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RESEARCH ARTICLE

Process optimization for the manufacturing of flax seed powder enriched *Kalakand*

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Abstract: *Kalakand* is made traditionally, with no concern for the quality of the raw materials as well as no functional properties. This product is consumed by a large sector of population, hence enriching it with flaxseed could impart many functional properties. Flaxseed is well-known for its nutritional benefits. It is recognized for its high quantities of alpha-linolenic acid, lignan, a phytoestrogen molecule, and soluble as well as insoluble fibre. Jaggery includes 60-85% sucrose, 5- 15% glucose and fructose, 0.4 % protein, 0.1 g fat, 0.6 to 1.0 g minerals (8 mg calcium, 4 mg phosphorus, and 11.4 mg iron), traces of vitamins and amino acids, and around 383 Kcal of energy per 100 g of jaggery. Flax seed is a functional food and generally help in treatment of numerous diseases. In terms of sensory qualities compared to the other treatments, T1 (with 1% flaxseed powder) was observed to have the required quality. The results show that enriched *Kalakand* was analyzed to have decreased moisture, carbohydrate, and pH while increased content of protein, fat, ash, total solids, acidity, and antioxidant activity as compared to the control. The heart and circulatory systems benefit from flaxseed in all forms. The another important component was jaggery, which is not only a natural sweetener but has been shown to reduce the risk of heart disease, cancer, control blood pressure, liver detoxification, cataracts, and many inflammatory changes, also.

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Introduction

Milk and milk products have long been recognised as important sources of key nutrients in the human diet. Milk products are very suitable vehicle for delivery of bioactive ingredients (Kaur et al. 2018). *Kalakand* is an important indigenous milk product that is appealing to all consumer classes. One of the native milk products, *Kalakand*, is made by heating milk, adding sugar, and finally using the right coagulant. Even though both types of milk had the same nutritional value, it was observed that *Kalakand* made from buffalo milk was more popular than *Kalakand* made from cow milk and acidic milk. Due to its higher fat content, buffalo milk is preferred to cow milk when making *Kalakand*, which is traditionally made with danedar *Khoa*. Furthermore, since citric acid and sugar have such a big impact on the product's texture and flavor, it is crucial to add the right amount to the mixture (David, 2015). Danedar *Khoa* is used in the preparation of *Kalakand* and *gourd burfi*, where granulation is highly valued (Keerthi et al. 2018). *Kalakand*, a whole milk concentrate, contains a good amount of lactose, minerals, fat, and energy-giving proteins. On a per-unit weight and calorific value basis, it is 4-6 times more nutrient-denser than milk (Arora & Chandra, 2015). One of the most well- known sweets made from *Khoa* is called *Kalakand*; it is made from *Khoa* and sugar and has a flavour that is mildly caramelised and pleasant. The sensory qualities, nutritive values, and physico-chemical properties of *Kalakand* are impacted by the addition of flaxseed (Marpalle et al. 2014).

Flaxseed (*Linum usitatissimum*), also known as linseed, is frequently referred to as *Alsi, Jawas,* or *Aksebija* in India (Anonymous, 2000) and is one of the most important oilseed crops for industrial applications (Singh et al. 2011; Chishty and Bissu, 2016). Flaxseed is an excellent source of fat (40 % of the content), fibre (28 % of the content), and proteins (10–30 % of the content) (Singh et al. 2011; Shim et al. 2014; Tripathi et al. 2013; Bartkowski, 2013; Soni et al. 2016). The addition of flaxseed components to food products has been shown to provide numerous health benefits (Kristina et al. 2018; Ambuja and Rajkumar, 2018). The high concentration of bioactive ingredients

