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Compositional studies of *Lassi* prepared from blends of germinated bio-fortified sorghum grain extract and skim milk

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Abstract
Parbhani Shakti is improved varieties proved for high iron Fe, Zinc and protein content with low phytates means higher bioavailability of improved nutrients. In present preparation an attempts was made to prepare *lassi* blended with extract of germinated bio-fortified sorghum (Parbhani Shakti) using skim milk and studied its compositional parameters. The normal properties for acidity, pH, fat, protein, total sugar, moisture, total solid, ash, viscosity were observed. However, highest zinc content was recorded for treatment T_4 i.e. 9.25 (ppm) whereas, lowest zinc contents was recorded for treatment T_1 i.e. 7.00 (ppm). The increased zinc in extract added *lassi* due to extract contained germinated sorghum flour and germination appeared to be a promising food processing method to improve bioavailability of minerals.

Keywords: Skim milk, *Lassi*, *dahi*, bio-fortified sorghum

Introduction
Sorghum grains used by people as sources of energy, proteins, vitamins and minerals having non energy nutrients also. In some areas they are intended for consumption as pasta, boiled and traditional beverage. Sorghum has nutritional composition similar to and better than rice and wheat in some aspects particularly contain high fiber and non-starchy polysaccharides and starch with some unique characteristics. There is considerable variation in sorghum for levels of proteins, lysine, lipids, carbohydrates, fiber, calcium, phosphorus, iron, thiamine and niacin, protein quality and amino acid profile of sorghum is better than many of the cereals and millets. Sorghum in general is rich source of fiber and B-complex vitamins. It provides dietary fiber by 48 per cent of the recommended daily value (Samarth *et al.* 2018) [22]. It is also has more antioxidants than blueberries and pomegranate. Sorghum consumption reduces the risk of colon and skin cancer more than any other grains consumption. Sorghum promotes cardiovascular health and lower cholesterol (Kumar and Das 2015) [13].

Several attempts were made to develop a technology for the manufacture of *Rabadi* like fermented milk beverage using sorghum (Modha and Pal 2011) [15] and pearl millet (Pintu, 2006) [19] in which cereal like sorghum and millet used in combination with skim milk and cream as source of milk solids. The product made was highly acceptable but the limiting factor was limited shelf life of about a week at refrigeration temperature. Fermentation is known to reduce the anti nutritional content in cereals. Chavan *et al*, 1988 [3] reported that fermentation of sorghum increased protein content, soluble protein and free amino acids. Similarly Kazands and Fields (1981) [9] found an increased in essential amino acids and nutritive value of sorghum during natural fermentation. Combination of cereals and milk can provide value addition to the dairy products.

Parbhani Shakti is improved varieties developed by Vasantrao Naik Marathwada Krishi Vidhyapeeth, showed its yield superiority in multi-location on farm and proved for high iron Fe (45ppm), Zinc (32ppm) and protein content (11.9 per cent) and low phytates (4.1mg/100g) means higher bioavailability of improved nutrients Kumar *et al.* (2018) [12].

In present preparation an attempts was made to prepare *lassi* blended with extract of germinated bio-fortified sorghum (Parbhani Shakti) using skim milk and studied its compositional parameters.

Material and Methods

Skim milk and Sugar

The clean and fresh buffalo skim milk, good quality, clean, crystalline, white cane sugar were procured from local market of Latur city. The standard mixed *dahi* culture i.e. Standard *dahi*, *NCDC-167* (BD4) contained *streptococcus thermophilus and lactococcus lactis* in this study was procured from the National Collection of Dairy Culture (NCDC), NDRI, Karnal. Stainless steel vessels of requisite capacity, muslin cloth, standard weight balance, thermometer, gas shegdi, electrical churner, mixture (HERO Mixture, 550 WATTS) and glass rod etc. were used for preparation of *lassi*. Before using this material it was properly cleaned and washed with detergent solution. All the precautionary measures were taken during the conduct of trials to avoid contamination. Analytical reagents (AR) or guaranteed grade (GR) reagents were used for the chemical analysis and Plastic glasses and glass bottle were purchased from local market, Latur.

