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Studies on characteristics of flaxseed powder supplemented Kulfi

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Abstract
The present investigation involved development of flaxseed powder supplemented kulfi by partial addition of different levels of flaxseed powder. Control of kulfi sample contained 12% milk fat, 14% sugar and 44% total solid. During the preparation of kulfi, flaxseed powder @5%, 10%,15% and 20% was added.Control sample had no flaxseed powder. The treatments were evaluated for various Oraganoleptic characteristic, physico – chemical parameters after sensory evaluation kulfi mix having 5% falxseed powder was found to have highest score for flavour and taste of 8.50, colour and appearance score 8.00, body and texture score of 8.00, melting resistance score 8.04 and overall acceptability score 8.00. The physico-chemical analysis results shows that kulfi prepared with 5% flaxseed powder had maximum total solid 42.4%, fat 15.55%, protein 7.72%, carbohydrate 25.33%, ash 0.97%, antioxidant properties 36.52% of flaxseed powder supplemented kulfi respectively.

Keywords: Kulfi, flaxseed powder, organaleptic evalution, composational analysis

Introduction
Kulfi is an indigenous frozen dairy product and also known as Malai kulfi/Malai-ka-baraf, which closely resembles ice cream in composition. In recent years, the consumption of ice cream in India has increased considerably in big cities as well as towns. After a long time it was realized that there is a need to develop the indigenous dairy product, as they have ready market in India (Aneja *et al.,* 2002) [2]. Traditionally Kulfi is prepared by evaporating of sweetened and flavoured milk by slow heating with continuous stirring to keep milk from sticking to the bottom of the vessel until reduced the volume by a half thus concentrating the milk. Kulfi has a distinctive taste due to caramelization of sugar and lactose during the lengthy heating process. The semi-condensed mix is then frozen in tightly sealed by molds and then submerged in ice mixed with salt to speed up the freezing process. The ice/salt mix, along with its submerged kulfi molds, is further placed in earthen pots or matkas that provide insulation from the external heat and slow down the melting of ice. Kulfi prepared in this manner is called the Matka Kulfi. Kulfi also prepared by slow freezing, it renders a unique smooth mouth feel that is devoid of water crystallization. The western country, ice cream is whipped with air or overrun, kulfi contains no air, it is solid dense frozen milk. Kulfi comes in various flavours including cream, mango, rose, cardamom, saffron, pistachio, the more traditional flavours as well as newer variations like apple, orange, peanut, strawberry and avocado. Bhagwan (2011) [6] reported that preparation of burfi blended with kesar mango pulp. Now in markets many types of kulfi is available like rose kulfi, honey and almond kulfi, saffron kulfi, chocolate kulfi etc. Different researchers utilize pulp of mango, apple, guava, banana, papaya, sapota in milk products such as- shrikhand, whey beverage etc. (Bardale *et al*. 1986, Singh *et al*. 1994, Renu *et al*. 2005) [5, 12, 10]. Kulfi is also served with faloodeh. Kulfi known as "Poor man's ice cream" and it is gaining more attention because of its good payability, nutritious and provide high pleasure of eating. It is defined as a frozen mixture of dried and condensed milk with addition of non-milk products for sweetening stabilizing (Yerriswamy *et al*. 1983) [13]. Kulfi is also made by suitable blending and processing of SMP and other dairy products, together with flavour and sugar with or without stabilizer or colour. Kulfi described in two phases like continuous and dispersed. The continuous phase is a combination of unfrozen solution, an emulsion and a suspension of solid in liquid. The aqueous phase also forms an emulsion with dispersed milk fat globules (Sharma and Hissaria, 2009) [11].

