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Studies on chemical quality of finger millet (*Eleusine coracana*) based fermented drink

RV Karche and Dr. KD Chavan

Abstract
Process for preparation of finger millet (*Eleusine coracana*) fermented Drink" was standardized with view to develop the product of better nutritional quality. Preliminary trials were conducted to choose the levels of finger millet flour in the fermented drink. The average chemical composition of fresh fermented drink prepared under different treatment combinations ranged from 2.14 (T_3) to 2.54 (T_0) per cent fat, 2.31 (T_0) to 2.41 (T_3) per cent protein, 15.21 (T_0) to 18.57 (T_3) per cent total solids, 2.19 (T_3) to 2.56 (T_0) per cent lactose, 0.72 (T_0) to 0.88 (T_3) per cent lactic acid, 3.64 (T_3) to 4.16 (T_0) pH. There was significant ($P< 0.05$) differences in the chemical constituents during storage at refrigeration temperature (5 ± 2^0C). The mineral content of fresh fermented drink prepared under different treatment samples varied from 0.65 (T_0) to 0.71 (T_3) g/lit Calcium, 0.95 (T_0) to 0.99 (T_3) g/lit Phosphorus, 345 (T_0) to 361 (T_3) µg/lit Iron and 0.050 (T_0) to 0.0.53 (T_3) g/lit Magnesium. The mineral content in the different samples of fermented drink did not significantly influenced due to incorporation of finger millet flour in the product. The fat, protein, total solids, lactose, titratable acidity and pH of fermented drink samples varied from 1.76 (T_3) to 2.54 (T_0) per cent, 2.08 (T_0) to 2.41 (T_3) per cent, 15.21 (T_0) to 18.74(T_3) per cent, 1.84 (T_3) to 2.56 (T_0) per cent, 0.72 (T_0) to 0.99 (T_3) per cent L. A. and 3.40 (T_3) to 4.16 (T_0), respectively upto 15 days of storage period.

Keywords: finger millet, fermented drink, chemical constituents

Introduction
Fermentation is one of the oldest and most economical method of producing and preserving milk. It is value addition and conversion of raw milk by microorganisms and enzymes into various types of products with distinct nutritional and sensory properties. Fermentation further enhances the nutritive value, palatability and functionality of cereals by reducing the antinutritional factors. Developments of technologies for the manufacture of cereal based fermented milk beverages will lead to the utilization of cereals like sorghum, pearl millet, finger millet (*Eleusine coracana*) etc.

Fermented foods not only provide nutrition but also confer a number of health benefits like immune system modulation, reduction in serum cholesterol, antihypertensive, anticancer and antidiabetic effect (Khetra *et al.,* 2011) [20].

All foods are functional to some extent because all foods provide taste, aroma and nutritive value. However, foods are now being examined intensively for added physiologic benefits, which may reduce chronic disease risk or otherwise optimize health. It is these research efforts that have led to the global interest in the growing food category now recognized as "functional foods."

Functional foods are generally described as foods and beverages that provide health benefits beyond their inherent nutritional value. It includes products that provide essential nutrients often beyond quantities necessary for normal maintenance, growth and development, and/or biologically active components that impart health benefits or desirable physiological effects. These products are similar to conventional foods in organoleptic attributes except that they have been enriched or formulated with ingredients possessing proven health benefits like calcium-enriched milk, probiotic dairy foods, phytosterol containing margarine and fibre enriched bakery foods among others.

Nutricereals are one of the economical and nutritious food sources in the human diet. Cereal/millets also have potential to incorporate in dairy product formulation because of their richness in fibre, oligosaccharides, free amino acids and certain minerals which promote the health of human beings. Addition of cereals into milk not only enriches its mineral value but also supplements fibre.

In India finger millet (*Eleusine coracana*) is one of the important nutricereals occupies highest area under cultivation among the small millets. Finger millet is comparable to rice with regard to protein (6-8%) and fat (1-2%) and is superior to rice and wheat with respect to mineral and micronutrient contents. It is a major source of dietary carbohydrates for a large section of society. Additionally finger millet (*Eleusine coracana*) has enormous health benefits and also a good source of valuable micro-nutrients along with the major food components. In order to develop the value added food products based on finger millet (*Eleusine coracana*), that can able to enrich the nutritional value and also beneficial for good health.