Preparation of germinated sorghum grain's extract

The fresh sorghum (Parbhani shakti) grains were collected, cleaned and stored up to final used. Sorghum soaked for 12 hrs at room temperature and after that germinated for 36 hrs at 37 ^{0}C temperature. The germinated sorghum grains were grinded in the mixer for homogenous fine mixture by using 1:5 ratio of grain with water for extraction and filtraed through muslin cloth.

Preparation skim milk *lassi* blended with germinated sorghum grains extract

The skim milk *lassi* blended with germinated sorghum grains extract was prepared as per the method by Padghan *et al*., 2015 [16]. The skim milk mixed with germinated sorghum extract at 35 to 40^{0}C temperature. Then germinated sorghum grains extract added skim milk was heated up to 90^{0}C. Then it was cooled up to temperature 37^{0}C. After cooling the standard culture was added in milk @ 2 per cent and incubated at 37^{0}C for 10-12 hrs. After *dahi* obtained the equal quantity of portable water was added and churned it by using electric churner. Then 15 per cent sugar was mixed in it. The prepared *lassi* was packed in glass bottle and storage at 5^{0}C.

Evaluation of physico-chemical properties of *lassi*

Lassi samples of different treatments were subjected for analysis for titratable acidity {IS: 1224 (part II) (1977)} [7], pH {digital pH meter (335)}, fat {IS: 1224 (part II) (1977)} [7], protein {A.O.A.C. (1965)} [1], total sugar (IS: SP: 18 (Part XI) 1981) [8], moisture/total solid/ash {IS: SP (Part XI) 1981} [8], viscosity {using Brook Field Viscometer (LVDV-E viscometer)} and For determination Zinc and Iron can be determined by flame AAS.

The data were analyzed statistically by using Completely Randomized Design (CRD) as per Panse and Sukhatme (1985) [17].

Result and Discussion

Physico-chemical analysis of *lassi*

The requisite samples of *lassi* with different treatments were subjected for proximate analysis viz. Acidity, pH, fat, protein, total sugar, moisture, total solid, ash, viscosity, iron and zinc.

Acidity percentage of *lassi*

The average scores obtained for developed *lassi* are presented in table no. 1. From table no. 1, it indicates that the mean average scores acidity of *lassi* was 0.82, 0.79, 0.78 and 0.76 per cent for treatment T_1, T_2, T_3 and T_4, respectively. It was observed that as the quantity germinated sorghum extract increased the acidity of the developed product was slightly decreased in developed *lassi* might be due to the less production of lactic acid or other acid during fermentation, less content of lactose in case of developed treatments. The highest value for acidity had shown by treatment T_1 (0.82) and lowest value for acidity had shown by treatment T_4 (0.76). In all above treatments T_2 and T_3 were at par with each other. The treatment T_1 and $T_4$was shown significant differed from all others treatments.

Table 1: Acidity percentage of germinated sorghum grains extract blended skim milk *lassi*

Replication/Treatment	R$_1$	R$_2$	R$_3$	R$_4$	Mean
T_1	0.82	0.80	0.83	0.81	0.82^a
T_2	0.78	0.79	0.81	0.79	0.79^b
T_3	0.78	0.77	0.79	0.77	0.78^b
T_4	0.76	0.76	0.77	0.76	0.76^c
S.E. = ± 0.005 C.D. at 5% = 0.01					

The values with different small letters superscripts row wise differ significantly at 5 per cent level of significance.

The above results were comparable with Pardhi *et al*. (2014) [18], observed that the acidity of finger millet *lassi* was 0.88, 0.84, 0.78 and 0.74 for treatment T_0, T_1, T_2 and T_3, respectively which similar to our findings with slight changes. Kumar and Das (2015) [13], noticed that acidity of sorghum based beverage decline slightly by adding sorghum flour. The acidity of sorghum based beverage was 0.85, 0.84, 0.80 and 0.75 per cent for treatments T_0, T_1, T_2 and T_3 respectively. Dhumal *et al.* (2018) [5], recorded that the average acidity content pudina extract *lassi* was 0.78, 0.76, 0.73 and 0.71 per cent for treatment T_1, T_2, T_3 and T_4, respectively.

