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Impact of Bio-preservatives on Sensory Quality of Milk Solids Incorporated *Khoa* Stored at Room Temperature (23±2°C)

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ABSTRACT

The study was conducted to find the effectiveness of bio-preservatives and packaging method on the shelf life of milk solids based *khoa*. *Khoa* samples were prepared individually by combinations of SMP (skimmed milk powder) with *ghee* and whey protein concentrates and SMP with cream (50% fat). The control sample was prepared utilizing full cream buffalo milk (6% fat). Natamycin at 10 ppm and nisin at 100 IU/g were incorporated while *khoa* was still hot (85-90°C). The samples without bio-preservatives were packaged in simple and vacuum packaging separately. The all treatments were evaluated for sensory quality during storage at room temperature (23±2 °C). The study revealed that vacuum packaged and bio-preservatives treated samples were organoleptically acceptable up to 20th day storage.

HIGHLIGHTS

- *Khoa* can be very well prepared using milk solids.
- Bio-preservatives and vacuum packaging increase the shelf life of *khoa*.

Keywords: *Khoa*, milk solids, bioreservatives, room temperature, storage

India has made significant progress in milk production and has emerged as the highest milk producing country in the world. India's annual milk production during 2016-17 was 165.4 million tonnes (DAHDF, Annual Report 2018, India). Approx. 50% of the total milk produced is converted to various traditional dairy products (Prasad *et al*., 2012). Conversion of liquid milk into traditional dairy products increases the longevity of milk solids. Traditional milk products which are converted from milk in order to preserve the milk solids in a concentrated form for extended period play a significant role in the economic, social, religious and nutritional values of the Indian masses from the time immemorial. As per Food Safety and Standards Authority of India (FSSAI, 2011) *khoa* by whatever variety of names it is sold such as *pindi*, *danedar*, *dhap*, *mawa* or *kava* means the product obtained from cow or buffalo or goat or sheep milk or milk solids or a combination thereof by rapid drying. About six lakh tonnes of *khoa* is being manufactured annually, mostly in private and unorganized sectors of India by utilizing about 7% of the total milk produced (Kumar, 2013). *Khoa* is a major intermediate base for a variety of sweets like *burfi, peda, kalakand, gulabjamun* etc. (Soumya *et al*., 2015). The regional and seasonal imbalances in milk production in India call for developing suitable technology for efficient use of surplus milk solids.

Food spoilage refers to the damage of the original nutritional value, texture and flavor of the food that eventually render food harmful to people and unsuitable to eat. Milk based sweets during storage undergo several physical, biochemical and microbiological changes

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making them unfit for human consumption (Londhe *et al*., 2012). Microbes may gain entry into food at any stage of processing right from the farm to till the food is reached to the final consumer like at the time of packaging, transport and storage etc, so it becomes imperative not only to take all kinds of preventive measures but also to evaluate at every stage (Agarwal and Rachappa, 2006).

The deteriorating agents of the food quality are oxygen contained in the air and microorganisms such as bacteria and moulds. Oxygen promotes several types of deteriorative reactions in foods including oxidation of fat, browning and pigment oxidation and is the key element required for the growth of common spoilage bacteria and fungi. Therefore, to increase the shelf life of foods, the package atmosphere should contain a low concentration of residual oxygen (Sandhya, 2010). In order to achieve improved food safety against pathogens, food industry makes use of chemical preservatives. But, these chemicals have many drawbacks, which include their proven toxicity, alteration of the organoleptic and nutritional properties of foods and recent consumer demands for safe and minimally processed products without additives. Thus, to harmonize consumer demands with the necessary safety standards, traditional means of controlling microbial spoilage and safety hazards in foods are being replaced by combinations of innovative technologies that include biological antimicrobial systems such as lactic acid bacteria (LAB) and/or their metabolites (Nath *et al*., 2013). In addition, the absence of proper packaging, the rate of chemical deterioration of *khoa* such as oxidation and browning increase. But, use of antioxidant, antimicrobial agent and packaging increase the shelf- life of *Khoa*.