Flaxseed consumption in various forms as a food ingredient and for medicinal properties since its cultivation. Linseed is an alternative name used for flaxseed. It is rich in fat, dietary fibre, and protein. The composition of flaxseed averages 41% fat, 28% total dietary fibre, 20% protein, 7.7% moisture, 3.5% ash and 1% sugars. Flaxseed has a unique fatty acid profile, it is low in saturated fatty acids and rich in ALA, the essential omega-3 fatty acid. Flaxseed contains saturated fatty acids 9%, monounsaturated fatty acids 18% and polyunsaturated fatty acids 73%. Of the unsaturated fatty acids, ALA constitutes the majority at 59% of the total fatty acids, making flaxseed one of the richest sources of this fatty acid (Bhatty, 1995) [7]. Flaxseed reduces cardiovascular diseases, decreased risk of cancer, particularly of the mammary and prostate gland, possess anti-inflammatory activity and laxative effect. Flaxseed is the most prominent oilseed studied as a functional food, it is a leading source of the omega-3 fatty acid, ALA (52% of total fatty acids), and the phenolic compounds known as lignans (> 500 μg/g). Flaxseed is also rich source of soluble fibre known as mucilage. Flaxseeds have nutritional characteristics and are rich source of ω-3 fatty acid: α-linolenic acid (ALA), short chain polyunsaturated fatty acids, soluble and insoluble fibers, (Ivanova *et al.*, 2011) [9].

Materials and Methods

The experiment "Studies on characteristics of flaxseed powder supplemented kulfi" was carried out in the Food and Science Technology lab Warner College of Dairy Technology, Prayagraj (U.P.) India.

Procurement and collection of ingredients

Milk, Sugar and Flaxseed was collected from local market of Prayagraj.

Preparation of Flaxseed

Flaxseed was roasted at 80-90ºC for 10min. Roasted flaxseed was ground to powder for further use.

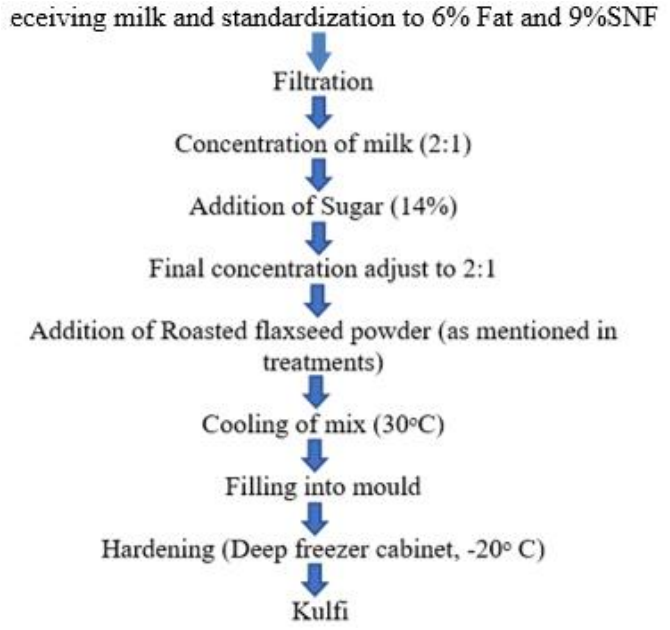

Fig 1: Flow diagram for manufacturing of Kulfi

Treatment combinations

T_0 = 100% concentrated milk
T_1 = 95% concentrated milk + 5% flaxseed powder
T_2 = 90% concentrated milk + 10% flaxseed powder
T_3 = 85% concentrated milk + 15% flaxseed powder
T_4 = 80% concentrated milk + 20% flaxseed powder

Sensory evaluation of flaxseed powder supplemented kulfi of different treatments

Sensory evaluation was carried out using 9-point Hedonic scale (Amerine *et al.*, 1965) [1].

Physico-chemical, sensory and microbiological analysis of flaxseed powder supplemented kulfi

The Physico-chemical analysis i.e. fat, protein, carbohydrate, total solids, ash and pH were estimated by using standardized procedures. Each Physico-chemical analysis was replicated five times. The total solid content was determined as per procedure of AOAC (1990) [4]. The Fat content of the sample was analyzed by Soxhlet method **(**AOAC, 1986**)** [3]**.** Protein content of the sample was determined by Kjeldahl method. Total carbohydrate was determined as per procedure of hydrolysis method as described in AOAC (1990) [4]. Ash content (AOAC, 1990) [4]. The antioxidant was determined as per procedure followed by (Iqbal *et al*., 2005) [8]. The acidity was determined as per procedure of AOAC (1986) [3].