Finger millet (Ragi, *Eleusine corcana*) is an important staple food in the eastern and Central Africa as well as some parts of India (Majumder *et al.*, 2006) [21]. It is rich in protein, iron, calcium, phosphorus, fibre and vitamin content. The calcium content is higher than all cereals. It is a good source of diet for growing children expecting women, old age people and patients (Desai *et al.*, 2006) [6].

Per 100 g edible portion of finger millet contains 72.6 g carbohydrate, 7.7 g protein, 1.5 g fat, 3.6 g crude fibre, 2.7 g ash, 344.0 mg calcium, 250 mg phosphorus, 6.3 mg iron, 3.5 mg manganese, 130 mg magnesium and 12% moisture (FAO, 1998) [7].

At the beginning of 20th century, Metchnikoff (1908) suggested consumption of milk fermented with a flora of human intestinal origin, such as, *Lactobacilli,* and he claimed that longevity of the Bulgarians resulted from the consumption of these milks. The organism he recommended was *Bacillus bulgaricus,* which later identified as *Bacillus acidophilus.* In the later years, the name of this organism was changed to *Lactobacillus acidophilus* (Gililand, 1979) [9].

Increased consumer's interest in the health benefits of food have led to the significant development of functional foods and nutraceuticals. Keeping these facts in view, the proposed investigation has been planned to develop finger millet *(Eleusine coracana)* based functional fermented drink.

Materials and Methods

Milk

The fresh crossbred cow milk samples were procured from Research Cum Development project (RCDP) on Cattle, Department of Animal Husbandry and Dairy Science, Mahatma Phule Krishi Vidyapeeth, Rahuri District-Ahmednagar (Maharashtra) for preparation of fermented drink.

Chemicals

All the chemicals used for analysis were of analytical grade (AR) and guaranteed reagents (GR) manufactured by the BDN, Sarabhai Chemicals, Glaxo India Ltd. Mumbai (India).

Electronic balance

The electronic "Anamade precision balance BT 2245, Sartorius ISO 9001, manufactured by Sharp Electronics, Pune was used for weighments.

Packaging material

Two hundred fifty ml capacity sterilized glass bottles with lids were used for packaging of fermented drink.

Hot air oven

An instrument manufactured by M/S Oswal Laboratories Corporation, Mumbai (India) was used for drying purposes.

Incubator

The digital temperature controlled B.O.D. incubator manufactured by M/S. Neutronic, Bombay was used for incubation of *Lb. acidophilus*, coliform and yeast and moulds counts from the prepared products.

Autoclave

An instrument manufactured by M/S Oswal Laboratories Corporation, Mumbai (India) was used for autoclaving purpose throughout the study period.

Colony Counter

A colony counter with hand operated magnifying lens manufactured by M/S Oswal Laboratories Corporation, Mumbai (India) was used for counting the colonies developed by microorganisms.

Laminar Air Flow

An instrument manufactured by Kirloskar Electrodyne Ltd., Mumbai (India) was used for microbiological work.

Digital pH meter

Digital pH meter manufactured by M/S Systronics (India) Limited, Ahmedabad (India) was used for determination of pH of the samples under study.

Thermometer

Thermometer made by M/S Jenson Deluxe type thermometer was used.

Muffle furnace

M/S New Technolab Instruments, Nashik (India) muffle furnace was used for determination of ash content in the samples under study.

Brabender flour mill unit

Brabender flour mill (Model: Quadrumat Junior, Plate 1) manufactured by Western Germany available in Wheat Quality Control Laboratory, Department of Food Science and Technology, Mahatma Phule Krishi Vidyapeeth, Rahuri (M. S.) was used for preparation of finger millet flour and screening of flour was done using 60 mesh screen.

Finger millet (*Eleusine coracana*)

Good quality finger millet grains were purchased from the local market.

Sugar

Good quality sugar was purchased from local market.

Water

Sterilized water was used to prepare the fermented drink.

Starter cultutre, its maintenance and propagation

The freeze dried pure culture of *Lactobacillus acidophilus*was procured from the National Collection of Dairy Cultures (NCDC), Division of Dairy Microbiology, National Dairy Research Institute, Karnal, Haryana (India). The culture was maintained in sterilized skim milk in the test tube.

The sterilized skim milk test tube was inoculated with the culture and incubated at 37^{0}C for 8 hour and thereafter stored at refrigerated temperature. In order to keep the culture active to propagate at frequent intervals.