found in α-linolenic acid (ALA), lignans, phenolic compounds, and soluble fibre makes flaxseed a functional food (Gutte et al. 2015; Mishra and Verma, 2013; Tavarini et al. 2019). Previous research has shown that flaxseed has the potential to prevent a variety of illnesses, including colon and breast cancer, rheumatoid arthritis, obesity, cardiovascular disease (CVD), and osteoporosis. It can also strengthen the immune system (Bartkowski, 2013; Soni et al. 2016; Ambuja and Rajkumar, 2018; Campos et al. 2019). An anti-cancer phytoestrogen called lignans aids in reducing cell division (Singh et al. 2011; Chishty and Bissu, 2016; Mishra and Verma, 2013). In addition it has been proved to have anti-inflammatory, anticoagulant, and antiarrhythmic properties, ALA helps reduce blood lipid levels and promote infant brain development (Kajla et al. 2015; Gutte et al. 2015). Flaxseed currently has new opportunities as a functional food due to consumers' growing interest in foods that have outstanding health benefits. It has gained popularity as a desirable ingredient in diets created specifically for potential health benefits owing to its excellent nutritional profile (Oomah, 2001). Flaxseeds have been incorporated several dairy products in differential forms (Kaur et al. 2018). Microencapsulated flaxseed oil was used to be prepare *dahi* by Goyal et al. 2016. Ice cream was fortified by flaxseed oil by Goh et al. 2006 and the properties of oil were intact after freezing too. Milk, whey and butter have also been supplemented by flaxseed extracts or additives successfully at Industrial processing conditions (Hyvarinen et al. 006, Ivanov et al. 2011). Therefore, the present study has been undertaken to manufacturing of flax seed powder enriched *Kalakand* and to identify the most appropriate inclusion rate for flaxseed for an organoleptically acceptable product.

Materials and Methods

Materials

The whole fresh clean buffalo milk required for this investigation was collected from the Dairy farm under the Department of Dairy Science and Food Technology, Institute of Agriculture Science, Banaras Hindu University Varanasi and standardized to 6% fat and 9% SNF. Superior quality of flaxseeds and jaggery were procured from the local market of Varanasi. For the manufacture of *Kalakand*, Anhydrous Citric acid (SRL) was utilised as a coagulant was provided from the Department of Dairy Science and Food Technology, Institute of Agriculture Science, Banaras Hindu University Varanasi. A control sample was also prepared using sugar purchased locally.

Preparation of flaxseed powder

Flax seeds powder was prepared by manually cleaning dust and other extraneous particles. The cleaned flax seeds were processed in a dry mixer (Make: Philips) to make powder. Flax seed powder enriched *Kalakand* was made using this powder made from flax seed.

Treatment combination

For preparation of enriched *Kalakand* by using flaxseed powder, the treatment combinations were finalized on weight basis such as, the control (T0) was having 100 % Milk, T1 was having 1% flax seed, T2 was standardized to contain 2 % flax seed. T3 was having 3% flax seed while the amount of jagerry was kept constant in all the 3 treatments (6% jaggery along with milk).

Preparation of flax seed powder enriched *Kalakand*

The flax seed powder enriched *Kalakand* was prepared as per the method suggested by Aneja et al. (2002) and was followed with slight modification. A clean, dry iron karahi was filled with one litre of Buffalo milk that had been precisely measured. For direct heating, it was placed over a brisk, smoke-free fire on a pressure stove. Khunti was used to stir the milk continuously in a circular motion. After 10 to 15 minutes of boiling, 0.02 % solution of citric acid was slowly poured, which caused the milk to partially coagulate. To produce a product of high quality at this stage, vigorous stirring was necessary. To stop the charring of milk solids, solid material stuck to the pan's side had to be scraped off frequently with the sharp edge of the khunti. The Karahi's contents were heated and stirred continuously until it reached a semi-solid consistency of danedar *Khoa*. At this point, 6% of jaggery was added, thoroughly mixed, and then the addition of flax seed powder (@ 1, 2, and 3%). For four to five minutes, the Karahi's contents were heated on low heat while being constantly stirred. After that, the finished product was taken out and placed in a greased aluminum tray and then it was left to cool at room temperature. Once the finished product had cooled, it was weighed and stored in a refrigerator (Figure 1).