Microbial analysis of flaxseed powder supplemented kulfi

Standard Plate Count (colony count) of sample was determined as per the procedure given in 'APHA Standard Methods for the Examination of Food Products' (1992). Coliform Count in determined as per the procedure given in 'APHA Standard Methods for the Examination of Food Products' (1992). Yeast and mould count of sample was determined as per the procedure given in 'APHA Standard Methods for the Examination of Food Products' (1992).

Statistical analysis

Data was analyzed using Analysis of Variance (ANOVA) and Critical difference (C.D) at 5% in WASP and excel software.

Results and Discussions

The present study was based to evolve "Studies on characteristics of flaxseed powder supplemented kulfi" the data collected on different aspects were tabulated and analysed statistically using MS Excel software, 2007. The data were analysed statistically using the methods of analysis of variance and critical difference. The significant differences observed have been analysed critically within and between the treatment combinations.

Organoleptic characteristics of flaxseed powder supplemented kulfi

The kulfi samples prepared by incorporating different percentages of flaxseed powder were subjected to sensory evaluation using 9- hedonic scale which was conducted by trained panellists of WCDT who have immense experience and are familiar with the characteristics of kulfi. The kulfi samples are rated colour and appearance, flavour and taste, body and texture, melting resistance, overall acceptability.

Table 1: Showing average data of organoleptic of flaxseed powder supplemented kulfi of different treatments

Organoleptic Score of Flaxseed Powder Kulfi					
Parameters	**T_0**	**T_1**	**T_2**	**T_3**	**T_4**
Flavour	8.00 ± 0.23^{a}	8.50 ± 0.72^{b}	$8.00\pm0.23^{a,c}$	$8.00\pm0.25^{a,c,d}$	7.00 ± 0.23^{e}
Colour & Appearance	7.50 ± 0.27^{a}	8.00 ± 0.02^{b}	$8.00\pm0.02^{b,c}$	$7.50\pm0.03^{a,d}$	7.00 ± 0.03^{e}
Body and Texture	8.00 ± 0.03^{a}	7.60 ± 0.22^{b}	$7.50\pm0.02^{b,c}$	$7.50\pm0.02^{b,c,d}$	7.00 ± 0.02^{e}
Melting resistance	7.50 ± 0.29^{a}	8.04 ± 0.26^{b}	$7.50\pm0.26^{a,c}$	$7.50\pm0.02^{a,c,d}$	7.00 ± 0.03^{e}
Overall acceptability	8.00 ± 0.58^{a}	$8.00\pm0.02^{a,b}$	7.50 ± 0.02^{c}	$7.50\pm0.02^{c,d}$	7.00 ± 0.03^{e}

Data are presented as Mean ± S.D.

[a, b, c, d, e] Means within row with lowercase superscript are significantly different ($P<0.05$) from each other.

The data presented in table-1 revealed that the sensory scores of flaxseed powder supplemented kulfi. The sample T_1 got highest score for flavour, colour & appearance, melting resistance, overall acceptability as 8.50, 8.00, 8.04, 8.00 respectively and T_0 was highest score of body and texture (8.00). The table 1 reveals that the mean score for flavour of flaxseed powder kulfi was found to be in the range of 7.00 to 8.50. The colour and appearance score of flaxseed powder kulfi of the mean value of T_0, T_1, T_2, T_3 and T_4 was found to be 7.50, 8.00, 8.00, 7.50 and 7.00 respectively. The highest mean colour and appearance score was recorded in T_1 and lowest was in T_4 (7.00). Similarly, the mean scores of body and texture of flaxseed powder kulfi of different treatment was found in the range of 7.00 to 8.00. The highest mean of body and texture was recorded in T_0 and lowest was recorded in T_4. The different treatments were observed to be significantly different ($P<0.05$). Similarly, the melting resistance score of flaxseed powder kulfi of T_0, T_1, T_2, T_3 and T_4 was found to be 7.50, 8.04, 7.50, 7.50 and 7.00 respectively. The highest mean melting resistance score was recorded in T_1 followed by T_0, T_2, T_3 and T_4. The different treatments were also observed to be significantly different ($P<0.05$). Table also reveals that for overall acceptability score of flaxseed powder kulfi ranged from 7.00 to 8.00. The results obtained in the study indicates that the variation amongst sensory scores for different treatments were found to be significant difference ($P<0.05$).

