Bulletin of Environment, Pharmacology and Life Sciences
Bull. Env. Pharmacol. Life Sci., Vol 7 [1] December : 95-103

Online ISSN 2277-1808
Journal's URL:http://www.bepls.com
CODEN: BEPLAD
Global Impact Factor 0.876
Universal Impact Factor 0.9804
NAAS Rating 4.95

ORIGINAL ARTICLE **OPEN ACCESS**

Effect of oat flour addition on the physico-chemical properties of synbiotic milk drink

Praveen Kumar Tiwari[1*], Shakeel Asgar[1], Sudhir Uprit[1], Manorama Chauhan[2], K. K. Choudhary[3], Kushal Kumar Sandey[4]

1. Department of Dairy Technology, College of Dairy Science and Food Technology, Raipur
2. Department of Dairy Microbiology, College of Dairy Science and Food Technology, Raipur
3. Department of Diary Business Management, College of Dairy Science and Food Technology, Raipur
4. Department of Dairy Engineering, College of Dairy Science and Food Technology, Raipur

*Corresponding author :Praveen.tiwari0611@gmail.com

ABSTRACT

The addition of prebiotic substrates in the probiotic product helps in colonizing the probiotic microorganisms in the human intestine. The oats and probiotics have long been recognized for their health benefits.The main purpose of this work was to develop the milk drink containing different concentrations of oat flour and asses the physico-chemical changes, due to its addition.The synbiotic milk drink was developed by using double toned milk (1.5 % fat and 9.0% SNF), in which different concentration of oat flour (0, 0.5, 1.0 and 1.5 %) were added along with fixed level of sugar (7%) and inoculated with 1:1 probiotic culture (1%) L. casei NCDC 019 and L. acidophilus NCDC 014.Addition of oat increased the chemical composition of the symbiotic milk drink as well as the acidity, viscosity and specific gravity of the product. The product made from 1.5 % oat flour i.e. T_3 contained 1.5 % fat, 3.18 % protein, 12.37 % carbohydrates, 0.80 % ash, 17.85 % total solids, 6.11 cp viscosity, 1.070 specific gravity and 0.21 % LA acidity. During storage, the fat, protein, ash, total carbohydrates and total solids were decreased but the decrease were found to be non-significant, whereas the acidity, viscosity and specific gravity were increased with an increase in storage period.

***Keywords**: Synbiotic, oat flour, probiotics, prebiotics,physico-chemical, shelf-life.*

Received 16.08.2017 Revised 19.10.2017 Accepted 12.11. 2017

INTRODUCTION

Now a day's people are becoming health conscious and moving to foods which gives health and nutritional benefit with good taste. Milk and milk products can be important in diversifying the diet.In the present scenario, with the increasing interest of consumers towards nutraceuticals and functional foods, there is a limited number of presence of fortified milk products containing bioactive compounds. There are very less dairy based functional products are present in the market, but the consumers are raising their demand for dairy products with functional properties, and this demand for functional foods is becoming the key factor for driving value sales growth in developed markets.Many bioactive ingredients such as omega 3-fatty acids, plant sterols, probiotics, prebiotics and bioactive peptides are added in functional dairy beverages with the purpose of delivering specific health benefits. Milk based beverages are becoming popular due to its easy availability, high nutrition, higher palatability and convenience can act as an ideal vehicles for delivery of bioactive compounds [29].

Milk or milk products when added with beneficial microorganisms i.e. probiotics, contributes in improvement of health and provide numerous health benefits. According to the Food and Agriculture Organization (FAO) and World Health Organization (WHO), probiotics are live microorganisms that provide health benefits to the consumers when used in adequate amounts. In human probiotics microorganisms, lactic acid bacteria (LAB) are the most common, particularly *Lactobacillus* and *Bifido bacterium* constitute the most frequently used genera, either singly or in combination, constitutes a significant proportion of probiotic cultures in nutritional supplements, pharmaceuticals and functional foods [23].

The applications of probiotic bacteria in food products are increasing due to their potential health benefits mainly through maintenance of normal intestinal microflora, protection against gastrointestinal

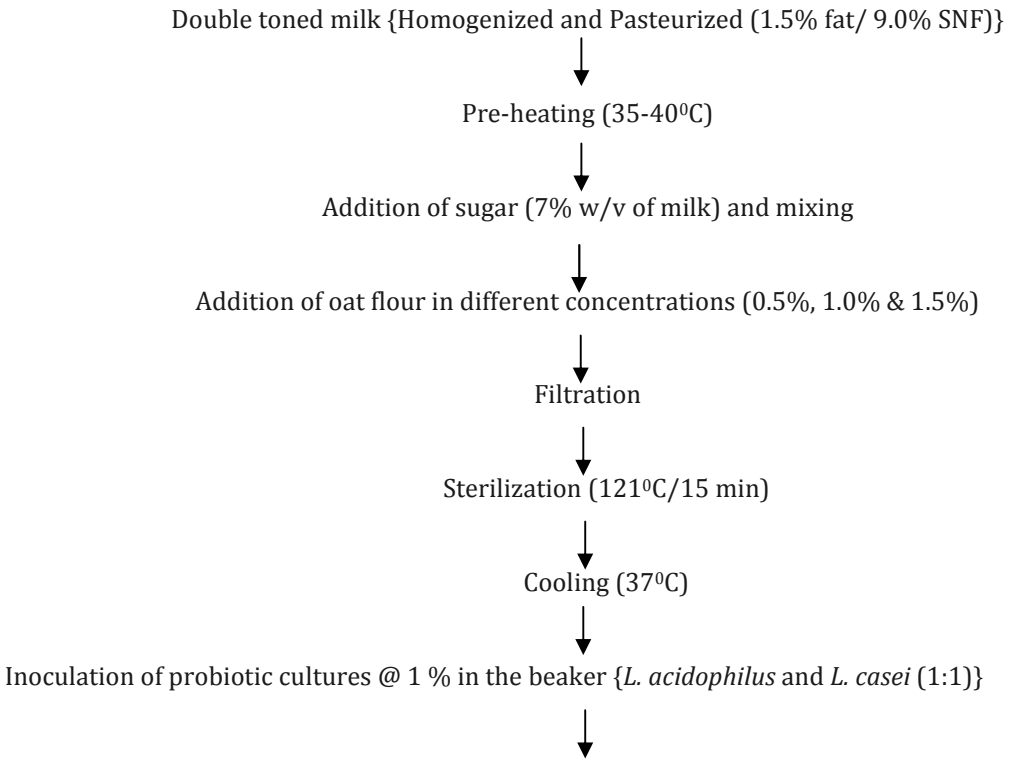
pathogens [2], enhancement of the immune system [9], reduction of serum cholesterol level, blood pressure and anti-carcinogenic activity [27], improved utilization of nutrients and improved nutritional value of food [15].