The concentration of natamycin for yoghurt preservation has been suggested to be in the range of 5-10 ppm (Thomas and Delves, 2001). The use of natamycin as a natural preservative in dairy products and other foods has been approved in over sixty countries (Delves *et al*., 2005). The use of nisin as bio-preservative has been widely investigated in a large variety of fresh and processed foods (Jung *et al*., 1992). It is effective against several pathogenic Gram-positive bacteria such as *Listeria monocytogenes* and *C. botulinum,* but also against some Gram-negative pathogens such as *Escherichia coli* and *Salmonella spp*. Keeping above points in view, this study was carried to develop bio-preservative incorporated milk solid based *khoa* and subjected to vacuum packaging as well and study their effect on organoleptic quality during storage at 23±2 °C.

MATERIALS AND METHODS

Place of Study

The present study was conducted in the Department of Livestock Products Technology, College of Veterinary Sciences, LUVAS, Hisar to develop *khoa* by utilizing milk solids and subsequent impact of packaging methods and bio-preservatives to enhance the shelf-life at room temperature (23±2 °C).

Procurement of raw materials

Ghee, cream (50% fat) and full cream buffalo milk (6% fat) were procured from experimental dairy plant, Department of LPT, LUVAS, Hisar. Skim milk powder (SMP), whey protein concentrates and low density polyethylene (LDPE) pouches were procured from local market.

Bio-preservative

Nisin was procured from Hi Media Laboratories and Natamycin from Sigma-Aldrich.

Preparation of *khoa* using milk solids

Khoa was standardized for fat by Pearson's square method as described by De (2004) to meet legal standard of fat (20% fat on fresh basis and 30% fat on dry basis). *Khoa* samples were prepared separately by combinations of SMP with *ghee* and whey protein concentrates and SMP with cream (50% fat).

For *ghee* based *khoa*; 680 g SMP (13.6%), 300 g *ghee* (6%) and 20 g (0.4%) pre-standardized whey protein concentrates were mixed and hot water (80%) was added to make total weight 5 kg. Similarly, for cream based *khoa*; 500g SMP (10%) + 480 g cream (9.6%) were mixed and hot water (80.4%) added to make total weight 5 kg. Proper mixing and filtration was done followed by preheating at 65°C. Then homogenization (double stage) and desiccation was carried out in gas operated semiautomatic machine. The control *khoa* sample was prepared utilizing full cream buffalo milk (6% fat).

Addition of bio-preservatives

Natamycin at 10 ppm (Rabee and Heba, 2017) and nisin at 100 IU/g (Gupta *et al*., 1989) were added while *khoa* was still hot (about 85-90 °C). Proper mixing was done in machine.

Packaging

Bio preservatives added *khoa* samples were simply packaged in LDPE bag and sealed with sealing machine. The samples without bio-preservative were packaged in two different packaging techniques i.e. simple packaging and vacuum packaging.

Sensory quality evaluation

Analysis of sensory quality of developed *khoa* samples was performed by using the nine point hedonic scale (Nelson and Trout, 1964) (Table 1). A semi trained panel evaluated the sensory attributes viz. color and appearance, flavor, and overall acceptability at regular interval of 5 days at room temperature (23±2 °C).

Table 1: Scores under 9 point hedonic scale

Data under 9-point hedonic scale	Score
Liked extremely	9
Liked very much	8
Liked moderately	7
Liked slightly	6
Neither liked nor disliked	5
Disliked slightly	4
Disliked moderately	3
Disliked very much	2
Disliked extremely	1

Statistical analysis

Data was analyzed statistically on 'SPSS-16.0' (SPSS Inc., Chicago, II USA) software package as per standard methods (Snedecor and Cochran, 1994). The statistical significance was estimated at 5% level ($P \leq 0.05$) and evaluated with Duncan's Multiple Range Test.

RESULTS AND DISCUSSION

Color and appearance

Color and appearance score of *khoa* stored at room temperature ranged from 8.25 to 8.50 (*i.e.* all treatments liked very much) on 0th day, however all values were found statistically similar to each other (Table 2). On every interval of storage there was continuous decrease in the color and appearance scores of all samples.

On 5th day the highest value of color and appearance score was reported in C_2 (8.00) and lowest value in T_5 (7.67). On 10th day of storage color and appearance scores ranged 6.92 to 7.33. There was no significant difference in color and appearance scores of all treatments on particular day till 15th day of storage. But on 20th day, T_5 had score 6.00 which was found significantly ($P \leq 0.05$) lower than that of C_2 (6.75), C_3 (6.83), C_4 (6.75), T_3 (6.67) and T_4 (6.58). However the all treatments were slightly liked till the 20th day of storage at room temperature. Sensory evaluation was not performed on 25th day due to visible spoilage of sample.