Preliminary trials

Preliminary trials were conducted to choose the levels of finger millet (*Eleusine coracana*) flour and water in the product. The prepared samples of product were subjected to sensory evaluation.

Following levels of finger millet flour were used to conduct preliminary trials,

T_0 : Control (without addition of finger millet flour)
T_1 : 1 gram finger millet flour + 99 ml milk
T_2 : 2 gram finger millet flour + 98 ml milk
T_3 : 3 gram finger millet flour + 97 ml milk
T_4 : 4 gram finger millet flour + 96 ml milk
T_5 : 5 gram finger millet flour + 95 ml milk
T_6 : 6 gram finger millet flour + 94 ml milk

Preparation of finger millet flour

The decortication of finger millet, was performed using standardized process as per the recommendation of Department of Food Science and Technology (Anon, 2012). The grains were cleaned and soaked in water for 6 hour and then steamed in a pressure cooker for 6 min followed by drying in dryer at 60^{0}C for 5 hours. The grains were conditioned using water at 2 per cent, tempered for 1 hour and dried in shade for 2 hours and milled in Brabender flour mill. This treatment resulted in production of whitish *ragi* flour.

Preparation of fermented drink

The finger millet fermented drink was prepared by using standard technique described by De (2008) [5] with suitable modifications.

Receiving milk
↓
Filtration/Clarification
↓
Pasteurization of milk (71^{0}C/15 sec.)
↓
Cooling milk (40^{0}C)
↓
Addition of finger millet (*Eleusine coracana*) flour
(As per treatments)
↓
Inoculation (with starter culture *Lactobacillus acidophilus* @ 1.5%)
↓
Incubation at 37^0 C (7.30 hours)
↓
Addition of sugar and water (@ 8% and 25%)
↓
Mixing
↓
Packaging in glass bottles
↓
Storage (5±2^{0}C)

Flow chart of preparation fermented drink

Experimental trials

Three levels of finger millet flour viz., 3, 4 and 5 per cent were chosen from preliminary trials and used for preparation of fermented drink by keeping 8% sugar and 25% sterilized water constant in the product.

Experimental treatment details

T_0 : Control (without addition of finger millet flour)
T_1 : 3 gram finger millet flour + 97 ml milk
T_2 : 4 gram finger millet flour + 96 ml milk
T_3 : 5 gram finger millet flour + 95 ml milk

Chemical analysis of milk

Fat

The fat content of milk was determined as per Gerber method described in IS: 1224, Part I, 1977 [12].

Protein

The protein content of milk was determined by Micro-Kjeldahl method as per the procedure recommended in IS: 1479 (part-II) (1961) [14].

Total Solids

The total solids content of milk was determined as per the gravimetric method given in IS: 1479 Part-II (1961) [14].

Lactose

The lactose content of milk was determined as per IS: 1479 (Part-II) 1961 [14], By Lane and Eynon method.

Titratable acidity (% lactic acid)

The titratable acidity of milk was determined as per the method given in IS: 1479, Part –I (1960) [13].

pH

The pH of milk was determined by using Systronic digital pH meter.

Mineral content

Mineral (Calcium, phosphorus, iron and magnesium) content of milk, finger millet and finger millet fermented drink was estimated as per the procedure given by Mani (2011) [22] using Atomic Absorption Photo spectrometer.

Chemical analysis of Finger Millet (*Eleusine coracana*) flour

The finger millet flour was analyzed for fat, protein, total fibre content, minerals viz; calcium, phosphorus, iron, magnesium and potassium.

Fat

The fat was determined by Soxhlet extraction method given in A. O. A. C. (1990).

Protein

The protein content was determined by Micro Kjeldhal method given in A.O.A.C. (1990).

Storage studies

The samples of fermented drink prepared under different treatment combinations were immediately filled in sterilized 250 ml capacity glass bottles, sealed under aseptic conditions and stored at refrigerated temperature (5 ± 2^{0}C) for 20 days. The samples were withdrawn and monitored at predetermined intervals of 5 days and analyzed for chemical quality on day 0, 5, 10 and 15. The analysis of stored samples was discontinued when the product became unfit for consumption.

Chemical analysis of fermented drink

Fat

The fat content of fermented drink samples was determined by Gerber method as described in IS: 1224, Part-I (1977) [12].