Oats, unlike other cereals have received considerable interest in recent years as a delivery vehicles for probiotics due to their high content of soluble and insoluble fibres such as β-glucan, arabinoxylans and cellulose, in addition to relatively high levels of protein, lipids (Unsaturated fatty acids), vitamins, antioxidants and phenolic compounds.Oats are the seeds of the plant *Avena sativa*, a minor and cool season crop that has been used as a foodstuff for both humans and livestock for millennia. It is a whole grain like wheat, barley, corn and is called "jau" or "jai" in Hindi. Oat is considered as a heart friendly health food because it contains zero cholesterol and zero trans-fatty acid. Oat is among the valuable functional crops with numerous nutritional, industrial and health benefits. It is an excellent source of dietary fiber β-glucan and are easily available food source that are incorporated into the diet. Oats grains does not contain any gluten, that's why oat groats and oat bran are used as an alternative food for persons suffering from celiac disease [8, 28].

Oat is also used in the preparation of different types of oat based products like oat flakes, pastes, bakery products, beverages etc. several breakfast cereals and bread products are also made from oat flour and rolled oat products. It also helps in the controlling the texture of various food products and have been used as a fat replacers in dairy, meat, and bakery products [11]. Another use of oats has been is in the dairy industry as an antioxidant and stabilizer in ice cream and other dairy products. Many workers used oat β–glucan in the manufacture of cheddar and white-brined cheeses [32]**.** Oat β–glucan due to its thickening and/or gelling properties is used in the food industry [16]; it may also influence the sensory quality of beverages. Plant cell walls and cell-wall polysaccharides: structures, properties and uses in food products

MATERIALS AND METHODS

Preparation of synbiotic milk drink: The synbiotic milk drink was prepared from fully pasteurized and homogenized milk with 1.5 % fat and 9 % SNF. The milk is pre-heated at 35-45^{0}C in a flask. After pre-heating, sugar was added @7% w/v and mixing properly, followed by addition of oat flour in 3 treatments (0.5%, 1.0% and 1.5%) and mix properly and control (0 % oat flour). Then filtration was done to remove the insoluble portion of oat. Sterilization was carried out in the flask by maintaining temperature at 121^{o}C for about 15 min. After sterilization, milk is allowed to cool in atmospheric conditions to 37^{0}C for inoculation of probiotic culture (*L. acidophilus* and *L. casei*in 1:1 ratio). The inoculated milk is transferred to clean, pre-sterilized plastic bottles for inoculation. After transferring in plastic bottles, milk is incubated at 37^{0}C for 2 h and stored at refrigerated temperature.



Transfer the inoculated milk in clean pre-sanitized plastic bottles followed by foil sealing

↓

Incubate at 37^{0}C for 2 h

↓

Storage at refrigerated temperature

Fig.1: Flow diagram for preparation of synbiotic milk drink

Table 1: Basic formulation for the synbiotic milk drink with different concentrations of oat flour

Ingredients	Treatment			
	T_0	T_1	T_2	T_3
Milk (ml)	92	91.5	91	90.5
Oat Flour (g)	0	0.5	1	1.5
Sugar (g)	7	7	7	7
Probiotic culture (ml)	1	1	1	1
Total	100	100	100	100

Storage studies:

The synbiotic milk drink supplemented with oats was prepared as per the standardized method and was evaluated for its shelf-life under refrigerated conditions. The samples were regularly evaluated for their quality at an interval of every 7 days till 21 days.

Physico-chemical analysis:

In the physico-chemical analysis, the fat, protein, ash, total carbohydrates, total solids, viscosity, titratable acidity and specific gravity were estimated with the help of standard procedures.

Statistical analysis

In order to study the effect of different levels of oat flour addition and storage periods on different character of synbiotic milk drink, the data regarding physico-chemical quality of synbiotic milk drink supplemented with oats, a laboratory experiment was conducted and desired data were collected. Analysis of variance of these data was worked out on the basis of Factorial Completely Randomized Design (Gupta and Kapoor, 2007).

RESULTS AND DISCUSSION

Effect of addition of oat on the physico-chemical quality of fresh synbiotic milk drink

The observations of the addition of oat flour on the physico-chemical quality of the fresh synbiotic milk drink are displayed in Table 2.