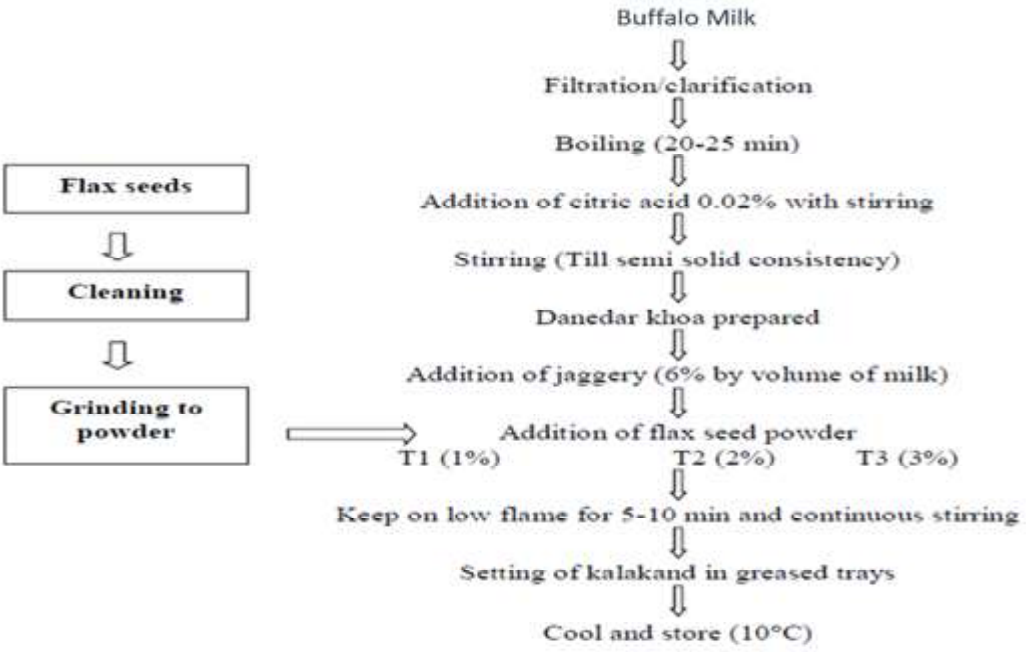
Optimization of flax seeds powder levels in *Kalakand*

Flax seeds powder levels were optimised by the sensory evaluation of *Kalakand* based on a panel of seven judges' approval on a 9-point hedonic scale score card. According to the sensory parameters, it was found that *Kalakand* with 1.0%, 2.0% and 3.0% of flaxseeds powder on 6% jaggery equivalence milk basis was acceptable. Sensory, physico-chemical, textural and microbiological analyses were examined for each of these three treatment combinations. Based on the product's sensory quality, the optimum product combination was chosen.

Physico-chemical analysis

The moisture content of *Kalakand* was determined using the gravimetric method outlined in the IS Handbook (SP: 18 (part XI) 1981). *Kalakand* fat content was calculated using the Soxhlet technique as described by AOAC (1995). The total protein content of *Kalakand* samples was determined by Micro Kjeldahl method as described by IS Handbook (SP: 18 (part XI) 1981). The ash content was determined as per AOAC, (2005). The total solid content of *Kalakand* was assessed using the IS Handbook (1479

Fig. 1 Flow diagram for Preparation of Flax seed powder enriched *Kalakand*



(Part-II) 1961) recommended method. The total carbohydrates content was calculated by subtracting the sum of the total major constituents such as moisture, protein, fat, and ash from 100. The titratable acidity of *Kalakand* was determined using the procedure outlined in the IS Handbook (SP: 18 (part XI) 1981). Kalakand sample was grated properly in pastle and mortar after which it was diluted using distilled water and the pH of *Kalakand* was determined at 25 p C using a digital pH meter (Elico digital pH meter).

Antioxidant activity

The Antioxidant activity was determined by DPPH method described in Ranganna (1986). The DPPH radical scavenging method is commonly used to assess the potential of natural antioxidants to scavenge free radicals. The determining factor for the reduction was the decrease in absorbance at 517 nm. The scavenging activity was determined as a portion of the scavenging impact using the formula:

$$\% \text{ RS Activity} = \frac{Ab - As}{Ab}$$

Where,

RS = Radical scavenging activity or % inhibition of DPPH

Ab = Absorbance of blank.