Protein
The protein content of fermented drink samples was determined by estimating the per cent nitrogen by Micro-Kjeldhal method as recommended in IS: 1479 Part-II (1961) [14]. The per cent nitrogen was multiplied by 6.25 to find out protein percentage.

Total solids
The total solids content was determined by Gravimetric method as per procedure given in IS: 1966 (Part-II, 1983) [15].

Lactose
The lactose content was determined as per procedure of Lane-Eynon in SP: 18 (Part-XI, 1981).

Titratable acidity (% lactic acid)
The lactic acidity of fermented drink samples was determined by using the method prescribed in IS: 1479 (Part I), 1960 [13].

pH
The pH of the samples was determined by using Systronic digital pH meter.

Sensory quality
The fermented drink samples prepared under different preliminary and experimental trials were subjected to sensory evaluation using the method described in the IS: 6273, Part-I and Part- II (1971) [16] adopting 9 point Hedonic scale.

Statistical design and analysis of data
The experiment was laid out in Completely Randomized Design (CRD) with 5 replications for preliminary and 4 replications for experimental trials.
The experimental data was analyzed using the Statistical methods of Snedeeor and Cochran (1994) [25].

Results and Discussion
Chemical composition of milk
The cow milk used for preparation of fermented drink, had an average fat 3.2 per cent, protein 3.6 per cent, lactose 4.67 per cent, Total solids 12.12 per cent, titratable acidity 0.14 per cent L.A., pH 6.6 and ash 0.65 per cent. The average Calcium, Phosphorus, Iron and Magnesium and Potassium content were 1.18 gram/litre, 0.87 gm/litre, 4.8 ug/litre and 0.09 gm/litre, 145 mg/litre of milk (Table1).

Table 1: Chemical composition of milk

Milk constituent	Composition
Fat	3.2%
Protein	3.6%
Lactose	4.67%
Total solids	12.12%
Titratable acidity	0.14% L. A.
pH	6.6
Ash	0.65%
Calcium	1.18 g/ litre of milk
Phosphorus	0.87 g/ litre of milk
Iron	438 µg/ litre of milk
Magnesium	0.09 g/ litre of milk
Potassium	145 mg

Chemical composition of finger millet (*Eleusine coracana*)

Table 2: Chemical composition of decorticated finger millet (*Eleusine coracana*) flour

Constituent	Composition (per 100 gm)
Fat	1.1 g
Protein	6.1 g
Fibre	3.3 g
Calcium	169 mg
Phosphorus	95 mg
Iron	3.3 µg
Magnesium	47 mg
Potassium	122 mg

The average chemical composition of finger millet (*Eleusine coracana*) flour used for preparation of fermented drink had fat 1.1 g, protein 6.1 g, fibre content 3.3 g. The Calcium, Phosphorus, Iron and Magnesium and Potassium were 169 mg, 95 mg, 3.3 µg, 47 mg and 122 mg.

Preliminary trials
Preliminary trials were conducted to choose the levels of finger millet flour and water in the product. The samples of fermented drink were prepared with six levels of finger millet flour as 1 (T_1), 2 (T_2), 3 (T_3), 4 (T_4), 5 (T_5) and 6(T_6) per cent. The sugar level was kept constant @ 8 per cent and sterilized water was added @ 25 per cent of volume of dahi.

Chemical composition of fermented drink during storage
Fat
The mean fat content of fresh and stored samples of fermented drink are presented in Table 3.

Table 3: Effect of different levels of finger millet flour on fat content (%) of fermented drink during storage

Treatment	Storage period			
	Day 0	Day 5	Day 10	Day 15
T_0	2.54^d	2.54^d	2.24^b	2.14^d
T_1	2.36^c	2.36^c	2.24^b	2.04^{bc}
T_2	2.26^b	2.26^b	2.24^b	2.02^b
T_3	2.14^a	2.14^a	2.1^a	1.76^a
SE $\pm$	0.0245	0.024494897	0.0212	0.0212
CD at 5%	0.0734	0.073435674	0.0636	0.0636

The average fat content of freshly prepared fermented drink sample was 2.32 per cent. The mean fat content (Table4.8) of fresh fermented drink ranged from 2.14 (T_3) to 2.54 (T_0) per cent. There was significant ($P<0.05$) difference among all the treatments during storage. The fat content in the product decreased as the level of addition of finger millet flour increased. It is also due to added water while manufacture of the product.
The values for the fat content observed in this investigation agree with the research report of Pardhi (2013) [23] who observed the fat content of finger millet lassi decreased from 2.70 to 1.82 with increased level of the finger millet flour and water.
From Table, it was revealed that, fat content decreased significantly ($P < 0.05$) during storage. The fat content of all treatments were remained same upto 5th day of refrigerated storage, i.e., 2.54, 2.36, 2.26 and 2.14 per cent for treatmentT_0, T_1, T_2 and T_3 respectively. On 10th day of

storage, the values of fat for the treatments T_0, T_1 and T_2 were at par.