Table 2: Physico-chemical quality of fresh Synbiotic milk drink *supplemented* with oat

T	Per cent					Acidity (%LA)	Sp. gr.	Viscosity (cp)
	Fat	Protein	TCH	TS	Ash			
T_0	1.4^A	2.99^A	11.89^A	17.05^A	0.772^A	0.18^A	1.057^A	1.94^A
T_1	1.43^{AB}	3.05^B	12.04^B	17.30^B	0.782^B	0.19^A	1.060^B	2.96^B
T_2	1.48^{BC}	3.12^C	12.15^C	17.54^C	0.792^C	0.21^B	1.062^C	4.71^C
T_3	1.5^C	3.18^D	12.37^D	17.85^D	0.803^D	0.22^B	1.070^D	6.11^D
F-value	6.667	143.237	141.999	8626.032	17.313	13.863	564.701	43257.06
SE(m)	0.0177	0.0070	0.0169	0.0037	0.0031	0.0052	0.0002	0.0089
CD	0.05	0.02	0.05	0.01	0.01	0.02	0.001	0.03

Note: TS- Total solids, TCH- Total carbohydrates, NS- Non-significant

Table 2 shows that the fat, protein, ash, TCH and TS were increased significantly with the every addition of oat flour. The fat, protein and ash content in synbiotic milk drink were increased from 1.4 % to 1.5 %, 2.99 to 3.18 % and 0.772 % to 0.803 % respectively. Ramanathan and Sivakumar, [25] prepared probiotic dahi enriched with oats and reported for gradual increase in the fat and protein content with an increase in the concentration of oat flour. Tesfaye, [30] prepared bio-yoghurt and reported that ash content was significantly ($p<0.05$) increased with an increase in the concentration of oat flour.

In the synbiotic milk drink, the TCH content were increased from 11.89 % (T_0) to 12.37% (T_3). The total carbohydrate content in the synbiotic milk drink samples constitutes of milk carbohydrate (lactose),

sugar and carbohydrate present in oat flour. Mohamed *et al*., [20] also reported similar findings that the addition of increased level of oat flour in the preparation of cheese results in significant increase in the carbohydrate content.

The increase in the total solids content in the experimental samples T_1 (17.30%), T_2(17.55%) and T_3(17.85%)could be associated with the increased level of oat flour addition. The total solids in the synbiotic milk drink samples depends upon different factors such as the type of milk used for the preparation of the milk drink, the concentration of sugar and the other additives that were added in the preparation of the product.The similar result was found by Mahrous *et al*., [17] when they prepared synbiotic yoghurt by adding oat flour and reported for increase in the total solids content in the final product.

The maximum and minimum titratable acidity were found to be 0.22% LA and 0.18 % LA in the sample T_3 and T_0, respectively. There was found a significant increase in the acidity after 1 % oat flour addition. The acidity of the synbiotic milk drink samples significantly increased ($p<0.05$)from 1.0% and 1.5% oat flour addition. Tesfaye, [30] reported for a significant ($p<0.05$) increase in the acidity of bio-yoghurt samples when added with oat flour.

The addition of oat flour significantly increased the specific gravity of synbiotic milk drink samples. Oat flour contains high percentage of total solids which contributes in increasing the specific gravity of the synbiotic milk drink with an increase in the concentration of oat flour. Mittal and Bajwa, [19] reported that the specific gravity was increased in the low calorie milk drink samples with an increase in the concentration of inulin.

The addition of oat flour significantly increased ($p<0.05$) the viscosity of synbiotic milk drink samples. The oat flourcontains high percentage of starch. During heating process, the morphological changes takes place of oat starch suspensions [4]. Oat starches undergone changes in the granule structure when heated. The viscosity of synbiotic milk drink was due to the gelatinzation of oat starches that was occurred during heating process. In gelatiniztion process, the amylose and amylopectin were co-leached from oat starches granules at 95^0C [6]. The leaching of amylose and amylopectin was responsible for increase in the viscosity of synbiotic milk drink.Tesfaye, [30] in his study reported that the oat flour have the ability to increase the viscosity of aqueous solutions and that may results in increasing the palatability of the product. Papageorgiou *et al*., [22] and Lyly *et al*., [16] in their studies had been reported that the oat causes an increase in the viscosity of the solutions thus providing the desired consistency and mouthfeel in the product.

Changes in Physico-chemical properties during storage:

The effect of addition of oat flour on the physico-chemical quality with respect to specific gravity, viscosity (cp), fat, protein, total solids, carbohydrates, ash and acidity were studied during storage at refrigeration temperature.

Changes in specific gravity during storage

The initial specific gravity of samples T_0, T_1, $T_2$and T_3 were found to be 1.057, 1.060, 1.062 and 1.070 respectively during storage and is presented in Fig.1. Whereas specific gravity of samples after 21 days of storage were 1.063, 1.064, 1.068 and 1.076 for T_0, T_1, $T_2$and T_3. The minor increase was found in the specific gravity of synbiotic milk drink during storage period.