pH content of *lassi*

The pH of product determines the acidic or basic nature of any product. The pH of the developed product was measured by using digital pH meter at room temperature. From table no. 2 it is revealed that, the average scores for pH of developed *lassi* went on increasing. The highest value of pH was shown by treatment T_4 i.e 4.46 and the lowest had shown by treatment T_1 i.e 4.29. The range of *lassi* scores for pH were ranged from 4.29 to 4.46. The mean average scores for treatments T_1, T_2, T_3 and T_4 were 4.29, 4.33, 4.39 and 4.46, respectively. The increase in pH of all treatments of developed *lassi* was due to addition of germinated sorghum grains extract. Among all the treatments of developed *lassi*, the treatments T1, and T2 were at par with each other and treatments T_3 and T_4 was significantly differ from them.

Table 2: pH content of germinated sorghum grains extract blended skim milk *lassi*

Replication/Treatment	R$_1$	R$_2$	R$_3$	R$_4$	Mean
T_1	4.32	4.22	4.28	4.35	4.29^a
T_2	4.33	4.28	4.33	4.37	4.33^{ab}
T_3	4.38	4.41	4.36	4.42	4.39^b
T_4	4.44	4.49	4.42	4.47	4.46^c
S.E.± 0.019751 C.D. at 5% 0.060859					

The values with different small letters superscripts row wise differ significantly at 5 per cent level of significance.

The above results were comparable with Kakade *et al*. (2018) [10], observed that the pH of wheat grass extract *lassi* changed due to addition of wheat grass extract. The pH of *lassi* of treatments T_1, T_2, T_3 and T_4 was 4.29, 4.32, 4.34 and 4.36,

respectively. They indicated that pH increased with increased level of extract added in the *lassi.* Dhumal *et al.* (2018) [5], recorded that the pH content of pudina extract *lassi* for the treatments T1, T2, T3 and T4 was 4.19, 4.24, 4.25 and 4.27, respectively. Monika *et al.* (2018) [14], recorded pH of whey germinated pearl millet *lassi*. Whey- germinated pearl millet *lassi* shown lower pH value i.e 4.40±0.05 and whey-soaked pearl millet *lassi* shown higher pH value i.e 4.65±0.09.

Fat percentage of *lassi*

From table no. 3 it is revealed that, the average score for fat percentage of developed *lassi* went on decreasing. The values for fat percentage of developed *lassi* were in the range of 0.32 to 0.44. The highest value for fat percentage was shown by the treatment T_1 and lowest had shown by the control treatment T_4. The mean average scores for fat percentage of developed *lassi* were 0.44, 0.42, 0.40 and 0.32 for treatments T_1, T_2, T_3 and T_4, respectively. The slightly decreased in fat percentage in developed *lassi* had seen due to the fat per cent in sorghum grains. In all above treatments T_1 and T_2, and T_3 were at par with each other and T_4 was significantly differed from them. The average scores for fat percentage of developed *lassi* are described in table no 3.

Table 3: Fat percentages for germinated sorghum grains extract blended skim milk *lassi*

Replication/Treatment	R1	R2	R3	R4	Mean
T1	0.45	0.44	0.42	0.44	0.44^{a}
T2	0.44	0.42	0.40	0.42	0.42^{ab}
T3	0.40	0.40	0.38	0.42	0.40^{b}
T4	0.32	0.30	0.34	0.30	0.32^{c}
S.E. = ± 0.008133 C.D. at 5% = 0.02506					

The values with different small letters superscripts row wise differ significantly at 5 per cent level of significance.

The findings were in differ with David *et al.* (2013) [4], prepared skimmed milk *lassi* blended with coconut milk at different a ratio T_1 (70:30), T_2 (60:40) and T_3 (50:50) and reported higher average fat content as 0.34, 0.44, 0.59 and 0.70 for treatment T_0, T_1, T_2 and T_4, respectively than this result might be due to the use of coconut milk. It means the effect of coconut milk in *lassi* was shown different result than sorghum for fat content of *lassi*.

Kumar and Das (2015) [13], observed that there was increase in fat content with increase in sorghum flour concentration. The fat content of the sorghum based fermented milk beverage sample under treatment T_0, T_1, T_2 and T_3 was 2.32, 2.40, 2.46 and 2.55, respectively.