There was significant decrease in color and appearance scores of *khoa* with advancement of storage period. This might be due to microbial growth (yeast and moulds), known to be responsible for discoloration and lipolytic defects in *khoa* (Goyal and Srinivasan, 1984). Microbial contamination produces undesirable effects e.g. change in color, odour, taste and texture of the products. Jain *et al*. (2015) and Acharya and Agrawal (2010) also reported decrease in sensory score of *kalakand* and *khoa*, respectively during storage at 25°C. Although, every treatment had sensory score more than 6 (*i.e*. slightly liked) till 20th day of storage. All natamycin treated *khoa* samples had higher color and appearance scores which might be due to lower yeast and mould counts by caused by bio-preservatives.

The *khoa* samples which were packaged under vacuum condition had better color and appearance score than simple packaged sample. This might be because of the reason that vacuum packaging did not allow atmospheric factors to distort the color and appearance of *khoa*. Kumar *et al*. (2010) also noticed the higher color and appearance score in vacuum packaged *khoa* than simple packaged *khoa. Khoa* samples prepared by using milk solids had

Table 2: Color and appearance scores of *khoa* at room temperature (23±2°C) (Mean±S.E., n=12)

Sample	Days				
	0th	5th	10th	15th	20th
C_1	8.42±0.15^{Aa}	7.92±0.19^{Aab}	7.42±0.22^{Abc}	7.17±0.17^{Ac}	6.50±0.19^{ABCd}
C_2	8.50±0.23^{Aa}	8.00±0.18^{Aab}	7.50±0.23^{Abc}	7.25±0.13^{Acd}	6.75±0.22^{ABd}
C_3	8.42±0.19^{Aa}	7.92±0.19^{Aab}	7.58±0.19^{Abc}	7.33±0.19^{Acd}	6.83±0.11^{Ad}
C_4	8.42±0.15^{Aa}	7.83±0.24^{Ab}	7.50±0.20^{Abc}	7.17±0.17^{Acd}	6.75±0.13^{ABd}
T_1	8.33±0.19^{Aa}	7.83±0.17^{Aa}	7.25±0.22^{Ab}	7.08±0.15^{Ab}	6.25±0.18^{ABCc}
T_2	8.42±0.15^{Aa}	7.92±0.15^{Ab}	7.42±0.23^{Ac}	7.17±0.11^{Ac}	6.50±0.20^{ABCd}
T_3	8.33±0.14^{Aa}	7.83±0.21^{Aab}	7.50±0.20^{Abc}	7.17±0.21^{Acd}	6.67±0.19^{ABd}
T_4	8.42±0.15^{Aa}	7.92±0.19^{Aab}	7.67±0.19^{Ab}	7.00±0.28^{Ac}	6.58±0.19^{ABc}
T_5	8.25±0.18^{Aa}	7.67±0.18^{Aa}	7.08±0.23^{Ab}	6.92±0.19^{Ab}	6.00±0.21^{Cc}
T_6	8.33±0.14^{Aa}	7.83±0.17^{Ab}	7.33±0.19^{Ac}	7.00±0.17^{Ac}	6.17±0.17^{BCd}
T_7	8.25±0.18^{Aa}	7.75±0.18^{Aab}	7.42±0.15^{Abc}	7.08±0.19^{Ac}	6.42±0.19^{ABCd}
T_8	8.33±0.23^{Aa}	7.83±0.17^{Ab}	7.42±0.14^{Ab}	6.92±0.19^{Ac}	6.25±0.13^{ABCd}

Mean with capital superscripts within column and small superscripts within the row differ significantly (P≤0.05).

C_1= simple aerobically packaged FCM *khoa*, C_2= vacuum packaged FCM *khoa*, C_3= natamycin treated FCM *khoa*, C_4= nisin treated FCM khoa, T_1= simple aerobically packaged SMP and cream *khoa*, T_2= vacuum packaged SMP and cream *khoa*, T_3= natamycin treated SMP and cream *khoa*, T_4= nisin treated smp and cream *khoa*, T_5= simple aerobically packaged SMP and ghee *khoa*, T_6= vacuum packaged SMP and ghee *khoa*, T_7= natamycin treated SMP and ghee *khoa*, T_8= nisin treated SMP and *ghee khoa*.

slightly lower color and appearance score as compare to buffalo milk based *khoa*. Voghra and Rajoria (1983) also reported lower color score for *khoa* prepared from milk powder than buffalo milk *khoa*.