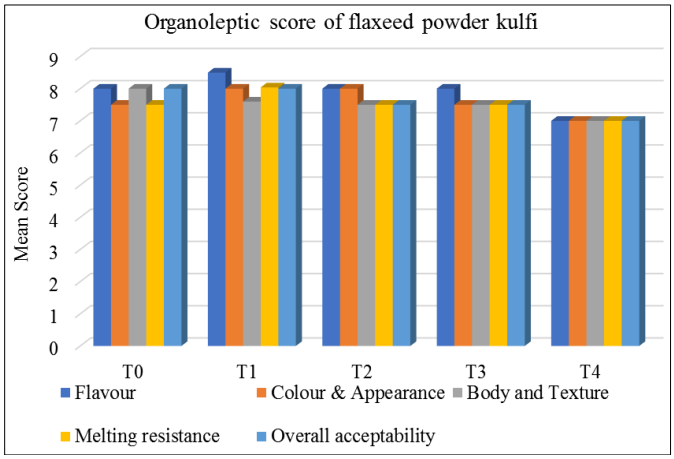

Fig 2: Graph representing organoleptic score of flaxseed powder supplemented kulfi of different treatments

Physico-chemical characteristics of control and flaxseed powder supplemented kulfi

Table 2: Table showing average data of physico-chemical flaxseed powder supplemented kulfi of different treatments:

Physico-chemical analysis of flaxseed powder kulfi					
Parameters	**T_0**	**T_1**	**T_2**	**T_3**	**T_4**
TS (%)	41.47 ± 0.02^{a}	42.40 ± 0.03^{b}	42.90 ± 0.03^{c}	44.23 ± 0.02^{d}	45.61 ± 0.02^{e}
Fat (%)	11.89 ± 0.72^{a}	15.55 ± 0.02^{b}	19.17 ± 0.02^{c}	22.73 ± 0.02^{d}	24.64 ± 0.23^{e}
Protein (%)	7.46 ± 0.29^{a}	7.72 ± 0.25^{b}	7.90 ± 0.02^{c}	8.18 ± 0.02^{d}	8.36 ± 0.03^{e}
Carbohydrate (%)	23.70 ± 0.64^{a}	25.33 ± 0.02^{b}	27.04 ± 0.02^{c}	28.75 ± 0.03^{d}	29.44 ± 0.02^{e}
Ash (%)	0.97 ± 0.02^{a}	1.10 ± 0.21^{b}	1.21 ± 0.03^{c}	1.30 ± 0.03^{d}	1.41 ± 0.02^{e}
Antioxidant Properties (expressed in ascorbic acid µg /100gm)	35.32 ± 1.42^{a}	36.52 ± 0.03^{b}	40.69 ± 0.02^{c}	38.85 ± 0.03^{d}	37.45 ± 0.02^{e}
Titratable acidity (% Lactic acid)	0.31 ± 0.11^{a}	0.22 ± 0.05^{b}	$0.31\pm0.03^{a,c}$	$0.27\pm0.02^{c,d}$	$0.31\pm0.02^{a,c,e}$
Hardness (N)	39.09 ± 0.02^{a}	42.20 ± 1.42^{b}	$41.72\pm0.02^{b,c}$	$40.76\pm0.03^{c,d}$	43.43 ± 0.02^{e}
Melting rate (min)	26.00 ± 0.02^{a}	28.29 ± 0.64^{b}	29.58 ± 0.02^{c}	30.87 ± 0.02^{d}	32.16 ± 0.03^{e}
Crude Fibre (%)	0.00 ± 0.00^{a}	3.00 ± 0.26^{b}	6.00 ± 0.02^{c}	9.00 ± 0.02^{d}	12.00 ± 0.03^{e}

Data are presented as Mean ± S.D.