As = Absorbance of sample.

Texture profile analysis (TPA)

A texture profile analyser (Brookfield TA. XT Plus, UK) was used to assess the hardness, cohesiveness, adhesiveness, springiness, gumminess, and chewiness of *Kalakand*. The textural parameters were calculated using the force-time curve acquired for each sample, with the probe force on the Y-axis and time on the X-axis. The sample was compressed by the plunger twice (like two bites) and the force exerted back by the sample on the plunger was sensed by the machine, yielding a two-peak force – time curve. The following were the Texture Analyzer conditions for measuring textural properties: Pre-Test Speed: 1 mm/s; Post-Test Speed: 5 mm/s; Test Speed: 5 mm/s; Trigger Force: 10 g; Time: 5 sec. Each evaluation used a sample weighing between 100 and 150 g for texture examination. The temperature of the materials was kept at 25°C for the textural examination.

Microbial analysis

Control and flaxseed powder enriched *Kalakand* samples were kept in refrigerator (10°C) and samples were tested at 0, 2, 4, 6 and 8 days of storage for the following analytical parameters: microbiological examination including standard plate count, coliform count, and yeast and mould counts by IS: (SP-18, Part XI) (1981). For standard plate count using Plate Count Agar; incubation of the plates was done at 37 °C for 24-48 hours. For coliform count using Violet Red Bile Agar; incubation of the plates was done at 37 °C for 24 hours. For yeast and mould count using Potato Dextrose Agar (PDA); incubation of the plates was done at 30 °C for 48-72 hours.

Sensory analysis

The samples of *Kalakand* were judged by a sensory panel composed of seven semi- trained panelists selected from the staff and students of the Dairy Science and Food Technology, Institute of Agricultural Sciences, BHU, Varanasi. The product was presented to the panelists at 30°C (room temperature) in portions of 40–50 g. The samples were assessed using a nine-point hedonic scale (range from 9—like highly to 1—dislike exceedingly) for a number of characteristics, including colour and appearance, flavour, body and texture, taste and overall acceptability.

Statistical Analysis

The results of preliminary studies were expressed as mean. Statistical significance was tested by employing analysis of variance (ANOVA). For computation of data, software application programmes like Microsoft Excel and OPSTAT were used.

Results and Discussion

Kalakand was made using the flaxseeds powder at the rate of 1, 2 and 3%. Flaxseed powder enriched *Kalakand* was examined for physico-chemical analysis, antioxidant activity, textural profile analysis (TPA), microbial analysis and sensory analysis.

Optimization of flaxseeds powder in *Kalakand*

According to the sensory evaluation, flaxseeds powder significantly lowers sensory scores ($p \leq 0.05$) than the control when employed at levels of 1, 2 and 3 % in *Kalakand*. Flaxseeds powder in *Kalakand* with a concentration of 1 % scored better overall in terms of perceived taste and resemblance the control. Sensory evaluation includes the analysis such as colour and appearance, body and texture, flavor, taste and overall acceptability. On the basis of sensory evaluation treatment T1 with 1.0 % flaxseed powder was finalized as the optimized product. In a study, it was found that addition of flaxseed powder in yogurt decreased the sensory parameters as compared to control (Mousavi et al. 2019).

Physico-chemical analysis

The data obtained for physico-chemical analysis of *Kalakand* are displayed in Table 1. The moisture content of experimental *Kalakand* samples decreased significantly ($p \leq 0.05$) when the level of flax seed powder was increased. The control T0 sample had significantly ($p \leq 0.05$) higher moisture content among all the *Kalakand* samples. T1 showed the highest moisture level among all the treatments but was lower than that of the control sample. This resulted from the inclusion of flaxseed powder, which contained less moisture. T3 showed the lowest moisture level. The fat content of experimental *Kalakand* samples increased significantly ($p \leq 0.05$) when the level of flax seed powder increased. T3, *Kalakand* made from 3 % flax seed powder, had a maximum fat content. This is due to the addition of flaxseed powder as it is an excellent fatty acid source; with high polyunsaturated fatty acids (PUFA) levels (73 %) especially Omega 3 fatty acids. T0 had the least amount of fat content as it does not contain flaxseed powder. The protein content of the *Kalakand* samples significantly increased in the following order: T0 < T1 < T2 < T3. T0 (control) had the lowest protein level. Treatment T3 had the highest protein level compared to the rest of the treatments. The carbohydrate level of *Kalakand* differed significantly ($p \leq 0.05$) and decreased in the order T0 > T1 >T2 > T3. The maximum total carbohydrate content in *Kalakand* was found in T0 with the addition of 100 % buffalo milk *Khoa* and the lowest total carbohydrate content was found in T3 with the addition of flax seed powder. The significant decrease in carbohydrate content with increasing flaxseed powder could be

