RESEARCH ARTICLE

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# Evaluating the effect of cardamom on lipolysis in heat desiccated milk product (khoa)

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## Abstract

The present study was carried out in two phases. In phase one optimization for the stage, form and rate of the addition of cardamom to control lipolysis was carried out. The prepared khoa was packed in polypropylene (PP) containers and stored at 7±1°C and/or 15±1°C. During storage, khoa samples were evaluated at an interval of 48 hours for acceptability by sensory analysis and monitored for lipolytic changes in terms of free fatty acids (FFA) content. Based on the highest sensory acceptability and ability to control lipolysis, that stage, form and rate of addition of cardamom were selected. khoa prepared by adding fine particles of cardamom in milk at the rate of 0.3 per cent significantly control the lipolysis and maintain the flavour when stored at 7±1°C and/or 15±1°C in PP containers. In the phase two, the selected method of addition of cardamom has been used in the preparation of khoa and evaluated for chemical and sensory characteristics of khoa. The chemical characteristics, rheological properties as well as sensory evaluation of control and cardamom treated fresh samples of khoa were statistically non-significant.

**Keywords:** Heat desiccated milk product, Khoa, Cardamom, Lipolysis, Free fatty acid

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## INTRODUCTION

India has emerged as the largest producer of milk in the world with over 187.7 million tonnes of production in 2018-19 (DAHD, 2019). According to Khatkar et al. (2017), there are good potential and availability of milk for the manufacture of milk products in India. Kumari et al. (2012) reported that 5.5% of the total milk produced is utilized for the production of khoa in India. Khoa is a heat desiccated dairy product. It is perishable product having lower shelf life. The higher nutritive value and water activity ($a_w$ 0.96) of khoa are responsible for the growth of bacteria (Sawhney et al., 1994). Lipolysis as well as proteolysis shortens the shelf life of the khoa. Lipolysis produces free fatty acids that cause rancid, butyric, bitter, unclean, soapy or astringent flavour defects in dairy products (Deeth, 2011).

Various chemical preservatives are used to extend the shelf life of khoa such as potassium meta-bisulphites, propionic acid, sorbic acid, nisin, antioxidants, etc. Regular use of such food additives lead to hyperactivity, allergies, increase blood pressure and other health-related problems (Haas, 1999; Amchova et al., 2015). Therefore, there is a need for replacement of such synthetic food additives with natural origin. Cardamom is referred 'Queen of Spices' because of its very pleasant aroma and taste. It shows a health-promoting role against various conditi-

ons such as constipation, colic, diarrhoea, vomiting, headache, epilepsy, and cardiovascular diseases (Jadav and Mehta, 2018). Various researchers have used cardamom in different food products such as shrikhand, herbal beverages, basundi, kachchagola sandesh, pedha, sandesh, paneer to improve the quality and extend the shelf life (Sen and Rajorhia, 1996; Narwade, 2003; Eresam, 2009; Gupta et al., 2011; Chougule et al., 2014). However, direct studies on the effect of cardamom on lipolysis of khoa are limited. Therefore, the present study was contemplated with a view to evaluate the effect of cardamom on lipolysis in khoa.

## MATERIALS AND METHODS

### Material

For the preparation of khoa, standardized milk (4.5% Fat, 8.5% SNF) was collected from Amul parlour. Cardamom (*Elettaria cardamomum*) was obtained from the market. The outer husk of cardamom was removed manually. The coarse particles and fine particles of cardamom were prepared in our laboratory in using mixer grinder. The cardamom particles were passed from the different mesh size sieve to obtained coarse (8 to 15 mesh size) and fine (30 to 36 mesh size) particles. Polypropylene (PP) container was used for the packaging of samples.

### Manufacturing of khoa

The samples of khoa (variety : pindi type) were prepared in the laboratory from standardized pasteurized milk using the method described by De (2004).

### Incorporation of cardamom and storage study of khoa

The present study carried out in two phases (i) optimization for the rate of addition of cardamom to control lipolysis in khoa, (ii) analysis of khoa for chemical and sensory characteristics. In first phase the cardamom was added at different stages (the initial stage of milk at 40 °C and final stage of pat formation), in different forms (coarse and fine) and at different rates (0 (control), 0.1, 0.2, 0.3, 0.4 and 0.5 per cent). The subsequent steps in the preparation of khoa remained the same as described by De (2004). Each samples of khoa were packed into a PP container and stored at 7±1°C and/or 15±1°C. During storage, khoa samples were evaluated at an interval of 48 hours for acceptability by sensory analysis (flavour score) using a 9-point hedonic scale. Simultaneously, the khoa samples were also monitored for lipolytic changes. Three replications were taken. Based on the highest score in sensory evaluation and/or control the lipolysis, that stage, form and rate of the addition were selected for further study. In the phase two, the selected method of addition of cardamom were used in the preparation of khoa and evaluated for chemical, rheological and sensory characteristics of khoa.

### Analysis of khoa for chemical characteristics

The free fatty acids content was determined by the extraction titration method as suggested by Deeth et al. (1975) with certain modifications. The acidity of the khoa sample was estimated according to BIS (1980) procedure specified for khoa.

### Analysis of khoa for proximate composition

Moisture and ash content in khoa were determined according to BIS (1983) procedure specified for khoa. The fat content of khoa was estimated by the method described by Ladkani and Mulay (1974). Protein content was determined by the Kjeldahl method as described by Horwitz (1980). Carbohydrate (lactose) content in khoa was estimated by difference.

