seed was thoroughly cleaned before experimentation. Each treatment consists of 250g of seed. Poly bags are sealed by polythene heat sealer using hardner and resin, aluminum vacuum packaging was packed with help of MAP machine, paper bags were packed with help of plastic tape, gunny bags and cloth bags sealed with help of thread and are stored under ambient condition in the laboratory for a period of 8 months (20.12.2012 to 20.08.2013).

Different observations were recorded just before packing the fennel seed and at 2, 4, 6 and 8 months of storage by using replicated trials of all the treatments using one replication at a time. The quantitative estimation of the oil present in the seed glands was done by the steam distillation method. The dried (50 g) seed sample was hydro-distilled in a Clevenger's type apparatus for 6 hours and after that collected oil with the help of pipette, recorded the volume and calculated in percentage oil content in the samples.

The sensory evaluation based on seed colour, flavour and taste of seeds was done by a panel of five judges

and the scores were given based on ten point hedonic scale (10-1). Freshly harvested seed bearing light green colour with pleasant flavour and good taste was given score 10 and accepted extremely, whereas aged seed dull brown colour with off/ no flavour and tasteless was given score 1.0 and rejected extremely. The organoleptic evaluation (based on texture) of seeds was visually assessed again by a panel of five judges and the scores were given on the basis of ten point hedonic scale (10-1). Freshly harvested physically complete seed shape with no damaged edges and shriveled corners was given score 10.0 for seed texture and accepted extremely, whereas aged seed with broken edges and shriveled corners showing complete loss of seed shape was given score 1.0 and rejected extremely. The experiment was laid out in Completely Randomized Design (CRD) with four replications. The values were subjected to ANOVA according to Panse and Sukhatme (9) and the significant difference determined at T ($P=0.05$), wherever 'F' test was significant.

Results and discussion

Findings of this study (Table 1) revealed that the essential oil content of fennel seed was decreased with the advancement of storage period irrespective of the packaging practices used. Before packaging it was recorded 1.35% which was reduced gradually with the advancement of storage period and at the end of storage period (after 08 months) the essential oil content in fennel grain was recorded in the range of 0.85% to 1.20%. The essential oil content of fennel grains was affected significantly with the different packaging practices, at all the stages of storage. The maximum essential oil content (1.30%, 1.35%, 1.28% and 1.20%, respectively), at 2, 4, 6 and 8 months of storage was recorded in the produce packed in aluminum vacuum packing (1000 μ). It was followed by (200 gauge) polythene bag packing (1.28%, 1.25%, 1.20% and 1.10%), at 2, 4, 6, and 8 months of storage, respectively as compared to minimum essential oil content (1.10%, 1.03%, 0.95%, and 0.85%), at 2, 4, 6, and 8 months of storage, respectively in gunny bag packing (control). At the end of storage period (after 8 months) it was recorded that seed packed in aluminum vacuum packing (1000 μ) was having 44.57% and in 200 gauge polythene bag packing 29.41% higher essential oil content than that of gunny bag packing (control). It is obvious from this study that aluminum vacuum packing (1000 μ) and polythene bag packing (200 gauge) were proved to be best for maintaining the essential oil of fennel seed. The air tight/vacuum packing which restricts the volatile loss of essential oil in the aluminum vacuum and polythene

bag packing and thus lowest essential oil was recovered in gunny bag packing as the permeability of these packaging materials permits more volatile loss of essential oil in the environment due to environmental factors such as temperature and moisture. Similar results were also reported by Siribel *et al.* (13) in *Carum carvi* seed and Agarwal and Sharma (1) in fennel.

With respect to sensory evaluation of the fennel seed in storage our study stated that there was a reduction in colour intensity, flavour and taste with the advancement of storage period, consequently the scores given to the produce at different storage periods reduced gradually in all the packaging treatments (Table 2). However, effect of different packaging practices on the sensory scores for colour, flavour and taste was significantly differed. The maximum sensory score was recorded (9.83, 9.58, 9.00 and 8.20) at 2, 4, 6 and 8 months of storage, respectively in the produce stored in aluminum vacuum packing (1000µ) followed by 200 gauge polythene bag packing (9.53, 9.28, 8.50 and 7.80, respectively) as compared to minimum score recorded (9.15, 8.20, 7.08 and 6.20), at 2, 4, 6, and 8 months of storage, respectively in produce packed in gunny bag (control) packing. After 8 months of storage, it was recorded that produce packed in aluminum vacuum packing (1000µ) and polythene bag packing (200 gauge) was having 32.25% and 25.80% higher sensory scores, respectively than that of gunny bag (control) packing.

Findings of this investigation further revealed that the seed texture of fennel was damaged gradually with storage period advancement resulted into reduced organoleptic scores irrespective of the packaging material used (Table 3). Though, the texture damage of fennel seed was influenced significantly with the use of

different packaging material. The maximum organoleptic score (9.73, 9.25, 9.10 and 8.10) for minimum texture damage was recorded at 2, 4, 6 and 8 months of storage, respectively in fennel seed stored in aluminum vacuum packing (1000µ), followed by 9.55, 9.12, 8.60 and 7.95, respectively in seed packed in polythene bag (200 gauge) packing as compared to minimum score (9.1, 8.10, 6.80 and 6.25), for maximum texture damage recorded at 2, 4, 6, and 8 months of storage, respectively under gunny bag (control) packing. At the end of storage period (after 8 months), it was recorded that seed packed in aluminum vacuum packing (1000µ) and polythene bag packing (200 gauge) had 29.60% and 27.20% higher organoleptic scores, respectively for less texture damage as compared to gunny bag (control) packing. It is obvious from this study that aluminum vacuum packing (1000µ) and polythene bag packing (200 gauge) were proved to be best for maintaining the essential oil of fennel seed and organoleptic quality with respect to colour, flavour, taste and texture and acceptability of the produce at higher level as compared to the other packaging material especially gunny bags (control), which are generally used in local markets.