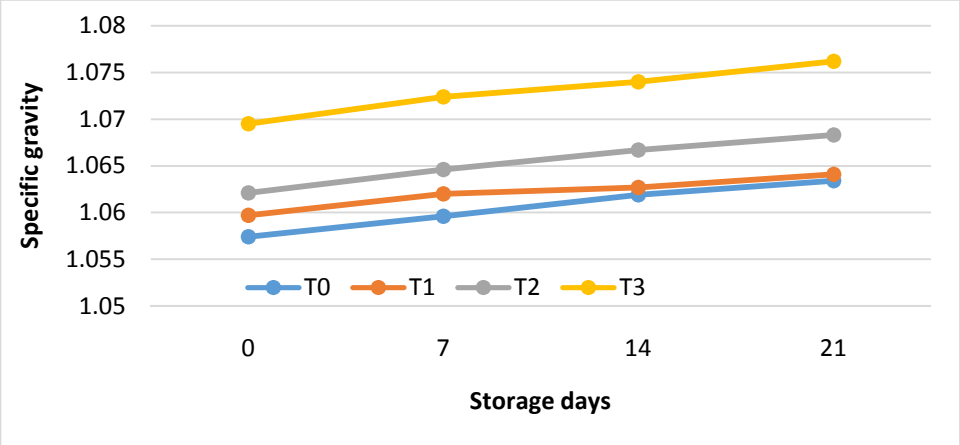


Fig.1 Effect of addition of oat flour on specific gravity of synbiotic milk drink samples during storage at refrigerated temperature (4 ± 2^0C)

Changes in viscosity during storage

The viscosity values of synbiotic milk drink samples during 21 days of storage period is presented in Fig.2 and it was found that at the end of 21 days of storage the viscosity were increased to 2.06, 3.07, 4.86 and 6.31 cp for the samples T_0, T_1, T_2 and T_3 respectively. The mean viscosity value in the control sample (T_0) of milk drink was 2.01 cp. It was observed that among all the experimental samples the mean viscosity increased from 3.03 cp (T_1) to 6.21 cp (T_3) with increased level of oat flour addition. The lowest viscosity was found to be in T_0(2.01 cp) and T_3had the highest viscosity of 6.21 cp. The results showed that the synbiotic milk drink supplemented with oats had higher viscosity than the control product. Viscosity of all samples were increased throughout storage.

As the level of addition of oat flour increased, the mean viscosity of beverage also increased. The increasing viscosity during storage could be due to the protein rearrangement and protein–protein contact [13, 1, 24]. Viscosity values of synbiotic milk drink increased throughout storage and were generally proportional to the level of oat flour addition.

Jirdehi *et al*., [14] prepared yoghurt by adding oat β-glucan and found that the viscosity of yoghurt was increased throughout storage period. The result for increased viscosity of synbiotic milk drink was also supported by the study of Guler-Akın *et al*., [10] in which they reported that viscosity of oat fiber added apricot probiotic drinking yoghurt (APDY) increased during storage period. Sahan *et al*., [28] were reported that viscosity values of the yoghurts with oat β-glucan were increased throughout storage.

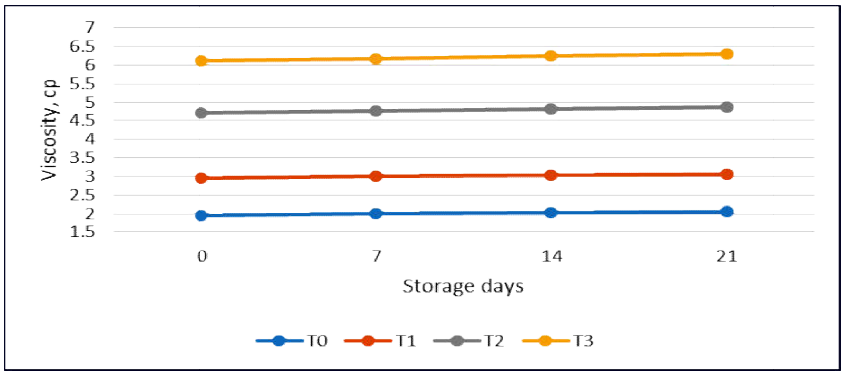


Fig.2Effect of addition of oat flour on viscosity of synbiotic milk drink samples during storage at refrigerated temperature (4 ± 2^{0}C)

Changes in titratable acidity during storage

During storage, the titratable acidity of control sample was observed to be 0.18 % LA on 0th day which gradually increased and reached to 0.21 % LA at the end of 21st day, while in case of experimental sample it ranged from 0.19 % LA (T_1) to 0.22 % LA (T_3) on 0th day and increased to 0.22 % LA to 0.27 % LA on 21st day (Fig.3). Among experimental samples, T_3 had the highest mean titratable acidity of 0.24 % LA and the lowest in T_1 (0.21 % LA).

Increase in titratable acidity might be due to the activity of micro-organisms during storage or due to the conversion of lactose into lactic acid by the probiotic micro-organisms present in the synbiotic milk drink. The increase in acidity during storage may also be correlated with the lactose consumption. The conversion of proteins into amino acids could also be the reason for increased acidity during storage.

Nikofar *et al*., [21] prepared non-fat yoghurt added with oat β-glucan and reported for increase in the acidity of samples during storage period.