Body and texture

Sensory panelist awarded body and texture scores more than 8 (i.e. liked very much) to all treatments on 0th day of storage (Table 3). There was no significant difference in body and texture scores on that day. Body and texture scores of all treatment ranged 7.75 to 8.05 on 5th day of storage. On 10th day C_3 (7.67) had highest value while T_5 (7.25) had lowest body and texture scores, this showed moderate acceptance of all samples on that day.

Till 15th day, body and texture scores of all treatment were found statistically similar to each other on every particular day of storage. But on 20th day of storage, body and texture score of T_5 (6.08) was observed significantly (P≤0.05) lower than C_2 (6.75), C_3 (6.83), C_4 (6.75) and T_3 (6.75). All stored sample have body and texture scores more than 6, this indicated that all sample were liked slightly on 20th day. But *khoa* samples were not subjected to sensory evaluation due to visibly spoilage of samples on 25th day storage.

There were significant decreases in color and appearance scores of *khoa* in each treatment with time during storage. This might be due to increase in microbial counts during storage. Microbial contamination produced undesirable effects e.g. change in color, odour, taste and texture of the product (Goyal and Srinivasan, 1984). The results were in agreement with Acharya and Agrawal (2010) and Jain *et al*. (2015), who also reported significant decrease in body and texture score of *khoa* and *kalakand*, respectively during storage at 25°C. However, body and texture of all treatments did not differ significantly on same day of storage. Every treatment had sensory score more than 6 (i.e. slightly liked) till end of 20th day of storage.

All natamycin treated *khoa* samples had higher body and texture scores, which might be owing to lower yeast and mould counts. Those *khoa* samples which were packaged under vacuum condition also had better body and texture score than simple packaged samples, which might be because of the reason that it did not allow atmospheric factors to distort the color and appearance of *khoa*. Kumar *et al*. (2010) also noticed higher body and texture score in

Table 3: Body and texture score of *khoa* at room temperature (23±2°C) (Mean±S.E., n=12)

Sample	Days				
	0th	5th	10th	15th	20th
C_1	8.42±0.15^{Aa}	8.00±0.17^{Aab}	7.42±0.23^{Abc}	7.25±0.17^{Ac}	6.50±0.15^{ABCd}
C_2	8.50±0.23^{Aa}	8.00±0.17^{Aab}	7.58±0.22^{Abc}	7.25±0.13^{Acd}	6.75±0.22^{ABd}
C_3	8.42±0.19^{Aa}	8.08±0.15^{Aab}	7.67±0.18^{Abc}	7.25±0.18^{Abcd}	6.83±0.11^{Acd}
C_4	8.50±0.15^{Aa}	7.83±0.24^{Ab}	7.58±0.19^{Abc}	7.16±0.17^{Acd}	6.75±0.13^{ABd}
T_1	8.42±0.14^{Aa}	7.92±0.15^{Ab}	7.33±0.18^{Ac}	7.17±0.11^{Ac}	6.33±0.14^{ABCd}
T_2	8.33±0.19^{Aa}	7.83±0.17^{Aab}	7.50±0.23^{Abc}	7.17±0.11^{Ac}	6.58±0.19^{ABCd}
T_3	8.42±0.15^{Aab}	7.92±0.19^{Aab}	7.58±0.19^{Abc}	7.17±0.21^{Acd}	6.75±0.18^{ABd}
T_4	8.42±0.15^{Aa}	7.92±0.19^{Aab}	7.50±0.23^{Abc}	7.08±0.23^{Acd}	6.58±0.19^{ABCd}
T_5	8.25±0.18^{Aa}	7.83±0.17^{Aa}	7.25±0.17^{Ab}	7.00±0.17^{Ab}	6.08±0.19^{Cc}
T_6	8.33±0.14^{Aa}	7.75±0.18^{Ab}	7.33±0.19^{Abc}	7.08±0.15^{Ac}	6.25±0.18^{BCd}
T_7	8.25±0.18^{Aa}	7.83±0.17^{Aab}	7.42±0.15^{Abc}	7.08±0.19^{Ac}	6.42±0.19^{ABCd}
T_8	8.33±0.23^{Aa}	7.83±0.17^{Aab}	7.33±0.19^{Abc}	7.00±0.17^{Ac}	6.25±0.13^{BCd}

Mean with capital superscripts within column and small superscripts within the row differ significantly (P≤0.05).