From 10th day of storage the fat content of all treatment showed decreasing trend with increased storage period. The fat content of fermented drink decreased from 2.54 to 2.14, 2.04, 2.02 and 1.76 per cent for treatmentT_0, T_1, T_2 and T_3 respectively from 0 day to 15th day of storage. On 15th day of storage, the treatments T_1 and T_2were at par.

This decrease in the fat content of the fermented drink samples might be due to lypolytic activity of bacteria in the product. Similar findings were reported by Huma *et al.* (2003) [10], Kauser *et al.* (2011) [18] and Selvamuthukumaran and Farhath (2014) [24].

Protein

The mean protein content of fresh and stored samples of fermented drink are presented in Table 4.

Table 4: Effect of different levels of finger millet flour on protein content (%) of fermented drink during storage

Treatment	Storage period			
	Day 0	Day 5	Day 10	Day 15
T_0	2.31a	2.31a	2.29a	2.08a
T_1	2.35b	2.33ab	2.32b	2.12b
T_2	2.38c	2.38c	2.37c	2.12b
T_3	2.41d	2.40d	2.38cd	2.08a
SE ±	0.0047	0.003464	0.0062	0.03
CD at 5%	0.0141	0.010385	0.0186	NS

The average protein content of freshly prepared fermented drink sample was 2.36 per cent. The mean protein content (Table4.9) of fresh fermented drink ranged from 2.31 (T_0) to 2.41 (T_3) per cent. There was significant (P<0.05) difference among all the treatments during storage. The protein content in the product increased as the level of addition of finger millet flour increased. It was due to protein content of the finger millet flour.

The values for the protein content observed in this investigation agree with the research report of Pardhi (2013) [23] who observed the protein content of finger millet lassi increased from 1.82 to 2.70 with increasing the levels of the finger millet flour.

From Table Table, it was revealed that, proteincontent decreased significantly (P < 0.05) during storage. The mean proteincontent of fermented drink samples were decreased from 2.31 to 2.08, 2.35 to 2.12, 2.38 to 2.12 and 2.41 to 2.08 for treatments T_0, T_1, T_2 and T_3, respectively from day 0 to 15th day of storage. On 15th day of storage, the treatments T_1 (2.04) and T_2 (2.02) were at par and all the treatment showed non-significant difference among them. The decrease in protein content during storage might be due to protein degradation leading to formation of soluble compounds (Ghalem and Zouaoui, 2013) [8] and proteolytic activity of bacteria. Due to proteolytic activity, proteins break down to some dipeptides and amino acids and also some volatile compounds. As the storage period progressed, the amount of proteins in the fermented drink samples decreased.

The results are in accordance with Ghalem and Zouaoui (2013) [8], Selvamuthukumar and Farhath (2014) [24] and Kavas and Kavas (2016) [19].

Total solids

The mean total solids content of fresh and stored samples of fermented drink are presented in Table 5.

Table 5: Effect of different levels of finger millet flour on total solids content (%) of fermented drink during storage

Treatment	Storage period			
	Day 0	Day 5	Day 10	Day 15
T_0	15.21a	15.27a	15.31a	15.41a
T_1	17.48b	17.57b	17.62b	17.71b
T_2	17.93c	18.08c	18.10c	18.11c
T_3	18.51d	18.60d	18.64d	18.74d
SE ±	0.0054	0.006819	0.0051	0.0147
CD at 5%	0.0163	0.020444	0.0154	0.0441

The average total solids content of freshly prepared fermented drink sample was 17.28 per cent. The mean total solids content in the fresh fermented drink were 15.21 (T_0), 17.48 (T_1), 17.93 (T_2) and 18.51 (T_3) per cent respectively. The influence of addition of finger millet flour in the fresh fermented drink significantly (P<0.05) influenced the total solids content of the product. All the treatments significantly differed among themselves. The values of the total solids content of the product significantly (P<0.05) increased as the level of addition of finger millet flour increased. The values of the total solids content reported by Pardhi (2013) [23] were increased from 21.53 to 23.11 per cent with increasing level of finger millet flour. Jain (2009) [17] also reported the total solids of oat based functional fermented product increased nearly to 3.5 per cent due to incorporation of oat flour.