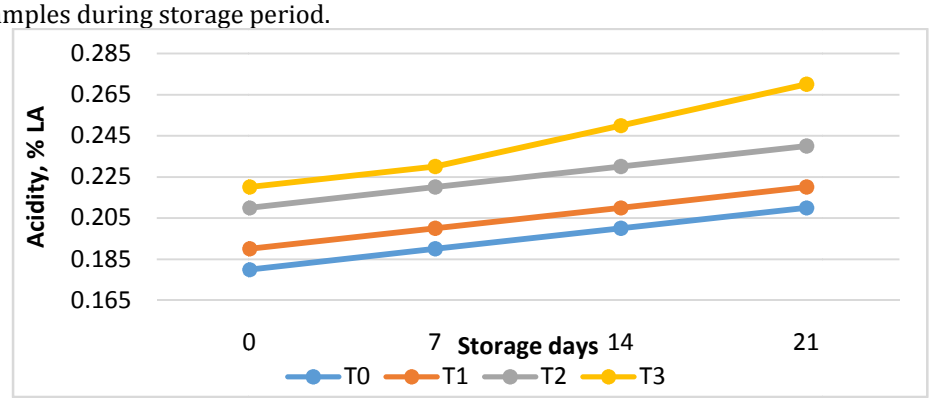


Fig.3 Effect of addition of oat flour on acidity of synbiotic milk drink samples during storage at refrigerated temperature

Changes in fat during storage

Fig. 4 shows the initial average values of fat of different samples T_0, T_1, T_2 and T_3 were 1.4, 1.43, 1.48 and 1.5 % respectively. Whereas the corresponding values of fat of respective samples at the end of 21 days of storage period were determined to be 1.35, 1.39, 1.44 and 1.46 % respectively. The addition of oat flour influences the mean fat content of synbiotic milk drink and also during storage period. The reason for the decrease in fat content may be due to the increased susceptibility of fat to oxidation, since it was not protected by a membrane and release of free fatty acids. So, the fat percent was reduced a little bit with storage.

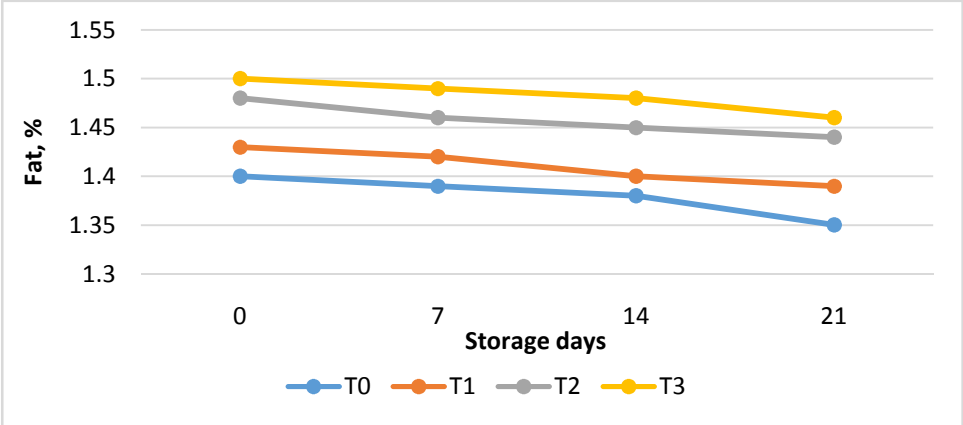


Fig.4 Effect of addition of oat flour on fat of synbiotic milk drink samples during storage at refrigerated temperature (4 ± 2⁰C)

Yadav *et al*., [34] prepared probiotic dahi and reported to decrease in the fat content of dahi during storage period of 10 days from 7.2% to 7.1%.

Changes in protein during storage

The protein content in the samples T_0, T_1, T_2 and T_3on 0^{th} day were ranged from 2.99, 3.05, 3.12 and 3.18 % respectively. Whereas the corresponding values of protein content of respective samples viz., T_0, T_1, T_2 and T_3 at the end of 21 days of storage period were found to be 2.97, 3.05, 3.11 and 3.17 % respectively (Fig.5). The decrease in protein content was found to be non-significant during storage. The minor decrease in the protein content during storage in synbiotic milk drink may be due to the enzymatic hydrolysis and subsequent degradation of peptides to act as nutrient for these bacteria.

Yadav *et al*., [34] in probiotic dahi reported a non-significant difference in the protein content during storage period. Hassan *et al*., [12] prepared fruit flavoured milk based beverage and reported that there was a non-significant difference in protein content of the beverage during storage.

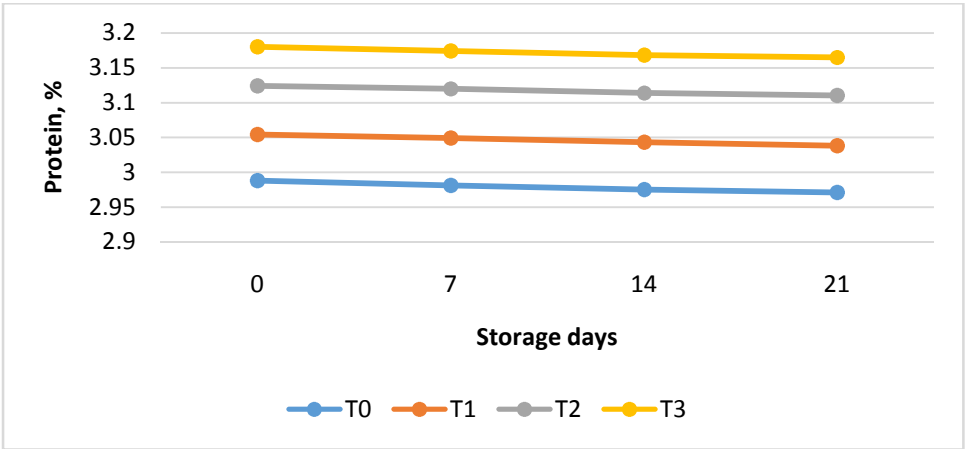


Fig.5 Effect of addition of oat flour on protein of synbiotic milk drink samples during storage at refrigerated temperature (4 ± 2⁰C)

Changes in the ash content of the milk drink

The ash content in the synbiotic milk drink on 0^{th} day for the treatments T_0, T_1, T_2 and T_3 were 0.772, 0.782, 0.792 and 0.803 % respectively (Fig.6). Whereas the corresponding values of ash content of

respective samples viz., T_0, T_1, T_2 and T_3 at the end of 21 days of storage period were found to be 0.768, 0.779, 0.789 and 0.799 % respectively.