### Determination of rheological properties of khoa

Rheological properties of khoa like chewiness, hardness, springiness, cohesiveness, gumminess and adhesiveness were analyzed by the Texture profile analyzer. Compression testing of khoa samples was done with Lloyd Instrument, Hampshire, UK (Model No. 01/2962).

### Statistical analysis

The data obtained for each of the attributes under study were subjected to statistical analysis in a completely randomized design.

## RESULTS AND DISCUSSION

### Effect of stage of addition of cardamom on flavour score and lipolysis of khoa

Changes in flavour score of khoa revealed that there were a significant ($p<0.05$) difference between the flavour score of the khoa when cardamom was added at different stages. The data obtained for changes in flavour score of khoa during storage at 7±1°C are presented in Table 1 and the trend is depicted in Figure 1.

**Table 1.** Effect of stage of addition of cardamom on flavour score of khoa stored at 7±1°C

| Storage periods (days) | Flavour score | | | |
|---|---|---|---|---|
| | Control | Milk | Pat formation | Mean (Days) |
| 0 | 8.27 | 8.57 | 7.73 | 8.19 |
| 2 | 8.10 | 8.37 | 7.77 | 8.08 |
| 4 | 7.20 | 7.67 | 7.03 | 7.30 |
| 6 | 6.90 | 7.53 | 6.93 | 7.12 |
| 8 | 5.50 | 6.70 | 6.17 | 6.12 |
| 10 | 4.47 | 6.13 | 5.40 | 5.33 |
| 12 | 4.23 | 6.03 | 5.43 | 5.23 |
| 14 | 4.20 | 5.13 | 5.10 | 4.82 |
| Mean | 6.11 | 7.02 | 6.45 | |
| Source of variation | | Treatment (Stage) | Days | Treatment (Stage) x Days |
| SEm | | 0.125 | 0.204 | 0.353 |
| CD (0.05) | | 0.36 | 0.58 | NS |
| CV (%) | | 9.36 | | |

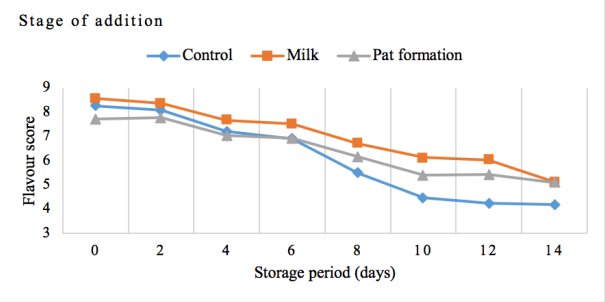


**Figure 1.** Effect of stage of addition of cardamom on flavour score of khoa stored at 7±1°C

The changes in flavour score revealed that both cardamom and storage period had significant ($p<0.05$) effect on the flavour score of the khoa. The flavour score decreased with the increasing storage period in all the khoa samples. Figure 1 revealed that extent of decrease in flavour score of khoa samples with cardamom added in milk was relatively less as compared to other samples upon storage. On the 8$^{th}$ day of storage, the flavour score was remained acceptable in all samples and maximum flavour score (6.70) was observed in a sample in with cardamom added in milk. The flavour score of all samples was unacceptable at the end of 14$^{th}$ days of storage when stored in PP containers at 7±1°C.

Desale and More (2017) observed that on the day of manufacture, highest flavour score (9) were obtained by cardamom treated basundi, followed by saffron treated basundi (8.4), while control samples and combination samples obtained minimum flavour score (8). Further, it was observed that the flavour scores of basundi decreased with increasing storage period (0-8 days). Prasad et al. (2017) worked on anti-oxidative, physico-chemical and sensory attributes of burfi affected by the incorporation of different herbs (clove, turmeric, basil leaves, curry leaf, ginger and cardamom) and its comparison with synthetic anti-oxidant (BHA). It was observed that the highest flavour (7.50) score was obtained by cardamom added burfi and the lowest flavour score of 5.20 was obtained for basil leaves incorporated burfi. Sensory evaluation revealed that among these herbs, cardamom added burfi was highly preferred followed by ginger, turmeric, clove, curry leaves and basil leaves.

The extent of lipolysis in khoa samples was measured using changes in free fatty acids (FFA) value. The changes in FFA value (per cent oleic acid) of khoa samples during storage at 7±1°C is presented in Table 2 and Figure 2.

A significant difference ($p<0.05$) was observed in the FFA content of cardamom treated and control samples of khoa. Though during storage FFA content was increased, the rate of increase in FFA of khoa samples with cardamom added in milk was relatively less as compared to other samples. The FFA content in the sample was 0.199 per cent oleic acid on 14$^{th}$ day of storage when khoa prepared from cardamom added in milk. This value of FFA was lowest among the all other samples indicating it was able to control the lipolysis in a sample during storage.