[a, b, c, d, e] Means within row with lowercase superscript are significantly different ($P<0.05$) from each other.

Total Solid: Table 2 revealed that the physico-chemical properties in control and experimental in flaxseed powder supplemented kulfi sample of different treatments. The mean value of TS percentage of five treatment *viz*. T_0, T_1, T_2, T_3 and T_4 was found to be 41.67, 42.40, 42.90, 44.23 and 45.61 respectively. Total solids percentage of flaxseed powder kulfi, highest mean total solids score was recorded in T_4 and lowest was recorded in T_0. The mean treatment values were increased from T_0 to T_4 experimental samples so the total solid of different treatment increased significantly ($P<0.05$).

Fat: The highest fat content of 24.64 percent was recorded for treatment T_4 and the lowest fat content of 11.89 percent was noted for treatment T_0. As the level of flaxseed powder in the kulfi increased, the fat content of kulfi from it also increased. The mean value of fat percentage in flaxseed powder supplemented kulfi sample of different treatments of T_0, T_1, T_2, T_3 and T_4 was found to be 11.89, 15.54, 19.17, 22.73 and 24.64 respectively. It was observed that mean treatment values were increased from T_0 to T_4 experimental samples so the fat of different treatment also increased significantly ($P<0.05$).

Protein: The mean value of protein of five treatment *viz*. T_0, T_1, T_2, T_3 and T_4 was found in the range of 7.46 to 8.36 percentage. Protein percentage of flaxseed powder kulfi, highest mean protein percentage was recorded in T_4 (8.36) followed by T_3 (8.18), T_2 (7.90), T_1 (7.72) and T_0 (7.46). The total protein content of the flaxseed powder kulfi was significantly higher than the that of the control. It was

observed that mean treatment values were increased from T_0 to T_4 experimental samples so the protein of different treatment increased significantly (P<0.05).

Carbohydrate

The mean value of carbohydrate percentage of different treatment T_0, T_1, T_2, T_3 and T_4 was found to be 23.70, 25.33, 27.04, 28.75 and 29.44 respectively. The carbohydrate percentage of flaxseed powder kulfi, highest mean carbohydrate percentage was recorded in T_4 and lowest was recorded in sample T_0.

Ash

The mean value of ash percentage of treatment T_0, T_1, T_2, T_3 and T_4 was found to be 0.97, 1.10, 1.21, 1.30 and 1.41 respectively. The presented data on ash percentage of flaxseed powder kulfi, highest mean ash percentage score was recorded in T_4 followed by T_3, T_2, T_1 and T_0. It can be observed from Table 2 that the values for ash increased slightly with the increase in proportion of flaxseed powder.

Antioxidant

The mean value of antioxidant of different treatment *viz*. T_0, T_1, T_2, T_3 and T_4 was found to be 35.32, 36.52, 40.69, 38.85 and 37.45 respectively. The presented data on antioxidant properties of flaxseed powder kulfi, highest mean antioxidant properties was recorded in T_2 and lowest score was found in the sample of T_0 (35.32). There are non-significant difference among all the treatments.

Titratable Acidity

The mean value of titratable acidity of treatment T_0, T_1, T_2, T_3 and T_4 was found in the range of 0.22 to 0.31% lactic acid. The titratable acidity of flaxseed powder kulfi, highest mean titratable acidity was recorded in T_4 and lowest was recorded in T_1. The difference in the titratable acidity content of all the treatments were non-significant at 5 percent level of significance.