During storage period, the ash content was not affected by addition of oat flour. Yadav *et al*., [34] prepared probiotic dahi and found non-significant difference in ash content during storage period of 10 days.

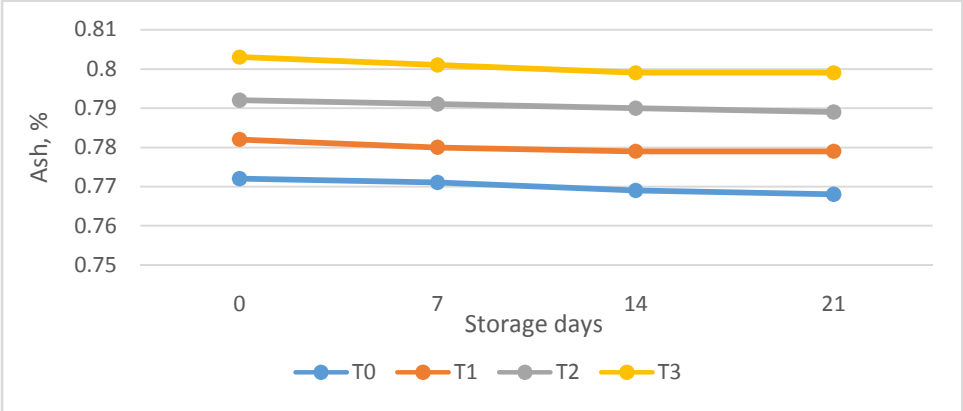


Fig. 6: Effect of addition of oat flour on ash of synbiotic milk drink samples during storage at refrigerated temperature (4 ± 2⁰C)

Changes in total solids content during storage

The total solids content on the 0th day for treatments T_0, T_1, T_2 and T_3 were 17.05, 17.30, 17.54 and 17.85 % respectively (Fig.7). Whereas the corresponding values of total solids of respective samples viz., T_0, T_1, T_2 and T_3 at the end of 21 days of storage period were found to be 16.98, 17.24, 17.48 and 17.79 % respectively.

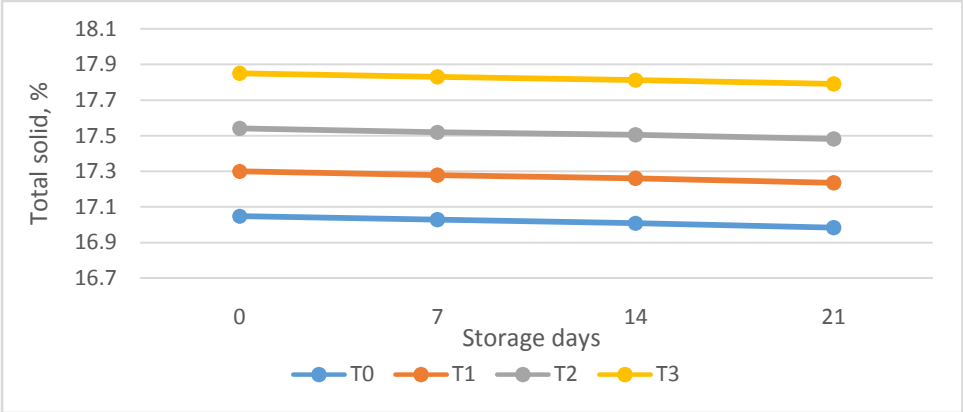


Fig.7 Effect of addition of oat flour on total solids of synbiotic milk drink samples during storage at refrigerated temperature (4 ± 2⁰C)

Though there was a slight decrease in the mean TS content during storage and this decrease was found to be statistically non-significant. It had been distinct obvious that there were variations in total solids of synbiotic milk drink due to longer storage period.

Changes in the carbohydrates content during storage

The addition of oat flour did influenced the total carbohydrate content of the synbiotic milk drink. The total carbohydrate content on the 0th day for treatments T_0, T_1, T_2 and T_3 were 11.89, 12.04, 12.15 and 12.37 % respectively. Whereas the corresponding values of total solids of respective samples viz., T_0, T_1, T_2 and T_3 at the end of 21 days of storage period were found to be 11.84, 12.00, 12.11 and 12.32 % respectively (Fig. 8).