**Table 2.** Effect of stage of addition of cardamom on free fatty acids of khoa sored at 7±1°C

| Storage periods (days) | FFA (% oleic acid) | | | |
|---|---|---|---|---|
| | Control | Milk | Pat formation | Mean (Days) |
| 0 | 0.150 | 0.149 | 0.148 | 0.149 |
| 2 | 0.166 | 0.157 | 0.158 | 0.160 |
| 4 | 0.175 | 0.158 | 0.174 | 0.169 |
| 6 | 0.174 | 0.174 | 0.174 | 0.174 |
| 8 | 0.191 | 0.174 | 0.174 | 0.180 |
| 10 | 0.200 | 0.182 | 0.200 | 0.194 |
| 12 | 0.216 | 0.191 | 0.199 | 0.202 |
| 14 | 0.223 | 0.199 | 0.215 | 0.213 |
| Mean | 0.187 | 0.173 | 0.180 | |

| Source of variation | Treatment (Stage) | Days | Treatment (Stage) x Days |
|---|---|---|---|
| SEm | 0.002 | 0.003 | 0.005 |
| CD (0.05) | 0.005 | 0.009 | NS |
| CV (%) | 5.07 | | |

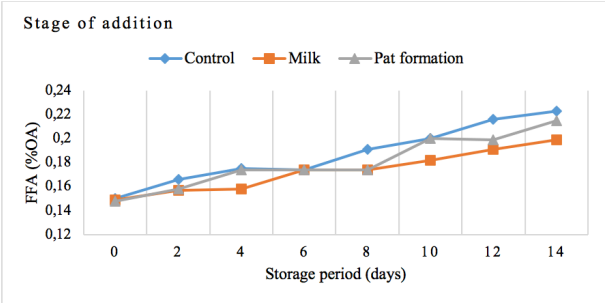


**Figure 2.** Effect of stage of addition of cardamom on FFA (% oleic acid) of khoa stored at 7±1°C

Gawde (2005) worked on enhancing the shelf life of kalakand using preservatives *viz*. cardamom, saffron and sorbic acid. It was observed that there was significant variation ($p<0.05$) in the free fatty acid content of kalakand due to different preservatives *viz*. saffron, cardamom and sorbic acid. The kalakand prepared with 0.15 per cent sorbic acid recorded minimum FFA of 0.23 per cent which was at par with 0.15 per cent cardamom (0.24 per cent) but different from the rest of the treatment. It could be seen that the storage period had significant ($p<0.05$) impact on the FFA content of kalakand. Ratiba et al. (2006) found that total volatile fatty acids (TVFA) of all cheese samples increased significantly ($p\leq0.05$) throughout the storage period when cardamom, thyme and clove powder were evaluated. There was some slight difference between the control and all other treatments in TVFA at the first stage of storage and the rate of increase in TVFA varied considerably among the treatments during storage. Cheese treated with 0.15 per cent thyme had the lowest value

throughout the storage period (45 days) while the control had the highest value of TVFA than other treatments. This suggested that added spices to the curd of cheese led to a slight decrease in TVFA because of inhibition of lipolytic enzymes.

Thus, the addition of cardamom at initially in milk having 40°C temperature was able to control both flavour as well as lipolysis in khoa during storage and hence this stage of the addition was selected for further study.

## Effect of form of addition of cardamom on flavour score and lipolysis of khoa

Changes in flavour score of khoa revealed that there was a significant ($p<0.05$) difference between the flavour score of the khoa when cardamom was added in different forms. The data obtained for changes in flavour score of khoa during storage at 15±1°C are shown in Table 3 and the trends are depicted in Figure 3.

**Table 3.** Effect of form of addition of cardamom on flavour score of khoa stored at 15±1°C

| Storage periods (days) | Flavour score | | | |
|---|---|---|---|---|
| | Control | Fine particles | Coarse particles | Mean (Days) |
| **0** | 8.89 | 9.00 | 8.92 | 8.94 |
| **2** | 7.53 | 8.44 | 8.03 | 8.00 |
| **4** | 6.58 | 7.64 | 7.08 | 7.10 |
| **6** | 5.55 | 6.94 | 6.17 | 6.22 |
| **8** | 4.06 | 5.97 | 5.03 | 5.02 |
| **Mean** | 6.52 | 7.60 | 7.04 | |
| **Source of variation** | | **Treatment (Form)** | **Days** | **Treatment (Form) x Days** |
| SEm | | 0.078 | 0.100 | 0.173 |
| CD (0.05) | | 0.23 | 0.29 | 0.50 |
| CV (%) | | | 4.25 | |

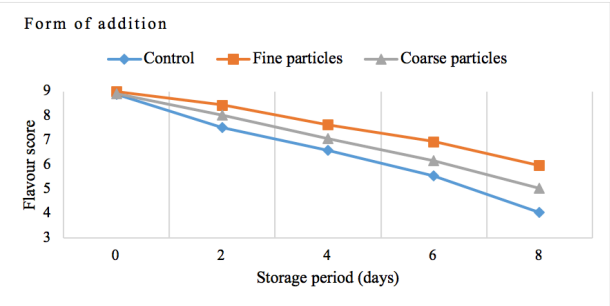


**Figure 3.** Effect of form of addition of cardamom on flavour score of khoa stored at 15±1°C

Figure 3 revealed that the addition of cardamom in different forms improved the flavour score of khoa samples compare to control sample during the storage period. The flavour scores of all samples were significantly ($p<0.05$) decreased during storage. Khoa samples with fine particles of cardamom possessed the characteristic flavour and secured significantly higher ($p<0.05$) average score. However, the flavour score of khoa with coarse particle decreases faster with storage periods than that of khoa with fine particles. The highest flavour score (5.97) was observed in khoa which was prepared using fine cardamom particles on the 8$^{th}$ day of storage. Visible mold growth was observed in all khoa samples after 8 days of storage at 15±1°C when stored in PP container.