Sudha *et al.* (2015) [23], prepared beverage using skim milk along with three different millets (finger millet, pearl millet and sorghum). The techniques used for processing millets are soaking, sprouting and extraction of milk from millets. The ratio of millet milk with skimmed milk was optimized using Mixture Design. The optimized fermented millet sprout milk beverage contained 1.5 per cent fat.

Dhumal *et al.* (2018) [5], observed that the incorporation of lemon grass extract increased the fat content of *lassi*. This increasing trend of fat content can be attributed to the fact that lemon grass extract contained higher amount of fat than that of skim milk. The fat content in lemon grass *lassi* varied within the narrow range of 0.47 to 0.65 per cent.

Protein content of *lassi*

Proteins are one of the essential content of any product in terms of its healthy constitution. The protein percentage for prepared product was evaluated by the Kjeldhal's distillation flask method.

Table 4: Protein percentages of germinated sorghum grains extract blended skim milk *lassi*

Replication/ Treatment	R1	R2	R3	R4	Mean
T1	2.18	2.14	2.10	2.16	2.15^{a}
T2	4.14	4.16	4.19	4.22	4.18^{ab}
T3	4.20	4.22	4.21	4.25	4.22^{b}
T4	4.32	4.28	4.33	4.35	4.32^{c}
S.E. = ± 0.015258 C.D. at 5% = 0.047015					

The values with different small letters superscripts row wise differ significantly at 5 per cent level of significance.

From the above table 4, it is revealed that, the protein percentage of developed product went on increasing. The mean average scores for protein percentage of *lassi* were ranged from 2.15 to 4.32. The highest value for protein percentage of developed *lassi* was shown by the treatment T_4 and the lowest value shown by the control treatment T_1. The mean average values for protein percentage were 2.15, 4.18, 4.22 and 4.32 for treatments T_1, T_2, T_3 and T_4, respectively. The increased in protein percentage in developed *lassi* had seen due to the high content of protein in sorghum and fermentation of cereal and germination may also result in increased in protein supported by Tatsadieu *et al*. (2004) [24]. In all above treatments T_2, T_3 and T_4 were at par with each other. The treatment T_1 had shown significant differed from all others treatments. The results were comparable with the finding of following research workers.

Tatsadieu *et al*. (2004) [24], studied physico-chemical qualities of *Kindimu* fermented milk-based sorghum flour. The recorded that addition of fermented milk increased protein content in the blend by 43.84 per cent and 45.32 per cent for the flour with non germinated and germinated sorghum respectively. Kumar and Das (2015) [13], recorded that physic-chemical properties of sorghum based fermented beverage. The values for protein content of developed beverage were 2.78, 3.12, 3.45 and 3.77 for treatments T_0, T_1, T_2 and T_3, respectively. The content of protein increased with addition of sorghum flour. Kakade *et al*. (2018) [10], recorded average protein content in wheat grass *lassi* was found to be 2.52, 2.53, 2.54 and 2.54 per cent for treatment T_1, T_2, T_3 and T_4, respectively. Prabhakar (2014) [21], studied on mango fortified bajara *lassi*. The average chemical composition mango fortified bajra *lassi* of treatment T_0, T_1, T_2, T_3 and T_4 contained Protein 3.33, 3.85, 3.89, 4.07, 4.13 per cent, respectively.

Total sugar content of *lassi*

The value recorded in respect of total suger content of the developed product is shown in Table 5.

Table 5: Total sugars content of germinated sorghum grains extract blended skim milk *lassi*

Replication/Treatment	R1	R2	R3	R4	Mean
T1	13.34	13.40	13.38	13.36	13.37^{a}
T2	14.33	14.42	14.42	14.48	14.41^{b}
T3	14.62	14.56	14.58	14.46	14.56^{b}
T4	14.77	15.28	14.64	15.16	14.96^{c}
S.E. = ± 0.080137 C.D. at 5% = 0.246925					

The values with different small letters superscripts row wise differ significantly at 5 per cent level of significance.