Table 1: Physico-chemical analysis of *Kalakand*

Parameter	T0	T1	T2	T3
Moisture	24.1 ± 0.70**	23.16 ± 0.65**	21.90 ± 0.62*	21.70 ± 0.59*
Fat	20.77 ± 0.64*	21.46 ± 0.15*	21.87 ± 0.59*	22.63 ± 0.45**
Protein	16.69 ± 0.52*	16.75 ± 0.47*	17.68 ± 0.36**	17.97 ± 0.64**
Carbohydrate	39.02 ± 0.57**	37.85 ± 0.70*	37.45 ± 0.48*	37.14 ± 0.84*
Ash	3.23 ± 0.13*	3.61 ± 0.15**	3.88 ± 0.13**	3.95 ± 0.07**
Total solid	75.90 ± 0.7*	76.83 ± 0.65*	78.01 ± 0.62**	78.29 ± 0.57**
pH	6.39 ± 0.05**	6.20 ± 0.10**	5.90 ± 0.14*	5.730 ± 0.09*
Acidity	0.346 ± 0.03*	0.45 ± 0.04*	0.51 ± 0.02**	0.53 ± 0.02**
Antioxidant	10.12 ± 0.98^{NS}	23.85 ± 0.88^{NS}	31.86 ± 0.39*	43.49 ± 0.37**

**=0.001, *=0.05 Level of significance NS= Non-Significance, S.D. = Standard Deviation, Values are means of triplicate ± S.D.
T0- Control Sample; T1- 1.0% Flaxseed powder; T2- 2.0% Flaxseed powder; T3- 3.0% Flaxseed powder

attributed to the *Kalakand*'s slightly higher fat, protein and ash content. Masoodi and Bashir, 2012 also reported that there was a decrease in carbohydrate content on addition of flaxseed flour. The ash content of the *Kalakand* samples differ significantly ($p \leq 0.05$) and increased in the following order: T0 < T1 < T2 < T3. The treatment T0 having the lowest ash content while T3 having the highest ash content. With increasing ash content in *Kalakand*, the incorporation of flax seed powder in different treatments increased. This could be because flax seed powder has more ash content than buffalo milk *Khoa* and jaggery is also a source of iron. The ash, protein, fat and crude fiber increased in cookies on addition of flaxseed flour (Kaur et al. 2018). The total solid content of enriched *Kalakand* significantly differ in the increasing order such as T3 > T2 > T1 > T0. The highest total solid content in *Kalakand* was found in T3 with a combination of buffalo milk *Khoa* and 3% flax seed powder, whereas the lowest total solid content was found in T0 without flax seed powder (control). The variance in total solid content among the enriched *Kalakand* samples is closely related to their moisture content. The pH content of *Kalakand* was dramatically altered by the addition of flax seed powder. It was discovered that adding flax seed powder to *Kalakand* significantly lowers the pH level in the order of T0 > T1 > T2 > T3. The pH of T0, a *Kalakand* made from 100% buffalo milk *Khoa* without the addition of flax seed powder (control) was higher than that of T3, a *Kalakand* made from 100% buffalo milk *Khoa* with the addition of 3 % flax seed powder which had the lowest pH content. The acidity content of *Kalakand* was dramatically altered by the addition of flax seed powder. The acidity content of *Kalakand* was shown to increase as the amount of flax seed powder was increased in the order of T3 > T2 > T1 > T0. T0 (control) has the lowest acidity content and T3 has a higher acidity level. This could be because flax seed powder has a higher acidity level than buffalo milk *Khoa Kalakand*. A study says that using 0.25% flax seed powder enhances physicochemical, rheological as well as sensorial attributes of formulated yogurt (Kalyas & Urkek, 2022).