Sen and Rajorhia (1996) studied the influence of powdered cardamom seeds as a natural preservative on the sandesh. Cardamom powder was incorporated at the rate of 0.05, 0.1 and 0.15 per cent by weight of chhana. The addition of 0.15 per cent cardamom (w/w) caused minimum chemical and microbiological changes during storage, but it imparted a strong aroma to the product. Sandesh samples treated with 0.10 per cent cardamom were found acceptable up to 24 days at 30°C and 85 days at 7°C as compared 4 and 47 days, respectively for control sandesh. This can be attributed to the presence of several antimicrobial phenolic compounds such as cineol, terpene, limonene, nerolidon, sabnine, pinene etc. Gaikwad and Hembade (2012) studied the physicochemical as well as the sensory quality of stored buffalo milk Ujani basundi, incorporated with or without potassium sorbate (0.1per cent w/w) and with or without cardamom (0.1 per cent w/w) at 30±1°C and 5±1°C over a period of 20 days. All the treatments secured nearly equal score on 0$^{th}$ day, except cardamom treated samples due to the pleasant flavour of cardamom. However, upto 5$^{th}$ days of storage, the flavour scores were decreased in all the samples. The flavour score of cardamom added samples found superior among all the treatment during storage. Patil (2018) studied the organoleptic and physico-chemical quality of Quarg type cheese on the addition of mango pulp and spices (cardamom and clove). The highest score of 47.85 was obtained by $T_2$ (72 per cent Quarg cheese + 27 per cent mango pulp + 0.6 per cent cardamom powder + 0.4 per cent clove powder) while lowest score of 47.00 was noticed for the $T_5$ (71.8 per cent Quarg cheese + 27 per cent mango pulp + 0.7 per cent cardamom powder + 0.5 per cent clove powder). Thus, $T_2$ was observed to be superior over other treatment for the flavour.

The changes in FFA value (per cent oleic acid) of khoa samples with fine particles and coarse particles of cardamom during storage at 15±1°C are shown in Table 4 and trends are depicted in Figure 4.

On addition of different forms of cardamom in khoa, there was a significant difference in the FFA value of the treated khoa compared to control khoa samples. It was observed that the FFA value of control khoa sample increases rapidly compare to cardamom treated khoa samples. The khoa with fine cardamom particles had the lowest FFA value compared to other khoa samples throughout the storage period. The lowest mean FFA value (0.166 % oleic acid) was of khoa with fine cardamom after 10 days of storage at 15±1°C.

**Table 4.** Effect of form of addition of cardamom on free fatty acids of khoa stored at 15±1°C

| Storage periods (days) | FFA (% oleic acid) | | | |
|---|---|---|---|---|
| | Control | Fine particles | Coarse particles | Mean (Days) |
| 0 | 0.150 | 0.149 | 0.149 | 0.149 |
| 2 | 0.158 | 0.157 | 0.158 | 0.158 |
| 4 | 0.175 | 0.158 | 0.166 | 0.166 |
| 6 | 0.183 | 0.166 | 0.175 | 0.175 |
| 8 | 0.200 | 0.175 | 0.199 | 0.191 |
| 10 | 0.208 | 0.192 | 0.200 | 0.200 |
| Mean | 0.179 | 0.166 | 0.175 | |
| Source of variation | | Treatment (Form) | Days | Treatment (Form) x Days |
| SEm | | 0.002 | 0.003 | 0.006 |
| CD (0.05) | | 0.007 | 0.010 | NS |
| CV (%) | | | 6.09 | |

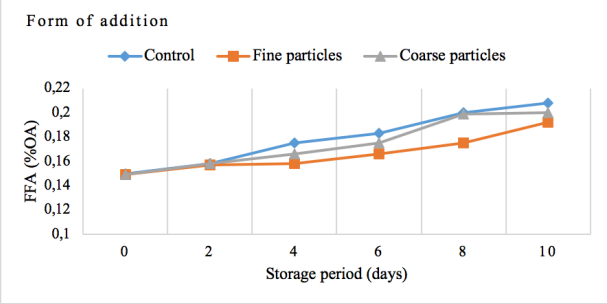


**Figure 4.** Effect of form of addition of cardamom on FFA (% oleic acid) of khoa stored at 15±1°C

Gaikwad and Hembade (2012) studied the physicochemical as well as the sensory quality of buffalo milk Ujani basundi. Free fatty acidity (per cent oleic acid) was measured to quantify hydrolytic changes during storage. The initial FFA found 0.54 per cent per cent oleic acid, these increased slowly during storage, however, the rate of increase of FFA in potassium sorbate ($T_1$) was very low as compared to control ($T_0$), and cardamom ($T_2$) treated samples. The sample ($T_0$) showed 0.66 per cent oleic acid whereas $T_2$ showed 0.64 per cent oleic acid FFA content on the 20$^{th}$ day of storage. The $T_1$ sample showed 0.60 per cent oleic acid on 20$^{th}$ day of storage. Therefore, it was reported that storage at low temperature with potassium sorbate and cardamom retards the increase in FFA. Jain et al. (2015) studied the influence of modified atmospheric packaging on microbial, textural, sensory and physico-chemical properties of Kalakand. The FFA content increased with increasing storage period. The values were found to be lowest for the samples stored at 10°C, which further increased in the case of samples stored at 25 and 37°C. The FFA content was higher in control samples during 30 days of storage as compared with MAP treated samples. It could be attributed to the absence of oxygen in the package of MAP treated samples.

Thus between the two forms of addition, the fine particles of cardamom was able to control both the flavour as well as lipolysis of khoa during storage at 15±1°C. Hence, the fine particles of cardamom was selected and carry forward in the next phase of the study.