From the above Table 5, it was observed that the mean total sugar content of the product was found to be 13.37, 14.41, 14.56 and 14.96 per cent for the treatments T_1, T_2, T_3 and T_4, respectively. The slightly increasing trend for total sugar

content was observed from T_1 to T_4 due to maltose sugar content in sorghum grains. The highest value for total sugar content of developed *lassi* was shown by the treatment T_4 (14.96) and the lowest value shown by the control treatment T_1 (13.37). In all above treatments T_2 and T_3 were at par with each other and T_1 and T_4 was significantly differed from themselves and other treatments.

The above results were comparable with Pardhi *et al*. (2014) [18], reported that the level of finger millet flour increased, the total sugar content in *lassi* also increased. It shows that average mean scores of sugar content ranges from 14.43, 14.83, 15.51 and 16.26 for the treatments T_0, T_1, T_2 and T_3 respectively. Kakade *et al*. (2018) [10], recorded that the average total sugar content of wheat grass *lassi* were 5.78, 6.19, 6.27 and 6.28 per cent for treatment T_1, T_2, T_3 and T_4, respectively. It indicates that as the wheat grass extract was increased the total sugar content also increased might be due to the higher sugar content in wheat grass.

Total solid content of *lassi*

The total solids are content of any product other than moisture amount. The values of percentage of total solids for developed products were recorded and are presented in table no.6.

Table 6: Total solid content of germinated sorghum grains extract blended skim milk *lassi*

Replication/ Treatment	R_1	R_2	R_3	R_4	Mean
T_1	13.30	13.46	14.44	14.40	13.90^{a}
T_2	14.60	14.70	15.55	15.77	15.16^{b}
T_3	15.47	15.77	15.80	15.80	15.71^{b}
T_4	16.60	16.66	16.88	16.76	16.73^{bc}
S.E. = ± 0.217323 C.D. at 5% = 0.669638					

The values with different small letters superscripts row wise differ significantly at 5 per cent level of significance.

It was clearly observed from table 6, that total solid content of *lassi* samples was increased as the germinated sorghum grains extract proportion in blend increased. The mean value for total solid of *lassi* samples were observed as 13.90, 15.16, 15.71 and 16.73 for T_1, T_2, T_3 and T_4, respectively. The highest total solid content was recorded for treatment T_4 i.e. 16.73 per cent whereas, lowest total solid contents was recorded for treatment T_1 i.e. 13.90 per cent. The slightly increased total solid in extract added *lassi* due to total solid contained sorghum extract. The treatment T_1 was shown significantly less total solid than others treatments. The present results were in agreement with following research workers.

Pradhi *et al*. (2014) [18], found similar results in finger millet added *lassi*. They reported that blending of finger millet four in *lassi* resulted in increased in total solid content. The mean value for total solid of *lassi* samples were observed as 21.06, 21.53, 22.55 and 23.11 for T_0 T_1, T_2 and T_3, respectively. Kumar and Das (2015) [13], recorded increased total solid content in sorghum based beverage and range from11.27 to 18.91. Gaikwad *et al*. (2018) [6], recorded that the total solid content of *lassi* increased with the increased level of menthol juice. The total solid contained of *lassi* were as 19.18, 19.26, 20.08 and 21.40 per cent, respectively.

Moisture content of germinated sorghum grains extract blended skim milk *lassi*

It was clear from the table 7 that the moisture content in *lassi* sample was ranged from 82.66 to 86.54 per cent. It was highest in T_1 (86.54) and lowest in T_4 (82.66). The average moisture content for treatment T_1, T_2, T_3 and T_4 were 86.54, 85.58, 84.51 and 82.66 per cent, respectively. As the proportion of germinated sorghum grains extract in blend increased there was decreased in the trend of moisture content in developed product. This may be due to germinated sorghum grains extract contained less moisture which was retained in unfiltered matter of extract.

Table 7: Moisture content of germinated sorghum grains extract blended skim milk *lassi*

Replication/Treatment	R_1	R_2	R_3	R_4	Mean
T_1	88.44	86.47	86.60	86.66	86.54^{a}
T_2	85.56	85.60	85.52	85.62	85.58^{b}
T_3	84.40	84.48	84.56	84.60	84.51^{bc}
T_4	82.30	83.38	82.44	82.52	82.66^{bcd}
S.E. = ± 0.127343 C.D. at 5% = 0.39382					

The values with different small letters superscripts row wise differ significantly at 5 per cent level of significance.