From Table 5, it was revealed that, total solids content was increased during storage. All the treatments differed significantly (*P* < 0.05) from each other during entire storage period. The mean total solids content in fermented drink samples during storage was varied from 15.21 to 18.74 per cent from day 0 to 15th day of storage. An increase in total solids during storage could be the result of loss of moisture from the samples of the product.

The results are in agreement with the reports of Chopade (2012) [4], who reported that, increase in total solids was might be due to decrease in moisture content of the refrigerated stored samples. The total solids of the cereal based probiotic health drink increased from 10.26 to 10.31 per cent upto 20 hours of storage.

Lactose

The mean lactose of fresh and stored samples of fermented drink are presented in Table 6.

Table 6: Effect of different levels of finger millet flour on lactose content (%) offermented drink during storage

Treatment	Storage period			
	Day 0	Day 5	Day 10	Day 15
T_0	2.56d	2.21d	2.20d	2.06d
T_1	2.50c	1.97c	1.95c	1.92b
T_2	2.34b	1.94b	1.92b	1.96c
T_3	2.19a	1.91a	1.89a	1.84a
SE ±	0.0072	0.003162	0.0032	0.0032
CD at 5%	0.0217	0.009481	0.0095	0.0095

The average lactose content of freshly prepared fermented drink sample was 2.39 per cent. The mean lactose content (Table 4.11) of fresh fermented drink ranged from 2.19 (T_3) to 2.56 (T_0) per cent. There was significant (P<0.05) difference among all the treatments during storage. The lactose content in the product decreased as the level of addition of finger millet flour increased.

It was revealed that, lactosecontent decreased significantly (P < 0.05) during storage. The mean lactosecontent of fermented

drink samples were decreased from 2.56 to 2.06, 2.50 to 1.92, 2.34 to 1.96 and 2.19 to 1.84 for treatments T_0, T_1, T_2 and T_3, respectively from day 0 to 15th day of storage.
The values of present investigation are in accordance with which reported by Ghalem and Zouaoui (2013) [8] and Kavas and Kavas (2016) [19].
Ghalem and Zouaoui (2013) [8] prepared steamed yoghurt treated with *Chamaemelum* and *Lavendula species* commercial extracts at the concentration of 0.14, 0.21, 0.29 and 0.36 g/L of milk (C_1, C_2, C_3, C_4 and L_1, L_2, L_3, L_4, Control as C) and noticed that, there is decrease in lactose per cent during 2nd to 21st day of storage in case of Control (C) sample -15.0 to 11.34 per cent. C_1, C_2, C_3 andC_4 as- 14.65 to 14.64, 14.65 to 14.57, 14.65 to 14.23 and 14.64 to 13.43 and L_1, L_2, L_3, L_4 – as- 14.65 to 14.64, 14.65 to 14.63, 14.64 to 14.52, 14.63 to 14.40, per cent respectively.

Titratable acidity

Lactic acidity of dairy product is one of the important parameter for consumer's acceptance. The mean lactic acidity (% LA) content of finger millet fermented drink is presented in Table 7. The influence of incorporation of finger millet flour on the lactic acidity of finger millet based fermented drink was significant (P< 0.05) during storage.

Table 7: Effect of different levels of finger millet flour on titratable acidity (% lactic acid) of fermented drink during storage

Treatment	Storage period			
	Day 0	Day 5	Day 10	Day 15
T_0	0.72^a	0.84^b	0.87^a	0.88^a
T_1	0.76^b	0.82^a	0.87^{ab}	0.88^a
T_2	0.80^c	0.85^c	0.88^c	0.89^{ab}
T_3	0.88^d	0.93^d	0.94^d	0.99^c
SE $\pm$	0.0062	0.004062	0.0026	0.0035
CD at 5%	0.0185	0.012178	0.0079	0.0104