## Effect of rate of addition of cardamom on flavour score and lipolysis of khoa

Changes in flavour score of khoa revealed that there was a significant ($p<0.05$) difference between the flavour score of the khoa when cardamom was added at different rates. The data obtained for changes in flavour score of khoa during storage at 15±1°C are shown in Table 5 and the trend are depicted in Figure 5.

**Table 5.** Effect of rate of addition of cardamom on flavour score of khoa stored at 15±1°C

| Storage periods (days) | Flavour score | | | | | | |
|---|---|---|---|---|---|---|---|
| | 0.0 | 0.1 | 0.2 | 0.3 | 0.4 | 0.5 | Mean (Days) |
| 0 | 8.78 | 8.36 | 8.83 | 8.95 | 8.58 | 8.22 | 8.62 |
| 2 | 8.06 | 7.97 | 8.61 | 8.78 | 8.00 | 7.36 | 8.13 |
| 4 | 7.22 | 7.25 | 7.86 | 8.14 | 7.11 | 6.81 | 7.40 |
| 6 | 6.03 | 6.39 | 7.00 | 7.42 | 6.14 | 5.92 | 6.48 |
| 8 | 4.67 | 5.17 | 5.80 | 6.42 | 5.72 | 5.61 | 5.56 |
| Mean (Rate) | 6.95 | 7.03 | 7.62 | 7.94 | 7.11 | 6.78 | |
| Source of variation | | | Treatment (Rate) | | Days | | Treatment (Rate) x Days |
| SEm | | | 0.053 | | 0.048 | | 0.118 |
| CD (0.05) | | | 0.15 | | 0.14 | | 0.33 |
| CV (%) | | | | | 2.83 | | |

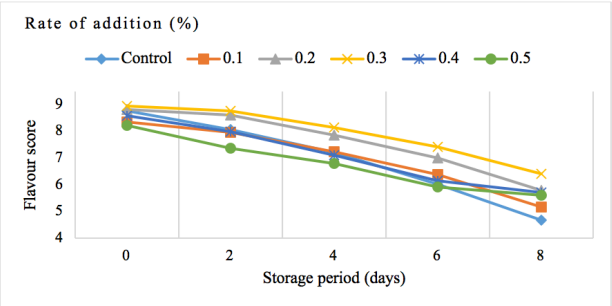


**Figure 5.** Effect of rate of addition of cardamom on flavour score of khoa stored at 15±1°C

The changes in flavour score revealed that both cardamom and storage period had significant ($p<0.05$) effect on the flavour score of the khoa. The flavour score of the khoa having 0.3 per cent cardamom was more or less similar to that of the control sample when it was fresh. However, higher than 0.3 per cent rate of addition of cardamom, the flavour score was decreased in the samples. Addition of higher rate of cardamom gave pronounced flavour to the khoa, which was not acceptable by the judges. The extent of decrease in flavour score of 0.3 per cent cardamom treated sample was relatively slow as compared to other samples upon storage. On the 6$^{th}$ days of storage, the flavour score was remained acceptable in all samples and maximum flavour score (7.42) was observed in 0.3 per cent cardamom treated sample. After the 8$^{th}$ day of storage, all the samples were unacceptable due to visible mold growth.

Kober et al. (2003) worked on the influence of cardamom powder on the shelf life of sandesh. Chhana sample was divided into four parts with the addition of cardamom powder at the rate of 0.05, 0.10 and 0.15 per cent with each part at the last stage of sandesh making. They observed that the sensory scores of all samples decreased gradually with increasing storage periods. It was suggested that the control samples were suitable for human consumption up to 12 days, but the addition of cardamom powder (0.05, 0.10 and 0.15 per cent) extended the storage life up to 20, 24 and 28 days at room temperature, respectively. Narwade (2003) reported that the use of different levels of crushed cardamom significantly affected the flavour score of pedha. Addition of 0.2 per cent cardamom had the highest mean flavour score (8.49) as compared to the addition of 0.4 per cent and 0.6 per cent. As the cardamom increased, the flavour became stronger which was not accepted by the judges. Chougule et al. (2014) prepared basundi from buffalo or cow milk. Efforts have been made to enhance the quality of basundi prepared by using cardamom and saffron. It was observed that up to 0.4 per cent level of cardamom, the mean flavour score was increased and later on, it was decreased in 0.6 per cent cardamom treated samples. This might be due to the higher concentration of cardamom flavour, which was unacceptable by the judges. The basundi treated with 0.4 per cent cardamom secured the highest flavour score (8.4) as compared to other treatments.

The changes in FFA value (per cent oleic acid) of khoa samples containing different rates of cardamom during storage at 15±1°C are shown in Table 6 and Figure 6.

The FFA content of the khoa samples varies from 0.149 to 0.150 per cent oleic acid on the first day. During storage, the free fatty acids content were increased and at the end of storage, the FFA content was varied from 0.210 to 0.241 per cent oleic acid in the samples. Though during storage FFA content was increased, the rate of increase in the 0.3 per cent added cardamom samples was relatively less as compared to other samples. The FFA content was 0.210 per cent oleic acid observed in 0.3 per cent cardamom treated sample on 10$^{th}$ day of storage, which was lowest among the all other samples indicating 0.3 per cent cardamom treated sample was able to control the extent of lipolysis in the sample during storage.