The moisture contents were comparable with Gaikwad *et al*. (2018) [6], recorded that moisture content of *lassi* significantly affected due to the addition of different levels of menthol juice. Moisture contents were as 82.51, 80.94, 80.58, 79.85 and 78.56 for treatments T_1, T_2, T_3, T_4 and T_5, respectively. It was also showed that increasing menthol juice proportion in the blend there was decreased in moisture content of *lassi*. Prabhakar (2018), studied on mango fortified bajara *lassi*. The average chemical composition for moisture content of mango fortified bajra *lassi* of treatment T_0, T_1, T_2, T_3 and T_4 contained 79.87, 77.80, 77.15, 76.70 and 76.05 per cent, respectively.

Ash content of germinated sorghum grains extract blended skim milk *lassi*

The ash percentage of developed *lassi* was estimated in muffle furnace in the laboratory. It was clear from the table 8 that the ash content in *lassi* sample was ranged from 0.72 to 0.83 per cent. It was highest in T_4 (0.83) and lowest in T_1 (0.72). The average ash content for treatment T_1, T_2, T_3 and T_4 were 0.72, 0.75, 0.81 and 0.83 per cent, respectively. The values recorded were found to be increasing order from treatment T_1 to T_4. This may be due to excess amount of minerals in germinated sorghum grains extract than buffalo milk. The treatment T1 was significantly differed from all other T2, T3 and T4 treatments, might be due to the higher content of minerals in sorghum (Kumar *et al*, 2018) [12]. The present results were in agreement with following research workers.

Table 8: Ash content of germinated sorghum grains extract blended skim milk *lassi*

Replication/Treatment	R_1	R_2	R_3	R_4	Mean
T_1	0.74	0.72	0.72	0.70	0.72^{a}
T_2	0.78	0.76	0.74	0.73	0.75^{b}
T_3	0.81	0.80	0.79	0.82	0.81^{c}
T_4	0.83	0.81	0.84	0.85	0.83^{c}
S.E. = ± 0.00872 C.D. at 5% = 0.02					

The values with different small letters superscripts row wise differ significantly at 5 per cent level of significance.

Tatsadjeu *et al.* (2004) [24], reported proximate composition of milky based sorghum flour. The addition of fermented milk also increased the ash content by 5.17 to 7.24 per cent respectively for flour with germinated sorghum and non germinated sorghum. Das and Kumar (2015) [13], prepared

quality evaluation of sorghum based fermented milk beverage. The ash content of sorghum based beverage for treatment T_0, T_1, T_2 and T_3 contained 0.72, 0.77, 0.84 and 0.90 per cent, respectively. Kakade *et al*. (2018) [10], reported that average ash per cent in wheat grass extract *lassi* were 0.44, 0.45, 0.46 and 0.47 per cent for treatment T_1, T_2, T_3 and T_4, respectively. The values recorded were found to be increasing order from treatment T_1 to T_4. This might be due to excess amount of mineral than buffalo milk.

Viscosity of germinated sorghum grains extract blended skim milk *lassi*

It was clearly observed from table 9, that total viscosity of *lassi* samples was increased as the germinated sorghum grains extract proportion in blend increased. The mean value for viscosity of *lassi* samples were observed as 27.21, 27.62, 28.38 and 28.50 for T_1, T_2, T_3 and T_4, respectively. The highest viscosity was recorded for treatment T_4 i.e. 28.50 while lowest viscosity was recorded for treatment T_1 i.e 27.21. The increased viscosity of extract added *lassi* due to extract contained germinated sorghum extract having more viscosity. Among all the treatments of developed *lassi*, the treatments T1 and T2, T3 and T4 were at par with each other. The present results were in agreement with following research workers.