Hardness

The mean value of hardness of different treatments *viz*. T_0, T_1, T_2, T_3 and T_4 was found to be 39.09, 42.20, 41.72, 40.76 and 43.43 respectively. The presented data on hardness percentage of flaxseed powder Kulfi, highest mean hardness percentage was recorded in T_4 and lowest was recorded in the sample T_0.

Melting rate

The data regarding melting rate in flaxseed powder supplemented kulfi sample of different treatments are shown in table 2. The mean value of melting rate of treatment T_0, T_1, T_2, T_3 and T_4 was found to be 26.00, 28.29, 29.58, 30.87 and 32.16 respectively. The melting rate of flaxseed powder kulfi, highest mean melting rate was recorded in T_4 and lowest was recorded in the sample of T_0. It indicates that increased the level of flaxseed powder, the melting rate of kulfi also increased.

Crude fibre

The data regarding crude fibre percentage in flaxseed powder supplemented kulfi sample of different treatments are presented in table 2. The mean value of crude fibre of treatment T_0, T_1, T_2, T_3 and T_4 was in the range of 0.00 to 12.00. The crude fibre percentage of flaxseed powder kulfi, highest mean crude fibre percentage was recorded in T_4 and lowest score was recorded in T_0. The difference in the crude fibre of all treatment were significantly (P<0.05).

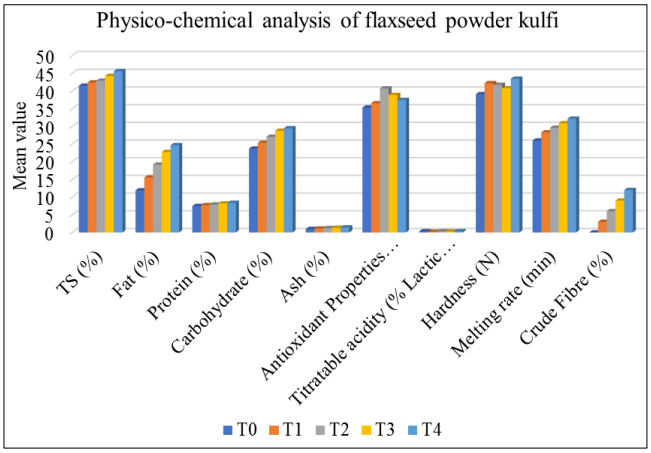

Fig 3: Graph representing physico-chemical analysis of flaxseed powder supplemented kulfi of different treatments

Microbiological analysis of control and flaxseed powder supplemented kulfi

Table 3: Table showing average data of microbiological of flaxseed powder supplemented kulfi of different treatments-

Microbiological Analysis of Flaxseed Powder Kulfi					
SPC (x10^3cfu/gm)	60.00±1.27^a	40.00±0.02^b	18.00±0.02^c	12.00±0.03^d	10.00±0.02^e
Yeast & mould (Per/gm)	5.00±0.58^a	3.00±0.02^b	3.00±0.02^c	1.00±0.23^d	0.00±0.00^e
Coliform count (per gm)	Nil	Nil	Nil	Nil	Nil

Data are presented as Mean ± S.D.

$^{a, b, c, d, e}$ Means within row with lowercase superscript are significantly different (P<0.05) from each other.

SPC: The data regarding standard plate count in flaxseed powder supplemented kulfi sample of different treatments are shown in table 3. The mean value of standard plate count of treatment T_0, T_1, T_2, T_3 and T_4 was found to be 60.00, 40.00, 18.00, 12.00 and 10.00 respectively. The presented data on standard plate count of flaxseed powder kulfi, highest mean standard plate count was recorded in T_0 and lowest score was recorded in T_4. The difference in the standard plate count of all the treatments were non-significant at 5 percent level of significance.