**Table 6.** Effect of rate of addition of cardamom on free fatty acids of khoa stored at 15±1°C

| Storage periods (days) | FFA (% oleic acid) | | | | | | |
|---|---|---|---|---|---|---|---|
| | 0.0 | 0.1 | 0.2 | 0.3 | 0.4 | 0.5 | Mean (Days) |
| 0 | 0.149 | 0.150 | 0.150 | 0.149 | 0.150 | 0.149 | 0.150 |
| 2 | 0.175 | 0.173 | 0.157 | 0.153 | 0.160 | 0.175 | 0.166 |
| 4 | 0.191 | 0.177 | 0.166 | 0.163 | 0.175 | 0.197 | 0.178 |
| 6 | 0.216 | 0.200 | 0.174 | 0.169 | 0.183 | 0.207 | 0.191 |
| 8 | 0.225 | 0.225 | 0.199 | 0.186 | 0.199 | 0.224 | 0.210 |
| 10 | 0.241 | 0.233 | 0.224 | 0.210 | 0.228 | 0.236 | 0.229 |
| Mean (Rate) | 0.200 | 0.193 | 0.178 | 0.172 | 0.183 | 0.198 | |

| Source of variation | Treatment (Rate) | Days | Treatment (Rate) x Days |
|---|---|---|---|
| SEm | 0.002 | 0.002 | 0.004 |
| CD (0.05) | 0.004 | 0.004 | 0.011 |
| CV (%) | | 3.45 | |

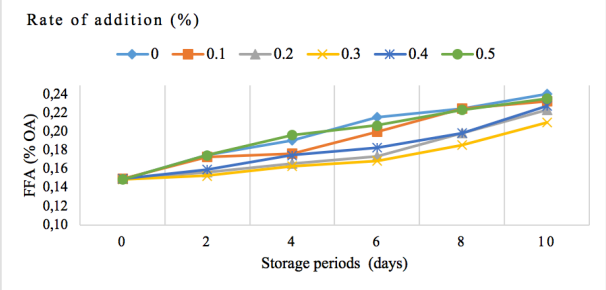


**Figure 6.** Effect of rate of addition of cardamom on FFA (% oleic acid) of khoa stored at 15±1°C

Sivakumar et al. (2014) studied the effect of betel leaves (Piper betel Linn) (0.5 per cent) extract on the different properties of cow milk khoa stored under room temperature. Lower rate of FFA production was observed in khoa samples treated with betel leaves extract than BHA treated samples during 9 days of storage. Hence, it was reported that BHA could be replaced by natural antioxidant like betel leaves extract. Bhatt (2012) observed that the addition of essential oils of spice had a significant effect on FFA content of paneer. The FFA content of control sample of paneer declined sharply from the beginning of the storage. Amongst the samples of paneer, the highest rate of increase in free fatty acid content was observed in case of essential oil of cinnamon and the lowest rate was observed in the case of cardamom. The FFA content in samples containing essential oil of cardamom remained constant during storage between 15 to 20 days. Thus, the

essential oil of cardamom proved to be the best spice extract to control the FFA content of paneer during storage. Eresam et al. (2015) tested the relative efficiency of black pepper, cardamom, cinnamon and clove in improving shelf life of paneer. The maximum rate of increase was observed in black pepper and the rate was minimum in cardamom. The FFA content in samples containing cardamom remained constant during storage between 21 to 28 days. Thus, cardamom proved to be the best spice to control the FFA content of paneer during storage.

Thus, 0.3 per cent fine particles of cardamom when added in milk for khoa making was able to control the flavour as well as lipolysis in khoa upon storage.

## Chemical composition of fresh khoa

The fresh sample of control and cardamom (0.3 per cent) treated khoa were analyzed for per cent moisture, fat, protein, lactose (by difference) and ash content. The results obtained from this are shown in Table 7 and trend are depicted in Figure 7.

**Table 7.** Chemical compositions of fresh khoa

| Sample of Khoa | Constituent (%) | | | | |
|---|---|---|---|---|---|
| | Moisture | Fat | Protein | Lactose | Ash |
| Control | 33.44 | 21.67 | 21.70 | 17.48 | 3.66 |
| Cardamom treated (0.3%) | 33.83 | 21.83 | 22.11 | 16.85 | 3.61 |
| SEm | 1.674 | 0.441 | 0.215 | 0.689 | 0.082 |
| CD (0.05) | NS | NS | NS | NS | NS |
| CV (%) | 8.62 | 3.51 | 1.70 | 6.96 | 3.89 |

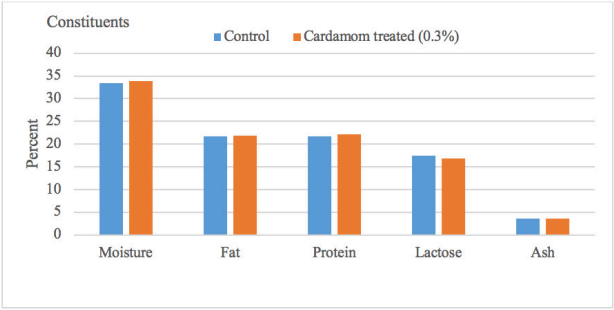


**Figure 7.** Chemical compositions of fresh khoa

The data obtained for the chemical composition of a control sample of fresh khoa revealed that the khoa contained 33.43 per cent moisture, 21.67 per cent fat, 21.70 per cent protein, 17.48 per cent lactose and 3.66 per cent ash while cardamom treated khoa contained 33.83 per cent moisture, 21.83 per cent fat, 22.11 per cent protein, 16.85 per cent lactose and 3.61 per cent ash. The per cent fat on dry matter basis of a control sample of khoa was 32.55 while cardamom added khoa was 32.99. Thus, data revealed that no significant difference ($p>0.05$) in the composition of control and cardamom treated khoa was observed.