Antioxidant activity

The antioxidant status of the *Kalakand* samples increased significantly ($p \leq 0.05$) in the order T0 < T1 < T2 < T3, respectively. Samples T3 and T0 (control) had maximum and minimum anti-oxidant content, respectively. T1 had the least amount of anti-oxidant in treated samples. This could be due to the fact that T3 had more flax seed powder, which improved anti- oxidant activity. The main source of antioxidants in flax seeds is p-coumaric acid, a polyphenol. Ferulic acid, another antioxidant found in flaxseed, may help prevent a number of chronic diseases. Lignans, which are found in almost all plants and function as both antioxidants and phytoestrogens, are also present in flax seeds. When compared to other foods, flax seeds have up to 800 times as much lignan. This could be the cause of the increased anti-oxidant activity observed when flaxseed concentration rises relative to control. A similar finding was seen in a flax seed fortified yogurts that states that the fortified yogurts had a higher antioxidant activity compared to the controls (Marand et al. 2020). Antioxidant activity increases due to high phytochemical content of flaxseeds (Kaur et al. 2018). Phytochemical properties include both antioxidant and total phenol content which increases significantly on addition of flaxseed in any forms (Kaur and Das, 2014, Rao et al. 2013).

Textural profile analysis (TPA)

Kalakand texture is a significant feature that influences consumer acceptance. Using the texture expert exceed software (v 2.55) provided by the manufacture along with the instrument, different textural qualities like as hardness, cohesiveness, adhesiveness, springiness, gumminess and chewiness were estimated for T0, T1, T2, T3, from the resulting force time curves. The texture profile analysis (TPA) of enriched *Kalakand* as well as control is illustrated in Figure 2. The most often used criterion for determining the texture of *Kalakand* is its hardness. It was observed that, when compared to other samples, sample T3 had the highest hardness which could easily be correlated to the lowest moisture and high total solid content of this sample. This indicates that adding flax seed powder to *Kalakand* boosts its hardness (Mousavi et al. 2018). *Kalakand*'s hardness is determined by several elements, including moisture content and mineral content. The ratio of the area under the second bite curve before reversal compression to the area under the first bite curve is known as cohesiveness. In terms of cohesiveness, the T3 *Kalakand* sample outperformed the other *Kalakand* samples, with the highest cohesion. The reason in support could be that the flaxseed shows influence on internal bonds like it did in case of yogurt structure, thus resulting in increased cohesiveness (Bhat et al. 2018). Adhesiveness is measured as a negative peak following the first peak and is connected to sensory stickiness. Sample T0 has the least amount of adhesion (control sample). The degree of springiness is determined by elements such as heat treatment and hardness. The results were obtained in terms of the springiness of association with an increase in flax seed powder content. However, in general the springiness of T3 samples was higher than T0 based on *Kalakand* sample. The addition of flaxseed to yoghurt enhances its textural integrity, which is why the increasing trend in springiness observed in the *Kalakand* containing flaxseed in comparison to the control sample (Mudgil et al. 2017). Gumminess is determined by multiplying the two fundamental characteristics of hardness and cohesion. The highest gumminess was found in the T3 sample, while the lowest values were found in the sample T0 (control). One of the most essential textural features of *Kalakand* is chewiness. The chewiness of *Kalakand* was greatly improved by adding flax seed powder. T1 had the least chewiness of all the samples, whereas T3 had the most. A study in which fortification was studied states that the addition of flax seed powder influences the textural attributes of the formulated product (Reeta et al. 2018). Similar results of texture analysis i.e. increase in