Table 9: Viscosity of germinated sorghum grains extract blended skim milk *lassi* (in cps, at 100 rpm, spindle size 61)

Replication/ Treatment	R_1	R_2	R_3	R_4	Mean
T_1	27.12	27.18	27.22	27.33	27.21^a
T_2	27.12	27.22	28.12	28.00	27.62^a
T_3	28.21	28.91	28.22	28.18	28.38^b
T_4	28.32	28.91	28.27	28.51	28.50^b
S.E. = ± 0.174204 C.D. at 5% = 0.536775					

The values with different small letters superscripts row wise differ significantly at 5 per cent level of significance.

The result secured with Modha and Pal (2011) [15], studied that effect of two milk solid source namely beverage made from butter milk and skim milk. The viscosity of beverage prepared from buttermilk (58cp) was higher than that of skim milk (53cp) based beverage. Pintu and Verma (2019) [20], optimized rabadi like sorghum based fermented milk beverage. The effect of milk solid source namely, sour buttermilk and skim milk, were tried. The viscosity of beverage prepared from sour buttermilk (62cp) was slightly higher than that skim milk (55cp) based beverage.

Iron content of germinated sorghum grains extract blended skim milk*lassi*

It was clearly observed from table 10, that total iron content of *lassi* samples was increased as the germinated sorghum grains extract proportion in blend increased. The mean value for iron mineral of *lassi* samples were observed as 8.75, 12.75, 14.00 and 16.00 for T_1, T_2, T_3 and T_4 respectively. The highest iron content was recorded for treatment T_4 i.e. 16.00 whereas, lowest iron contents was recorded for treatment T_1 i.e. 8.75. The increased iron in extract added *lassi* due to germination appeared to be a promising food processing method to improve bioavailability of minerals and to decrease phytate levels and therefore to decrease deficiencies of minerals. In all above treatments T_2, T_3 and T_4 were at par with each other with some significant difference. The treatment T_1 had shown significant differed from all others treatments.

Table 10: Iron content of germinated sorghum grains extract blended skim milk *lassi* (in ppm)

Replication/Treatment	R_1	R_2	R_3	R_4	Mean
T_1	9	9	9	8	8.75^a
T_2	12	14	12	13	12.75^b
T_3	13	16	14	13	14.00^{bc}
T_4	15	15	16	18	16.00^{bcd}
S.E. = ± 0.568258 C.D. at 5% = 1.750976					

The values with different small letters superscripts row wise differ significantly at 5 per cent level of significance.

The findings were in comparable with Basu and Tomar (2016) [2], reported total iron (Fe) mineral content for pearl millet based fermented skim milk products were 8.27, 8.37 and 8.41 mg/100gm and average value of iron 8.35 mg/100gm recorded from three observations. Prabhakar (2018), reported that average chemical composition mango fortified bajra *lassi* of treatment T_0, T_1, T_2, T_3 and T_4 contained iron 1.97, 5.26, 5.32, 6.87 and 6.91 ppm, respectively. Karche and chavan (2019) [11], recorded iron content of finger millet fermented drink were 345, 354, 358 and 361µg/lit for treatmentT_0, T_1, T_2 and T_4, respectively.

Zinc content of germinated sorghum grains extract blended skim milk *Lassi*

It was clearly observed from Table 11, that total zinc content of *lassi* samples was increased as the germinated sorghum grains extract proportion in blend increased. The mean value for zinc mineral of *lassi* samples were observed as 7.00 8.75, 9.00 and 9.25 for T_1, T_2, T_3 and T_4 respectively. The highest zinc content was recorded for treatment T_4 i.e. 9.25 whereas, lowest zinc contents was recorded for treatment T_1 i.e. 7.00. The increased zinc in extract added *lassi* due to extract contained germinated sorghum flour and germination appeared to be a promising food processing method to improve bioavailability of minerals and to decrease phytate levels and therefore to decrease deficiencies of minerals. In all above treatments T_1, T_2 and T_3 were at par with each other with no significant difference. The treatment T_1 had shown significant differed from all others treatments. The present results were in agreement with following research workers.