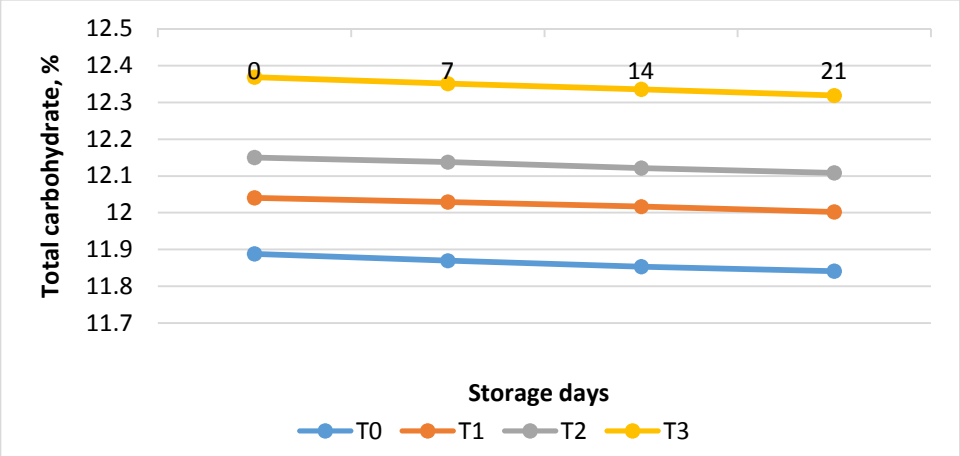


Fig. 8: Effect of addition of oat flour on total carbohydrates of synbiotic milk drink samples during storage at refrigerated temperature (4 ± 2^{0}C)

The slight decrease in total carbohydrate content might be attributed to accelerated hydrolysis of insoluble sugars present in the milk drink. The maillard reaction and other chemical reactions of sugars with acids during storage also lead to a decrease in total sugar content. The carbohydrates present in the milk products are the major food substrates for the growth of the microorganisms.

Alm, [3] reported for decrease in the milk carbohydrate (lactose) content in yoghurt during storage period. Yilmaz-Ersan and Kurdal, [35] prepared set type bio-yoghurt and found that the milk carbohydrate (lactose) was decreased during storage period. Bae *et al*., [5] prepared yoghurt and reported for decreasing in the carbohydrate content during storage period.In the study of Yadav *et al*., [34] they reported for decrease in the milk carbohydrate (i.e. lactose) and increased in the titratable acidity of probiotic dahi added with *L. casei* and *L. acidphilus* during storage period, which confirmed that the lactose was metabolized by probiotic lactobacilli cultures into lactic acid.

CONCLUSION

In the present literature, the synbiotic milk drink was prepared by addition of oat flour and probiotic culture. The addition of oat flour had increased the fat, protein, ash, total carbohydrates (TCH) and total solids (TS) content in all the experimental samples. The addition of oat flour had significantly increased the viscosity with an every increase in the concentration of oat flour as it contains higher amount of carbohydrates content. The acidity was also increased in all the experimental samples of the milk drink. During storage, the fat, protein, ash, total carbohydrate and total solids content were decreased but the decrease were found to be non-significant. The viscosity, acidity and specific gravity were increased during storage.

REFERENCES

1. Abu-Jdayil, B. and Mohameed, H. (2002). Experimental and modelling studies of the flow properties of concentrated yogurt as affected by storage time. J. Food Engg., 52:359–365.
2. Aimmo, M. R.D., Modesto, M. and Biavati, B. (2007). Antibiotic resistance of lactic acid bacteria and Bifido bacterium spp. Isolated from dairy and pharmaceutical products. Int. J. Food Microbiol., 115:35-42
3. Alm, L. (1982). Effect of fermentation on lactose, glucose and galactose content in milk and suitability of fermented milk products for lactose intolerant individuals. J. Dairy Sci., 65:346-352.
4. Autio, K. (1990). Rheological and microstructural changes of oat and barley starches during heating and cooling. Food Structure, 9: 297-304.
5. Bae, H. C., Nam, M. S. and Lee, J.Y. (2002). Probiotic characterization of acid- and bile-tolerant Lactobacillus salivarius subsp. salivarius from Korean faeces. Asian-Aust. J. Anim. Sci., 15: 1798-1807.
6. Doublier, J.L., Paton, D. and Llamas, G. 1987. A rheological investigation of oat starch pastes. Cereal Chem., 64:21-26.
7. El Owni, O. A. O. and Mahgoub, M. S. A. (2012). The effect of storage on chemical, microbial and sensory characteristics of goat's milk yoghurt. J. Nov. Appl. Sci., 1:63-67.
8. Garsed, K. and Scott, B.B. (2007). Can oats be taken in a gluten-free diet? A systematic review. Scand. J. Gastroenterol., 42: 171-178.
9. Gilliland, S. E. (1990). Health and nutritional benefits from lactic acid bacteria. FEMS Microbiology Letters, 87: 175-188.
10. Guler-Akın, M.B., Ferliarslan, I. and Akın, M.S. (2016). Apricot Probiotic Drinking Yoghurt Supplied with Inulin and Oat Fiber. Adv. Microbiol., 6: 999-1009