C_1= simple aerobically packaged FCM *khoa*, C_2= vacuum packaged FCM *khoa*, C_3= natamycin treated FCM *khoa*, C_4 = nisin treated FCM *khoa*, T_1= simple aerobically packaged SMP and cream *khoa*, T_2= vacuum packaged SMP and cream *khoa*, T_3= natamycin treated SMP and cream *khoa*, T_4= nisin treated SMP and cream *khoa*, T_5= simple aerobically packaged SMP and *ghee khoa*, T_6= vacuum packaged SMP and *ghee khoa*, T_7= natamycin treated SMP and *ghee khoa*, T_8= nisin treated SMP and *ghee khoa*.

Table 4: Flavor score of *khoa* at room temperature (23±2°C) (Mean±S.E., n=12)

Sample	Days				
	0th	5th	10th	15th	20th
C_1	8.33±0.19^{Aa}	7.83±0.21^{Aab}	7.33±0.26^{Abc}	7.08±0.19^{ABc}	6.33±0.23^{ABCDEd}
C_2	8.42±0.23^{Aa}	7.92±0.19^{Aab}	7.42±0.23^{Abc}	7.25±0.13^{ABc}	6.67±0.19^{ABCd}
C_3	8.42±0.19^{Aa}	7.92±0.19^{Ab}	7.58±0.15^{Abc}	7.33±0.14^{Ac}	6.83±0.11^{Ad}
C_4	8.42±0.15^{Aa}	7.83±0.24^{Ab}	7.50±0.15^{Abc}	7.17±0.17^{ABcd}	6.75±0.13^{ABd}
T_1	8.25±0.18^{Aa}	7.75±0.25^{Aab}	7.25±0.17^{Abc}	6.92±0.15^{ABc}	6.17±0.21^{CDEd}
T_2	8.42±0.15^{Aa}	7.92±0.15^{Ab}	7.33±0.18^{Ac}	7.17±0.11^{ABc}	6.33±0.19^{ABCDEd}
T_3	8.33±0.14^{Aa}	7.83±0.20^{Aab}	7.50±0.19^{Abc}	7.25±0.18^{ABc}	6.67±0.18^{ABCd}
T_4	8.42±0.15^{Aa}	7.75±0.22^{Ab}	7.42±0.15^{Abc}	7.08±0.23^{ABc}	6.50±0.15^{ABCDd}
T_5	8.17±0.24^{Aa}	7.67±0.19^{Aab}	7.17±0.17^{Abc}	6.75±0.18^{Bc}	5.83±0.20^{Ed}
T_6	8.33±0.14^{Aa}	7.83±0.17^{Aa}	7.25±0.22^{Ab}	7.08±0.15^{ABb}	6.00±0.21^{Dec}
T_7	8.25±0.18^{Aa}	7.75±0.18^{Ab}	7.33±0.14^{Abc}	7.17±0.17^{ABc}	6.25±0.13^{BCDEd}
T_8	8.33±0.23^{Aa}	7.67±0.23^{Ab}	7.25±0.13^{Abc}	6.92±0.15^{ABc}	6.17±0.11^{CDEd}

Mean with capital superscripts within column and small superscripts within the row differ significantly (P≤0.05).

C_1 = simple aerobically packaged FCM *khoa*, C_2 = vacuum packaged FCM *khoa*, C_3 = natamycin treated FCM *khoa*, C_4 = nisin treated FCM *khoa*, T_1 = simple aerobically packaged SMP and cream *khoa*, T_2= vacuum packaged SMP and cream *khoa*, T_3= natamycin treated SMP and cream *khoa*, T_4= nisin treated SMP and cream *khoa*, T_5= simple aerobically packaged SMP and *ghee khoa*, T_6 = vacuum packaged SMP and *ghee khoa*, T_7 = natamycin treated SMP and *ghee khoa*, T_8 = nisin treated SMP and *ghee khoa*.

vacuum packaged *khoa* than simple packaged *khoa*. The samples developed by using milk solids had slightly lower body and texture score as compared to full cream buffalo milk *khoa*. Voghra and Rajoria (1983) also reported lower body and texture score for *khoa* prepared from milk powder than buffalo milk *khoa*.