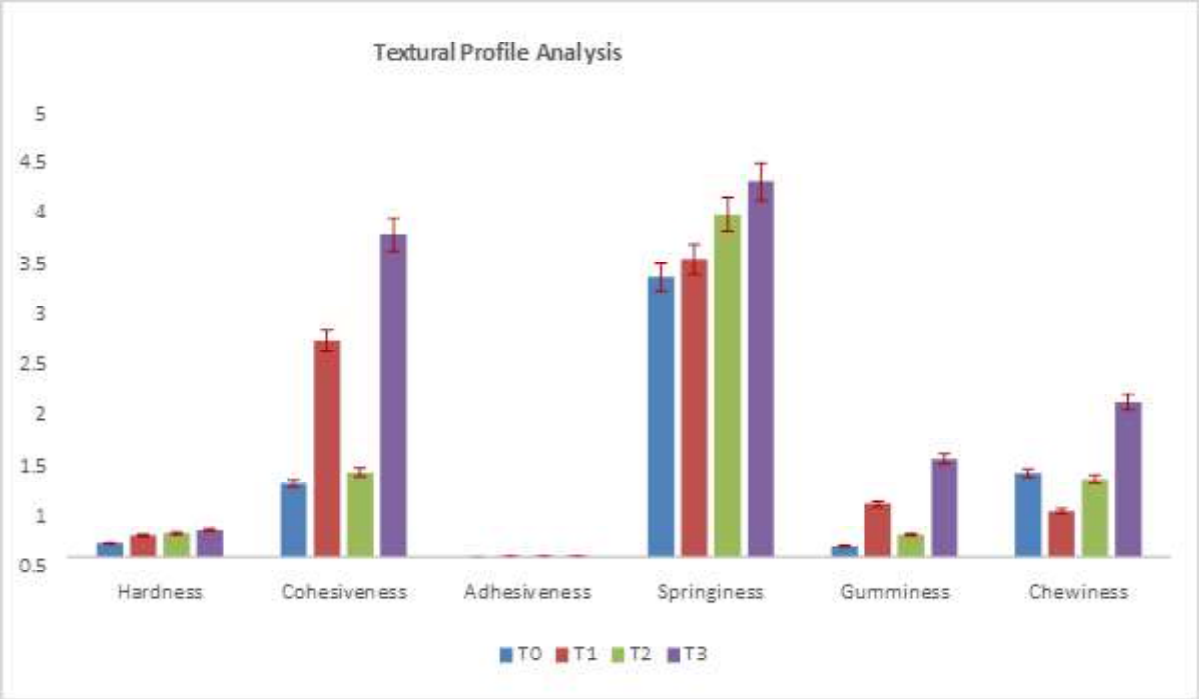


Fig. 2 Texture profile analysis of *Kalakand* Values are mean of 3 Samples ±S.D.

Table 2: Microbial analysis of *Kalakand*

Parameters (cfu $\times 10^3$ / gm)	Treatments			
	T0	T1	T2	T3
SPC	11.00±0.68**	4.33±0.57*	6.33±0.87*	8.33±0.45*
Yeast & Mould	6.66±0.57**	2.33±0.65*	3.66±0.73*	4.33±0.84*
Coliform	ND	ND	ND	ND

**=0.001, *=0.05 Level of Significance NS= Non-Significance, S.D. = Standard Deviation, ND = Not Detectable
The values shown are the average of 8 days of storage± S.D.

Table 3: Sensory analysis of *Kalakand*

Treatments	T0	T1	T2	T3
Colour and Appearance	8.4±0.50**	7.5±0.64**	6.7±0.71*	5.7±0.92*
Body and texture	8.2±0.63**	7.4±0.67**	6.5±0.56*	4.9±1.30*
Flavour	8.5±0.45**	7.5±0.58*	6.6±0.87*	5.3±0.64NS
Taste	8.3±0.48**	7.6±0.46*	6.5±0.85*	5.2±0.89NS
Overall Acceptability	8.3±0.11**	7.5±0.03*	6.5±0.04*	5.2±0.28NS

**=0.001, *=0.05 level of significance NS= Non-significance, S.D. = Standard Deviation The values mean of 7 replicates ± S.D.

hardness have been reported by various ither researchers (Kaur et al. 2018).