Table 11: Zinc content of germinated sorghum grains extract blended skim milk *lassi* (in ppm)

Replication/ Treatment	R_1	R_2	R_3	R_4	Mean
T_1	6	7	8	7	7.00^a
T_2	9	8	8	10	8.75^b
T_3	9	8	10	9	9.00^b
T_4	10	9	10	8	9.25^b
S.E.± 0.444818 C.D. at 5% 1.370806					

The values with different small letters superscripts row wise differ significantly at 5 per cent level of significance.

The findings were in comparable with Basu and tomar (2016) [2], preparation of pearl millet based fermented skim milk product. Reported total iron (Zn) mineral content for pearl millet based fermented skim milk products were 3.71, 3.82 and 3.91 mg/100gm and average value of zinc 3.83mg/100gm recorded from three observations.

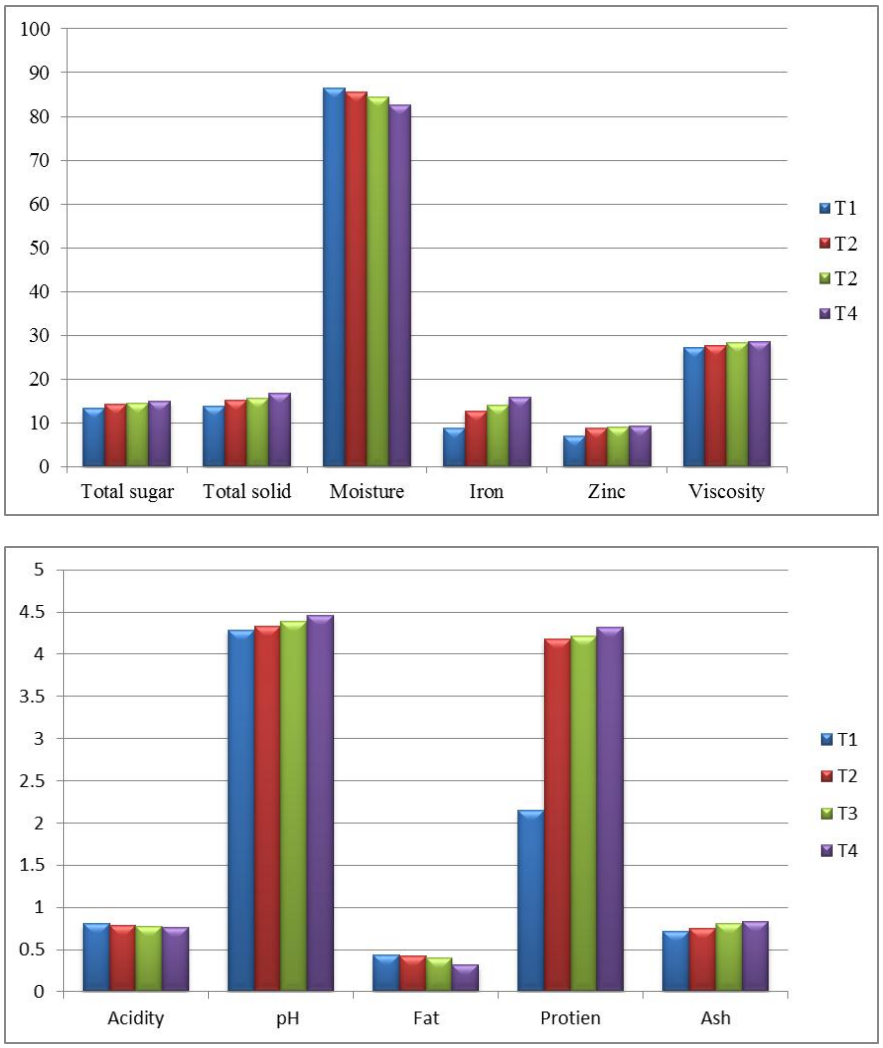

Fig 1: Graphical representation for physicochemical properties of germinated sorghum grains extract blended *lassi*

Conclusion

The developed sorghum based *lassi* highly nutritious having more iron and zinc content compared with the normal *lassi* may be prepared by using improved varieties developed by Vasantrao Naik Marathwada Krishi Vidhyapeeth i.e. Parbhani Shakti. The combination of skim milk and germinated sorghum grains extract for *lassi* was 70:30 produce acceptable, and comparatively cheaper *lassi* as far as processing technology is concerned.

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