The average acidity content of fresh samples was 0.79 per cent LA. The mean lactic acidity content was ranged from 0.72 to 0.88, 0.76 to 0.88, 0.80 to 0.89 and 0.88 to 0.99 per cent LA. For treatments T_0, T_1, T_2 and T_3 respectively, from day 0 to 15th day of storage at refrigeration temperature (5 ± 2^0C). The acidity of fresh fermented drink ranged from 0.72 to 0.88 per cent L. A. (Table 4.12). All the treatments significantly (P<0.05) differed among them selvesduring storage period. The treatment T_3 had highest acidity i. e. 0.88 per cent LA whereas treatment T_0 had lowest acidity i.e. 0.72 per cent LA.
These results are in collaboration with Jain (2009) [17], Inyang and Idoko (2006) [11], Ali and Mustafa (2009) [1] and Arora *et al.* (2010) [3]. Jain (2009) [17] reported that the per cent lactic acid of freshly prepared oat based functional fermented product ranged from 0.628 to 0.690 per cent. The sample treatments T_0, and T_1 were at par on 15th day of storage period. The sample treatments T_0, T_1 and T_2 were at par on 15th day of storage period.
During storage there was increase in the acidity content of all the fermented drink samples during the period of 15 days storage. This increase in acidity is due to conversion of lactose in to lactic acid as a result of microbial activity and formation of organic acids such as formic acid and CO_2 in the product.
The results are in agreement with the findings of Jain (2009) [17] who observed that the acidity of oat based functional fermented product samples were significantly higher (0.6 to 1.3 % LA) at the end of 28th day storage period as compared to the 0th day.

pH

The mean pH of fresh and stored samples of fermented drink are presented in Table 8.

Table 8: Effect of different levels of finger millet flour on pH of fermented drink during storage

Treatment	Storage period			
	Day 0	Day 5	Day 10	Day 15
T_0	4.16^d	3.800^d	3.7^d	3.56^{bc}
T_1	3.88^{bc}	3.674^c	3.654^c	3.56^{bc}
T_2	3.78^b	3.612^b	3.602^b	3.6^{cd}
T_3	3.64^a	3.504^a	3.500^a	3.4^a
SE $\pm$	0.0353	0.0041	0.0114	0.0235
CD at 5%	0.1059	0.0122	0.0342	0.0703

The average pH of freshly prepared fermented drink sample was 3.86. The pH of fermented drink samples ranged from 3.8 to 3.56 from 5th day to 15th day of storage. During storage there was gradual but statistically significant (P<0.05) decreasing trend observed in all samples. The decrease in pH was due to lactic acid production by the microbes in the product. The pH values in the fresh product sample of treatment $T_1$and T_2 were at par.pH of the product is related with the acidity. As the acidity of the product increases, pH of the product decreases. Jain (2009) [17] reported that the initial pH values of all samples of A, B, C of oat based functional fermented product was similar (around 4.5) at 0 day, and it decreased to 3.9 on 28th day of storage.
From Table 8, it is revealed that the pH of fermented drink decreased with increasing storage period. On 15th day of storage, treatments T_0, T_1, T_2 were at par. Jain (2009) [17] also reported the same trend of decrease in pH with increasing storage period in oat based functional fermented product.

Mineral contents of fresh finger millet fermented drink

The mineral contents of fresh finger millet fermented drink are given in Table 9. It is seen that the values for mineral contents varied from 0.95 to 0.99 g//lit, 0.65 to 0.71 g/lit, 345 to 361 µg/lit and 0.050 to 0.053 g/lit for Calcium (Ca), Phosphorus (P), Iron (Fe) and Magnesium, respectively.

Table 9: Mineral content of fresh finger millet fermented drink

Treatment	Calcium (g/lit)	Phosphorus (g/lit)	Iron (µg/lit)	Magnesium (g/lit)
T_0	0.95	0.65	345	0.050
T_1	0.96	0.67	354	0.051
T_2	0.97	0.68	358	0.052
T_3	0.99	0.71	361	0.053
SE $\pm$	0.0045	0.0031	1.6534	0.0002
CD at 5%	NS	NS	NS	NS

Conclusions

From the present investigation, It is concluded that an acceptable quality of finger millet based functional probiotic fermented drink can be developed using 4 per cent finger millet flour, 8 per cent sugar and 25 per cent sterilized water. The product had shelf life of at least 15 days at 5±2^0C temperature with minor physicochemical changes.

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