11. Harris, P.J. and Smith, B.G. (2006). Plant cell walls and cell-wall polysaccharides: structures, properties and uses in food products. Int J Food Sci Tech., 41: 129–143
12. Hassan, M., Dar, B.N., Rather, S.A., Akhter, R. and Huda, A.B. (2015). Physicochemical, sensory and microbial characteristics of fruit flavoured milk based beverages during refrigerated storage. Adv. Biomed. Pharma., 2:32-39.
13. Isleten, M. and Karagul-Yuceer, Y. (2006). Effects of dried dairy ingredients on physical and sensory properties of nonfat yogurt. J. Dairy Sci., 89:2865– 2872.
14. Jirdehi, S.Z., Qajarbeygi, P. and Khaksar, R. (2013). Effect of Prebiotic Beta-Glucan Composite on Physical, Chemical, Rheological and Sensory Properties of Settype Low-Fat Iranian Yogurt. J. Basic. Appl. Sci. Res., 3: 205-210.
15. Lourens-Hattingh, A. and Viljoen, B. C. 2001. Yoghurt as probiotic carrier food. Int. Dairy J., 11: 1-17.
16. Lyly, M., Salmenkallio-Marttila, M., Suortti, T., Autio, K., Poutanen, K. and Lähteenmäki. L. (2004). The sensory characteristics and rheological properties of soups containing oat and barley -glucan before and after freezing. LWT Food Sci. Technol., 37:749–761.
17. Mahrous, H., Kholy, W.M.E. and Elsanhoty, R.M. (2014). Production of new synbiotic yoghurt with local probiotic isolate and oat and study its effect on mice. J. Adv. Dairy Res., 2: 1-7.
18. Mattila-Sandholm, T., Myllarinen, P. M., Crittenden, R., Mogensen, G., Fonden, R., and Saarela, M. (2002). Technological challenges for future probiotic foods. Int. Dairy J., 12: 173-182.
19. Mittal, S. and Bajwa, U. (2014). Effect of heat treatment on the storage stability of low calorie milk drinks. J. Food Sci. Technol., 51:1875–1883.
20. Mohamed, A. G., Abbas, H. M., Bayoumi, H. M., Kassem J. M. and Enab, A. K. (2011). Processed cheese spreads fortified with oat. J. Amer. Sci., 7: 631-637.
21. Nikoofar, E., Hojjatoleslamy, M., Shakerian, A., Molavi, H. and Shariaty, M.A. (2013). Surveying the effect of oat beta glucan as a fat replacer on rheological and physicochemical characteristics of non-fat set yoghurt. Int. J Farm Alli. Sci., 2: 790-796.
22. Papageorgiou, M., Lakhdara, N., Lazaridou, A., Biliaderis, C.G. and Izydorczyk, M.S. (2005). Water extractable (1 →3, 1→4)-β-D -glucans from barley and oats: an intervarietal study on their structural features and rheological behaviour, J. Cereal Sci., 42: 213–224.
23. Piano, D.M., Morelli, L., Strozzi, G.P., Allesina, S., Barba, M., Deidda, F., Lorenzini, P., Ballar´e, M., Montino, F., Orsello, M., Sartori, M., Garello, E., Carmagnola, S., Pagliarulo, M. and Capurso, L. (2006). Probiotics: from research to consumer. Digestive Liver Disease, 38:248-255.
24. Ozer, B. H., Robinson, R. K., Grandison, A. S. and Bell, A. E. (1998). Gelation properties of milk concentrated by different techniques. Int. Dairy J., 8:793– 799.
25. Ramanathan, A. and Sivakumar, K.(2013). Evaluation of fibre enriched and VitaminC fortified sweetened probiotic dahi. In: National seminar on Probiotics in Sustainable Food Production: Current Status and Future Prospects - Probiotic Foods, India, : 72-76.
26. Rashid, M., Butzner, D., Burrows, V., Zarkadas, M., Case. S., Molloy, M., Warren, R., Pulido, O. and Switzer, C. (2007). Consumption of pure oats by individuals with celiac disease: A position statement by the Canadian Celiac Association. Can. J. Gastroenterol., 21: 649-651.
27. Rasic, J. L. (2003). Microflora of the intestine probiotics. In: Caballero, B., Trugo, L. and Finglas, P. (Eds), Encyclopedia of food sciences and nutrition, Academic Press, Oxford, : 3911-3916.
28. Sahan, N., Yasar, K. and Hayaloglu, A.A. 2007. Physical, chemical and flavour quality of non-fat yoghurt as affected by a β–glucan hydrocollidal composite during storage. Food Hydrocoll., 22: 1291-1297.
29. Sharma, R. (2005). Market trends and Opportunities for functional dairy beverages. Australian J. Dairy Technol., 60: 196-199.
30. Tesfaye, Y. (2013). Effect of oat flour concentration on the physico-chemical and microbiological quality of probiotic bio-yoghurt. MSc. Thesis. Addis Ababa Institute of Technology, Ethopia.
31. Venturi, A., Gionchetti, P., Rizzello, F., Johansson, R., Zucconi, E. and Brigidi, P. (1999). Impact on the composition of the faecal flora by a new probiotic preparation: by a new probiotic preparation: Preliminary data on maintenance treatment of patients with ulcerative colitis. Alimentary Pharmacol. Therapeutic, 13: 1103-1108.
32. Volikakis, P., Biliaderis, C.G., Vamvakas, C. and Zerfiridis, G.K. (2004). Effects of a commercial oat-β-glucan concentrate on the chemical, physico-chemical and sensory attributes of a low-fat white-brined cheese product. Food Res. Int., 37: 83-94.
33. Wang, L.Z. and White, P.J. (1994). Structure and physicochemical properties of starches from oat with different lipid contents. Cereal Chem., 71:443-450.
34. Yadav, H. Jain, S. and Sinha, P.R. (2007). Production of free fatty acids and conjugated linoleic acid in probiotic dahi containing Lactobacillus acidophilus and Lactobacillus casei during fermentation and storage. Int. Dairy J., 17:1006-1010.
35. Yilmaz-Ersan, L. and Kurdal, E. (2014). The Production of set-type-bio-yoghurt with commercial probiotic culture. Int. J. Chem. Engg. Application, 5: 402-408

Citation of this Article
P K Tiwari, S Asgar, Sudhir Uprit, Manorama Chauhan, K. K. Choudhary, K K Sandey. Effect of oat flour addition on the physico-chemical properties of synbiotic milk drink. Bull. Env. Pharmacol. Life Sci., Vol 7 [1] December : 95-103