Fennel seed colour, flavour, taste and texture are affected by the environmental factors such as moisture, humidity, temperature and biotic factors like insect pest infestation, disease (fungal/ bacterial) infection etc. Higher the level of these factors lower was the score index for fennel seed in the storage. The barrier packaging viz., aluminum vacuum packing (1000µ) and polythene bag packing (200 gauge) reduced the level of these factors and kept the produce safe with high quality resulted into higher organoleptic score and the produce

Table 1: Effect of different packaging materials on essential oil content of fennel seeds during storage.

| Treatments | Essential oil content in fennel seeds during storage (%) | | | | |
|-----------------------------------|--|------------------|-------------------|------------------|--------------------|
| | Before packaging | After two months | After four months | After six months | After eight months |
| Aluminum vacuum packaging (1000µ) | 1.35 | 1.30 | 1.35 | 1.28 | 1.20 |
| Polythene bag (200 gauge) | 1.35 | 1.28 | 1.25 | 1.20 | 1.10 |
| Polythene bag (100 gauge) | 1.35 | 1.25 | 1.23 | 1.18 | 1.08 |
| Paper Bag (120 gsm) | 1.35 | 1.15 | 1.15 | 1.08 | 1.00 |
| Cloth Bag (muslin) | 1.35 | 1.13 | 1.08 | 1.02 | 0.90 |
| Gunny Bag (control) | 1.35 | 1.10 | 1.03 | 0.95 | 0.85 |
| S Em (±) | - | 0.04 | 0.03 | 0.04 | 0.05 |
| CD (P=0.05) | - | 0.12 | 0.10 | 0.11 | 0.14 |

Table 2: Effect of packaging materials on sensory evaluation of fennel seeds based on colour, flavour and taste during storage.

| Treatments | Score as per hedonic scale out of 10.0 | | | | |
|---|--|-----------------|------------------|-----------------|-------------------|
| | Before packaging | After two month | After four month | After six month | After eight month |
| Aluminum vacuum packaging (1000 μ) | 10.0 | 9.8 | 9.6 | 9.0 | 8.2 |
| Polythene bag (200 gauge) | 10.0 | 9.5 | 9.3 | 8.5 | 7.8 |
| Polythene bag (100 gauge) | 10.0 | 9.5 | 9.1 | 8.2 | 7.5 |
| Paper Bag (120 gsm) | 10.0 | 9.5 | 9.0 | 7.9 | 6.9 |
| Cloth Bag (muslin) | 10.0 | 9.2 | 8.6 | 7.3 | 6.4 |
| Gunny Bag (control) | 10.0 | 9.2 | 8.2 | 7.1 | 6.2 |
| S Em (\pm) | - | 0.06 | 0.07 | 0.06 | 0.08 |
| CD ($P=0.05$) | - | 0.17 | 0.22 | 0.19 | 0.25 |

Table 3: Effect of different packaging materials on organoleptic rating of fennel seeds based on texture during storage.

| Treatments | Score as per hedonic scale out of 10.0 | | | | |
|---|--|-----------------|------------------|-----------------|-------------------|
| | Before packaging | After two month | After four month | After six month | After eight month |
| Aluminum vacuum packaging (1000 μ) | 10 | 9.7 | 9.3 | 9.1 | 8.1 |
| Polythene bag (200 gauge) | 10 | 9.6 | 9.1 | 8.6 | 8.0 |
| Polythene bag (100 gauge) | 10 | 9.5 | 9.1 | 8.2 | 7.6 |
| Paper Bag (120 gsm) | 10 | 9.4 | 8.7 | 7.6 | 6.3 |
| Cloth Bag (muslin) | 10 | 9.2 | 8.3 | 7.2 | 6.1 |
| Gunny Bag (control) | 10 | 9.1 | 8.1 | 6.8 | 6.3 |
| S Em (\pm) | - | 0.06 | 0.07 | 0.08 | 0.09 |
| CD ($P=0.05$) | - | 0.17 | 0.21 | 0.25 | 0.27 |

was highly acceptable after eight months of storage. Lal and Mehta (6) also stated in an another study that spices should be stored in barrier films such as polypropylene and aluminum packets in areas of high humidity to provide an attractive package, retain spices quality and prevent contamination and losses. Similar results were also reported by Bhardwaj (2) in fennel, Meena *et al.* (7) in seed spices, Silva *et al.* (12) in bean seed, Hong *et al.* (5) in peanuts seed and Ogori *et al.* (8) in millet grains.

Hence, on the basis of above study it can be concluded that the use of aluminum vacuum packing (1000 μ) and polythene bag packing (200 gauge) is best for long term storage of fennel seed.

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