The literature on the chemical composition of khoa indicates that the moisture, fat, protein, lactose and ash content of laboratory-made khoa samples vary from 23.8 to 35.00, 21.73 to 45.90, 16.30 to 25.80, 18.85 to 35.97 and 2.74 to 5.20 per cent respectively (Dastur and Lakhani, 1971; Kumar and Srinivasan, 1982; Gothwal and Bhavadasan, 1992; Kashyap, 2007; Kumar, 2013; Choudhary et al., 2019). Therefore, in the present study, the data obtained for the chemical composition of khoa was well within those reported in the literature. According to the Food Safety and Standards Authority of India (FSSAI, 2017), khoa should contain a minimum 30 per cent fat on dry matter basis and total solids should be minimum 55 per cent. The ash content should not exceed 6.0 per cent. Therefore, the samples of khoa prepared in the present study fulfilled the FSSAI requirements for the chemical composition.

## Chemical characteristics of fresh khoa

The chemical characteristics like free fatty acids and acidity of control and cardamom (0.3 per cent) treated fresh khoa were analysed. The results obtained from this are shown in Table 8.

The data obtained for chemical characteristics of a control sample of fresh khoa revealed that the khoa have FFA content: 0.150 per cent oleic acid and acidity: 0.54 per cent lactic acid while cardamom treated khoa sample contained 0.149 per cent oleic acid FFA and 0.53 per cent lactic acid. It was observed that the chemical characteristics of the samples were statistically non-significant ($p>0.05$).

The literature on the chemical composition of khoa indicates that the FFA content of fresh khoa ranged from 0.065-0.332 per cent oleic acid (Rudreshappa and De, 1971; Sai, 1981; Sharma, 1999; Choudhary et al., 2019). The acidity of the fresh sample of khoa ranged from 0.54-0.59 per cent lactic acid (Rudreshappa and De, 1971; Sharma, 1999; Kashyap, 2007; Chaudhary et al., 2019). Therefore, in the present study, the data obtained for FFA content and acidity of khoa was well within those reported in the literature.

## Rheological Properties of Fresh Khoa

The fresh sample of control and cardamom (0.3 per cent) treated khoa were analyzed for textural analysis by texture profile analyzer. The results obtained are shown in Table 9 and trend are depicted in Figure 8.

The data obtained for the rheological properties of a control sample of fresh khoa revealed that the khoa had 37.51 N hardness, 0.13 cohesiveness, 2.99 mm springiness, 4.25 N gumminess, 15.20 Nmm chewiness and 0.15 Nmm adhesiveness while cardamom treated khoa had 36.90 N hardness, 0.16 cohesiveness, 2.81 mm springiness, 5.45 N gumminess, 17.71 Nmm chewiness and 0.13 Nmm adhesiveness. Thus, statistical data show that rheological properties of fresh control and cardamom (0.3 per

**Table 8.** Chemical characteristics of fresh khoa

| Sample of Khoa | Chemical characteristics | | | |
|---|---|---|---|---|
| | Free fatty acids (% oleic acid) | Acidity (% LA) | Peroxide value (millimolecules of oxygen per kg of fat) | Thiobarbituric acid value (OD at 532 nm) |
| Control | 0.150 | 0.54 | 0 | 0 |
| Cardamom treated (0.3%) | 0.149 | 0.53 | 0 | 0 |
| SEm | 0.001 | 0.026 | 0 | 0 |
| CD (0.05) | NS | NS | NS | NS |
| CV (%) | 1.06 | 8.41 | 0 | 0 |

**Table 9.** Rheological properties of fresh khoa

| Sample of Khoa | Rheological properties | | | | | |
|---|---|---|---|---|---|---|
| | Hardness (N) | Cohesiveness | Springiness (mm) | Gumminess (N) | Chewiness (Nmm) | Adhesiveness (Nmm) |
| Control | 37.51 | 0.13 | 2.99 | 4.25 | 15.20 | 0.15 |
| Cardamom treated (0.3 %) | 36.90 | 0.16 | 2.81 | 5.45 | 17.71 | 0.13 |
| SEm | 3.365 | 0.008 | 0.218 | 0.506 | 1.799 | 0.007 |
| CD (0.05) | NS | NS | NS | NS | NS | NS |
| CV (%) | 15.67 | 10.04 | 12.99 | 18.06 | 18.93 | 9.33 |

cent) treated khoa was not statistically different ($p>0.05$) from each other.