Flavor

There were non-significant differences in flavor scores of all treatment on 0^{th} day of storage and similar trend were observed till the 10^{th} day of storage at room temperature (Table 4). On 5^{th} day of storage flavor scores ranged 7.67 to 7.92, although all value differed non-significantly. Sensory panelist awarded highest flavor score to C_3 (7.58) and scores ranged 7.17 to 7.58 on 10^{th} day of storage.

On 15^{th} day, flavor score of C_3 (7.33) was found significantly ($P \leq 0.05$) higher than T_5 (6.75). Scores for each sample were observed more than 7 except T_1 (6.92), T_5 (6.75) and T_8 (6.92). According to flavor score all *khoa* samples were liked moderately except three samples (T_1, T_5 and T_8) those were liked slightly.

Flavor scores of all treatments ranged 5.83 to 6.83 on 20^{th} day. Flavor scores of C_3 were reported significantly ($P \leq 0.05$) higher than T_1 (6.17), T_5 (5.83), T_6 (6.00), T_7 (6.25) and T_8 (6.17). Hence, depending on flavor score, all samples were liked slightly by sensory panel except T_5 which was neither liked nor disliked. Sensory evaluation was not performed on 25^{th} day due to visible spoilage of sample.

There were significant decreases in flavor scores of *khoa* in each treatment during storage time. That might be due to increase in microbial counts during storage. Microbial contamination produces undesirable effects e.g. change in color, odour, taste and texture of the product (Goyal and Srinivasan, 1984). Jain *et al*. (2015) and Acharya and Agrawal (2010) also reported decrease in flavor scores of kalakand and *khoa*, respectively during storage at 25°C. Every treatment had sensory score more than 6 (*i.e.* slightly liked) at end of 20^{th} day of storage. All natamycin treated *khoa* samples had higher flavor score, which might be due to lower yeast and mould counts.

Those *khoa* samples which were packaged under vacuum condition had better flavor score than simple packaged samples. That might be because of the reason that it did not allow atmospheric factors to distort the flavor of *khoa*. Kumar *et al*. (2010) also noticed the higher color and appearance score in vacuum packaged *khoa* than simple packaged *khoa. Khoa* samples prepared by using milk solids had slightly lower flavor score as compared to buffalo milk *khoa*. Voghra and Rajoria (1983) also reported lower flavor score for *khoa* prepared from milk powder than buffalo milk *khoa*.

Overall acceptability

Sensory panelist awarded highest overall acceptability scores to C_2 (8.50) while lowest to T_7 (8.17) on 0^{th} day of storage (Table 5). Overall acceptability scores of all treatments were found more than 8 (i.e. liked very much). On each particular interval of storage overall acceptability score of all treatments differed non-significantly and that trend remained same till 15^{th} day of storage. However, the overall acceptability scores were decreased continuously during the storage period.

On 5^{th} day the overall acceptability score ranged 7.58 to 8.00. Overall acceptability score of T_5 was found lowest which differed non-significantly to all treatments. Overall acceptability score of all *khoa* samples were found more than 7 (i.e. liked moderately) on 10^{th} day of storage. Sensory panelist awarded the highest score to C_3 (7.67) and lowest to T_5 (7.25). On 15^{th} day the overall acceptability scores of *khoa* samples ranged 6.92 to 7.33. C_3 (7.33) had highest while T_5 (6.92) had lowest score but all value differed non-significantly.

Sensory panelist awarded overall acceptability scores ranged 5.92 to 6.92 on 20^{th} day during storage study. Overall acceptability score of C_3 (6.92) was found significantly ($P \leq 0.05$) higher than C_1 (6.33), T_1 (6.17), T_5 (5.92), T_6 (6.08), T_7 (6.33) and T_8 (6.17). Depending on overall acceptability score, all *khoa* samples were liked slightly except T_5 on 20^{th} day of storage. But on 25^{th} day all samples were found spoiled, so not subjected to sensory evaluation.

There were significant decreases in overall acceptability scores in each treatment during storage period. This might be due to microbial growth responsible for discoloration and lipolytic defects in *khoa* (Goyal and Srinivasan, 1984). Microbial contamination produces undesirable effects e.g. change in color, odour, taste and texture of the product.