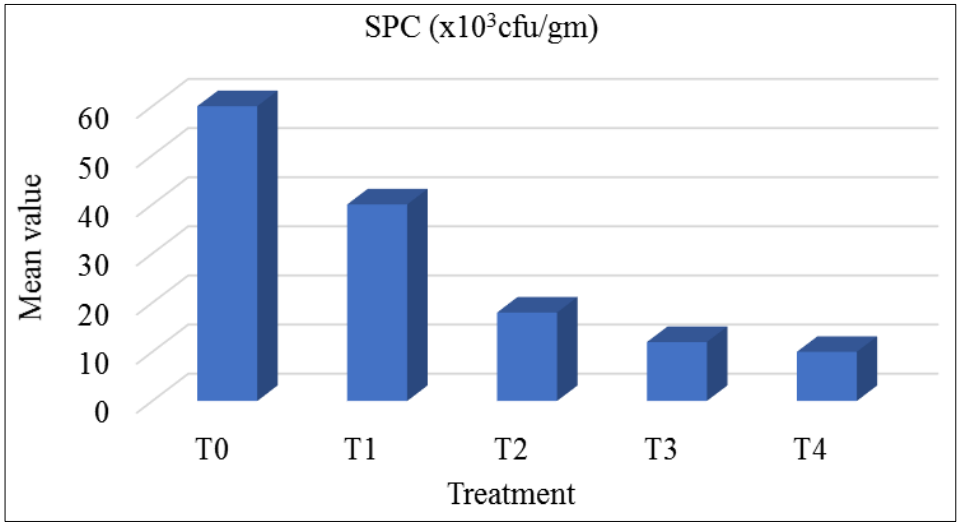

Fig 4: Graph representing standard plate count of flaxseed powder supplemented kulfi of different treatments

Yeast and mould: The data regarding yeast and mould count in flaxseed powder supplemented kulfi sample of different treatments are score in table 3. The mean value of yeast and mould of treatment T_0, T_1, T_2, T_3 and T_4 was found to be 5.00, 3.00, 3.00, 1.00 and 00.00 respectively. The yeast and mould count of flaxseed powder kulfi, highest mean yeast and mould count was recorded in T_0 (5.00) followed by T_1 (3.00), T_2 (3.00), T_3 (1.00) and T_4 (0.00). There are non-significant difference (P≤0.05) between these treatments.

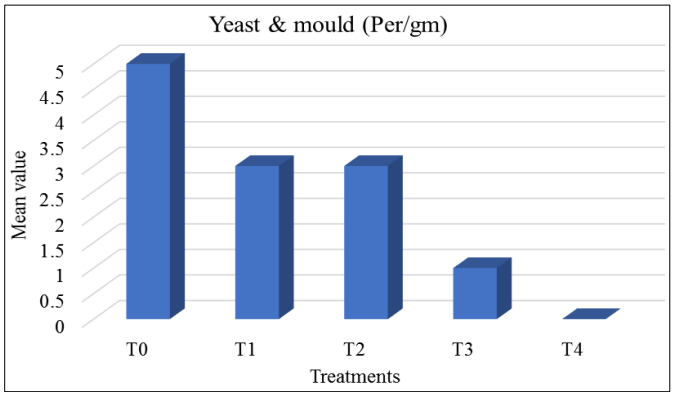

Fig 5: Graph representing yeast and mould count of flaxseed powder supplemented kulfi of different treatments.

Coliform count for control and flaxseed powder supplemented kulfi

Coliform was found to be absent in all the kulfi samples which indicates that proper hygienic conditions were maintained during the preparation and storage of the product. Therefore, all the treatments are non-significant.

Conclusion

The present investigation involved development of flaxseed powder supplemented kulfi by partial addition of different levels of flaxseed powder. During the preparation of kulfi, flaxseed powder were addded at four different concentration. Control sample had no flaxseed powder. The treatments were evaluated for various oraganoleptic characteristic, physico – chemical parameters after sensory evaluation kulfi having T_1 was found to have highest score for flavour and taste, colour and appearance, melting resistance and overall acceptability. The physico-chemical analysis results shows that kulfi prepared with 5% flaxseed powder had maximum total solid, fat, protein, carbohydrate, ash and antioxidant properties of flaxseed powder supplemented kulfi respectively. Considering the health beneficial aspects of flaxseed powder, the present investigation is being used for kulfi preparation.

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