Patil et al. (1990) reported that the khoa market sample has a hardness (N) 46.1, cohesiveness 0.43, adhesiveness 17.3, springiness (mm) 14.8, gumminess (mN) 19.7, chewiness (mN.mm) 291.8. Puranik et al. (1998) studied the textural analysis of recombined milk and cow milk khoa and reported hardness (N) 1.23, cohesiveness 0.26, adhesiveness 1.30, springiness (mm) 5.00, gumminess (mN) 0.32, chewiness (mN.mm) 1.60. Dodeja and Deep (2012) reported that danader khoa market sample has a hardness (N) 33.553, cohesiveness 0.222, adhesiveness -0.311, springiness (mm) 0.349, gumminess (mN) 7.448, chewiness (mN.mm) 2.59. Badola et al. (2018) reported no significant effect ($p>0.05$) on the instrumental textural attributes of burfi by incorporation of herbal essential oil at any level of incorporation. This may be attributed to the negligible amount of essential oil present in the burfi. Prasad et al. (2018) evaluated effect of incorporation of essential oils of ginger, turmeric and cardamom on the instrumental texture parameters. Hardness values in the burfi samples ranged from 39.59 N to 41.58 N, adhesiveness from (-) 2.64 Ns to (-) 2.93 Ns, springiness (mm) 0.14 to 0.20, cohesiveness from 0.12 to 0.15, gumminess from 5.35 to 6.02 and chewiness from 0.95 to 1.17. It was observed that essential oil or synthetic antioxidant incorporation did not result in significant ($p>0.05$) modification of the textural attributes of burfi, compared with the control burfi.

## Sensory evaluation of fresh khoa

The fresh khoa were analyzed for sensory evaluation by 9-point hedonic scale. The colour, flavour, body & texture and overall acceptability score of control and khoa treated with cardamom (0.3 per cent) are shown in Table 10 and trend were depicted in Figure 9.

**Table 10.** Sensory evaluation of fresh khoa

| Sample of Khoa | Sensory Score | | | |
|---|---|---|---|---|
| | Colour | Flavour | Body & texture | Overall acceptability |
| Control | 8.33 | 8.67 | 8.50 | 8.57 |
| Cardamom treated (0.3%) | 8.60 | 8.83 | 8.67 | 8.73 |
| SEm | 0.189 | 0.167 | 0.312 | 0.113 |
| CD (0.05) | NS | NS | NS | NS |
| CV (%) | 3.86 | 3.30 | 6.29 | 2.26 |

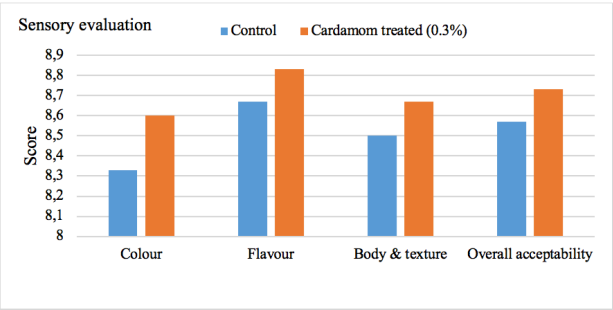


**Figure 9.** Sensory evaluation of fresh khoa

From the Table 10, it was observed that the colour, flavour, body & texture and overall acceptability scores of a control sample of fresh khoa were 8.33, 8.67, 8.50 and 8.57 respectively while for cardamom added fresh khoa

was 8.60, 8.83, 8.67 and 8.73 respectively. The sensory evaluation data of control and cardamom treated khoa were not statistically different (p>0.05) from each other.

Sivakumar et al. (2014) observed that the there was no statistical difference between the scores for colour and appearance, flavour, body and texture and overall acceptability between control and betel leaves (0.5 per cent) extract-treated khoa which indicates that the addition of aqueous extract of betel leaves did not influence the sensory quality of khoa. Anurag et al. (2017) studied the shelf life of bottle gourd burfi. For fresh bottle gourd burfi, the flavour, colour & appearance, texture and overall acceptability scores were 8.40, 8.43, 8.14, and 8.26, respectively. Prasad et al. (2017) worked on anti-oxidative, physicochemical and sensorial properties of burfi affected by the incorporation of different herbs (clove, turmeric, basil leaves, curry leaf, ginger and cardamom) and its comparison with BHA. It was observed that the lowest flavour score of 5.20 was obtained for basil leaves added burfi, while highest score was obtained by cardamom incorporated burfi (7.50), which was not significantly different (p>0.05) from the control sample. Colour and appearance scores of the herbs added burfi ranged from 5.10 for clove added burfi to 7.30 for ginger incorporated burfi. Texture scores of herbs added burfi ranged from 7.26 for cardamom added burfi to 7.33 for turmeric burfi. No significant (p>0.05) difference was observed in the textural scores of burfi upon the incorporation of different herbs. It was observed that overall acceptability scores for the herbal burfi ranged from 5.27 for basil leaves added burfi to 7.39 for cardamom-incorporated burfi. Thus, data shows that sensory evaluation of fresh control and cardamom (0.3 per cent) treated khoa was not statistically different (p>0.05) from each other.

## CONCLUSION

This study, therefore, entails to conclude that the addition of cardamom helps to control the lipolysis in khoa during storage. Addition of cardamom initially into milk was more effective than pat formation stage for khoa making. Khoa samples prepared using fine particles of cardamom were effective in controlling the FFA during storage. Among the various rate of additions, the 0.3 per cent fine particle of cardamom in milk for khoa making was found best in controlling lipolysis of khoa during storage. Addition of cardamom did not affect the rheological properties of khoa samples and it also fulfilled the legal requirements for quality standards prescribed under FSSAI.

## COMPLIANCE WITH ETHICAL STANDARDS

### Conflict of interest

The authors declared that for this research article, they have no actual, potential or perceived conflict of interest.

### Author contribution

The contribution of the authors to the present study is equal. All the authors read and approved the final manuscript. All the authors verify that the Text, Figures, and Tables are original and that they have not been published before.

### Ethical approval

Ethics committee approval is not required.

### Funding

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### Data availability

Not applicable.

### Consent for publication

Not applicable.

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