Microbial analysis

Due to the entire dependence of product shelf life on the growth of microorganisms in the product during storage, the microbiological quality of dairy products like *Kalakand* becomes more substantial. As a result, microbiological analysis of the flaxseed blended *Kalakand* samples as well as untreated *Kalakand* (control *Kalakand*) was performed. Table 2 displays the microbial analyses of the enriched *Kalakand* and the control sample According to Table 2, both the control and the enriched *Kalakand* had higher total plate counts, yeast and mould counts, and coliform counts at storage days, although these numbers remained within the acceptable range until the 8th day of storage and this finding is in accordance to the results concluded by Jain et al. (2015). In samples T0 (control) and T1, the highest and lowest standard plate count (SPC) count mean values were 11.00 x 10^3 CFU and 4.33 x 10^3 CFU, respectively. The proportion of untreated samples in T1 was the lowest. This could be because the amount of flaxseed powder in T3 enhanced the number of

SPC in the treated samples. Yeast and Mould count were 6.66 and 2.33 x 10^2 CFU per g, individually in samples T0 and T1 (control). T1 revealed that treated samples had the lowest yeast and mold count. This could be because T3 contained more flaxseed powder, which increased the Yeast and Mould count. The Coliform test for both the control and experimental samples was 100% negative. It reveals that there were no gram-negative bacteria, indicating that high hygienic standards were followed during the preparation.

Balasova et al. 2018 studied the influence of flaxseed oil and meal on the activity and growth of yogurt culture. The researchers concluded that oil did not influence the growth of *Lactobacillus acidophilus* while the activity of *Streptococcus acidophilus* was affected as clear from lack of acidification. Whereas the addition of meals stimulated the growth of both microorganisms.

Sensory analysis

Table 3 displays the sensory analysis of the enriched *Kalakand* and control. The sensory scores for colour and appearance, body and texture, flavor, taste and overall acceptability of the *Kalakand* samples decreased in the following order: T0 > T1 > T2 > T3. The treatment T0 (control) received the highest rating for colour and appearance, body and texture, flavor, taste and overall acceptability. The treatment T3 received the lowest rating for colour and appearance, body and texture, flavor, taste and overall acceptability. Among the treated samples, T1 received the highest rating for colour and appearance, body and texture, flavor, taste and overall acceptability. The judging panel determined that Treatments T1, T2, and T3 were all suitable in terms of colour and appearance, body and texture, flavor, taste and overall acceptability of the product. The score for colour and appearance, body and texture, flavor, taste and overall acceptability decreases as the addition of flaxseed increased. A study had shown that the yogurt fortified with flaxseed powder was found to be acceptable in terms of organoleptic properties (Marand et al. 2020). Various studies are in line with current finding that although sensory scores decrease due to flaxseed fortification but the product is acceptable overall (Ramacharitar et al.2005, Rangrez et al.2014, Masoodi and Bashir, 2012, Bashir et al. 2012). The reason may be that the flaxseed impart a slightly nutty flavor to the product which increases its acceptability to certain extent (Ivanov et al. 2011).

Conclusion

Flaxseed powder can be successfully used to make *Kalakand*, according to the results of this study. T1 with 1 % flaxseed powder was determined to be the desirable in terms of sensory qualities among the other treatments. According to the results, addition of flaxseed powder in *Kalakand* reduced moisture, carbohydrate and pH while increasing protein, fat, ash, total solids, acidity and antioxidant activity in the treated product as compared to the control. In treatment, *Kalakand* prepared with flaxseed powder T1 had the best organoleptic qualities and scored the highest score (colour & appearance, body & texture, flavour & taste, overall acceptability). Flaxseed in any form is beneficial to heart and circulatory health. The addition of flax seed powder in *Kalakand* is generally an increase in omega-3 fatty acid content of products and made the omega-3 fatty acid enriched product because flax seed is a great source of omega-3 fatty acid. Jaggery was the key ingredient, a natural sweetener that has been demonstrated to lower the risk of heart illness, cancer, control blood pressure, detoxification of liver, cataracts and several inflammatory changes.

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