Table 5: Overall acceptability score of khoa at room temperature (23±2°C) (Mean±S. E., n=12)

Sample	Days				
	0th	5th	10th	15th	20th
C_1	8.42±0.15^{Aa}	7.92±0.19^{Aab}	7.42±0.22^{Abc}	7.17±0.17^{Ac}	6.33±0.14^{BCDEd}
C_2	8.50±0.23^{Aa}	8.00±0.17^{Aab}	7.50±0.23^{Abc}	7.25±0.13^{Ac}	6.67±0.19^{ABCd}
C_3	8.42±0.19^{Aa}	8.08±0.19^{Aab}	7.67±0.19^{Abc}	7.33±0.18^{Acd}	6.92±0.08^{Ad}
C_4	8.42±0.15^{Aa}	7.83±0.24^{Ab}	7.58±0.19^{Abc}	7.25±0.13^{Ac}	6.75±0.13^{ABd}
T_1	8.33±0.19^{Aa}	7.83±0.17^{Aab}	7.33±0.18^{Abc}	7.08±0.15^{Ac}	6.17±0.21^{CDEd}
T_2	8.33±0.14^{Aa}	7.92±0.08^{Aa}	7.42±0.23^{Ab}	7.17±0.11^{Ab}	6.42±0.15^{ABCDEc}
T_3	8.25±0.18^{Aa}	8.00±0.21^{Aab}	7.50±0.20^{Abc}	7.25±0.22^{Acd}	6.75±0.18^{ABd}
T_4	8.33±0.19^{Aa}	7.92±0.19^{Aab}	7.42±0.15^{Abc}	7.17±0.21^{Ac}	6.58±0.19^{ABCDd}
T_5	8.25±0.18^{Aa}	7.58±0.23^{Ab}	7.25±0.17^{Abc}	6.92±0.17^{Ac}	5.92±0.15^{Ed}
T_6	8.25±0.18^{Aa}	7.67±0.14^{Ab}	7.33±0.17^{Abc}	7.00±0.12^{Ac}	6.08±0.19^{DEd}
T_7	8.17±0.17^{Aa}	7.83±0.17^{Aab}	7.42±0.15^{Abc}	7.08±0.19^{Ac}	6.33±0.14^{BCDEd}
T_8	8.25±0.22^{Aa}	7.75±0.18^{Ab}	7.33±0.14^{Abc}	7.00±0.17^{Ac}	6.17±0.11^{CDEd}

Mean with capital superscripts within column and small superscripts within the row differ significantly (P≤0.05).

C_1 = simple aerobically packaged FCM *khoa*, C_2 = vacuum packaged FCM *khoa*, C_3 = natamycin treated FCM *khoa*, C_4= nisin treated FCM *khoa*, T_1= simple aerobically packaged SMP and cream *khoa*, T_2 = vacuum packaged SMP and cream *khoa*, T_3 = natamycin treated SMP and cream *khoa*, T_4 = nisin treated SMP and cream *khoa*, T_5= simple aerobically packaged SMP and *ghee khoa*, T_6 = vacuum packaged SMP and *ghee khoa*, T_7 = natamycin treated SMP and *ghee khoa*, T_8 = nisin treated SMP and *ghee khoa*.

Jain *et al*. (2015) and Acharya and Agrawal (2010) also reported decrease in sensory score of *kalakand* and *khoa*, respectively during storage at 25°C. However, overall acceptability of all treatments did not differ significantly on same day of storage. Every treatment had sensory score more than 6 (i.e. slightly liked) at end of 20th day of storage.

All natamycin and nisin treated samples had higher overall acceptability scores, which might be due to lower yeast and mould counts. Those *khoa* samples which were packaged under vacuum conditions had better overall acceptability score than simple packaged sample. This may be because of the reason that it did not allow atmospheric factors to distort the sensory properties of *khoa*. Kumar *et al*. (2010) and Sharma *et al*. (2001) also revealed higher overall acceptability score in vacuum packaged *khoa* than simple packaged *khoa*. The samples developed by using milk solids had slightly lower overall acceptability scores as compared to full cream buffalo milk based *khoa*. Voghra and Rajoria (1983) also reported lower color score for *khoa* prepared from milk powder than buffalo milk *khoa*.

CONCLUSION

The present study revealed that the milk solids (SMP, cream and *ghee*) could be very well used to prepared *khoa* which was comparable to from full cream buffalo milk based *khoa* and also met the legal standards. Natamycin at the levels of 10 ppm and nisin at 100 IU/g were found equally effective in extending shelf-life of *khoa*. In addition, vacuum packaging also significantly maintained sensory quality. Bio-preservative treated and vacuum packaged *khoa* samples were organoletically acceptable up to 20 days at room temperature (23±2 °C).

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