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Fortification of low-fat frozen carrot yoghurt

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Fermentation of milk sugar produce lactic acid, which acts on milk protein to give yoghurt its texture and its characteristics taste. Yoghurt is a fermented milk product which is produced by adding a mixed culture of *Lactobacillus bulgaricus* and *Streptococcous thermophilus*. The present study was carried out with different levels (2%, 3%, 4% and 5%) of carrot pulp. Frozen yoghurt mix was standardisation to 12 per cent sugar, 12 per cent SNF, @ 2 per cent culture, fat (0.5%, 1.5% and 3.0%) and stabilizer (0.5%) adjusted to 26 per cent total solids for frozen yoghurt. The low fat frozen yoghurt samples of different treatments were analyzed for nutritional characteristics (fat, protein, calcium and total carotene). The data obtained on various parameters were statistically analyzed. Based on the results, it was concluded that the low fat frozen flavoured yoghurt with 3 per cent carrot pulp and 3.0 per cent fat (T_3F_3) were high as comparable with other treatments in the nutritional characteristics (fat, protein, calcium and total carotene). The energy wise low-fat frozen yoghurt treatment combinations were more acceptable as compared to high-fat frozen yoghurt. The cost of low fat frozen yoghurt incorporated with carrot pulp was 61.42 Rs./lt. Its cost is low and this may be available in the market for the consumers at reasonable prices.

Key Words : Yoghurt, Frozen yoghurt, Sensory quality, Carrot pulp, Nutritional quality

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INTRODUCTION

The yoghurt bacteria stimulate the host's immune system to resist infection by producing bactericidal or bacteriostatic agents such as organic acids (Welch, 1987). Fermented milks have been used to improve intestinal health since ancient times. The most common use of yoghurt has been in treatment of gastrointestinal disorders such as diarrhoea and constipation, gastroenteritis, diarrhoea, skin infections and herpetic and aphthous stomatitis. Fermented products and lactic acid bacteria have potential anticarcinogenic activity (Goldiin and Gorbach, 2003 and 2007). Antimutagenic effects of yoghurt have been reported by Cenci (2002). Hypocholesterolemic effects of yoghurt have been reported by Mann and Spoerry (1994). Dahi as a traditional fermented milk product is fairly similar to yoghurt, the value of fermented milks as therapeutic agents in the treatment of gastrointestinal disorder and other ailments was recognized in the ayurvedic system of medicine in India quite long, time ago. Yoghurt has a sharp characteristic acid flavour pleasant sensation on the palate. Whereas, dahi has a delicate bouquet of diacetyl besides other flavour components.

Ice cream is a frozen dessert usually made from dairy products, such as milk and cream, and often combined with fruits or other ingredients and flavours. Most varieties contain sugar, although some are made with other sweeteners. In some cases, artificial flavourings and colourings are used in addition to (or in replacement of) the natural ingredients. This mixture is stirred slowly while cooling to prevent large ice crystals from forming, the result is a smoothly textured ice cream. Frozen yoghurt is a dessert similar to ice cream but made with yoghurt rather than cream. It tends to be healthier than ice cream so many people choose it as an alternative. It is important to realize, however, that frozen yoghurt, is richer in many minerals and nutrients than ice cream.

Carrot is one of the most healing foods that provide the finest and highest quality in nutrients, especially from its juice. It is an excellent source of pro-vitamin A, vitamins C, D, E, K, B_1 and B_6. It is rich with biotin, potassium, calcium, magnesium, phosphorus, organic sodium and some trace minerals. The known phytonutrients in carrots are lutein, lycopene, anti-

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oxidants alpha, beta and gamma carotenes, zeaxanthin and xanthophyll. These phytonutrients are nature's marvelous provision for healing of various diseases (Marker, 2002). This study aimed at development and optimization of low fat frozen carrot yogurt and to evaluate nutritional characteristics and cost of production of low fat frozen carrot yogurt.

METHODOLOGY

The experimental work was carried out in the research laboratory of Warner school of food and dairy technology, Sam Higginbottom Institute of Agriculture, Technology and Sciences, Allahabad.

Raw Materials :

Culture :

Freeze dried culture of *Lactobacillus bulgaricus* and *Streptococcus thermophilus* were obtained from the Dairy Microbiology Division of N.D.R.I., Karnal (Haryana).

Other materials :

Milk, fresh carrot and sugar were purchased from the local market of Allahabad. Plastic cups of 100ml capacity also purchased from the local market of Allahabad. Stabilizer (sodium alginate) was obtained from dairy technology.

Culture propagation :

Mixed culture :

Mixed culture of *Lactobacillus bulgaricus* and *Streptococcus thermophilus* were propagated in sterile skim milk test tubes by inoculation and incubation at 37^0C. After incubation the culture were stored at 50^0C.

Bulk culture :

Bulk culture was routinely propagated in sterile skimmed milk for this purpose, 2 per cent of the active culture was introduced into skimmed milk and incubated at 37^0C. After setting the culture were transferred and stored at 5^0C until further use.

Analysis of milk :

Determination of milk fat :

Fat percentage of milk was determined by Gerber method as per procedure given in ISI: 1224 part I (1977).

Determination of solid not fat :

The SNF content of milk was determined by Richmond's formula as per the procedure laid down by Indian Standard: 2311(1973) hand book of food analysis.

Standadization of milk :

SNF:

Milk SNF 12 per cent was standardized by using skimmed milk powder.

Preparation of carrot pulp :

Carrots were washed with warm water after removing top, bottom and surface layers to avoid surface contamination and blanched in hot water for 5 min to inactivate pectinase and peroxidise enzymes and also to tenderize it. Carrot was blended by using a food processor for carrot pulp (INALSA, INDIA) and evaluated for total solids (AOAC, 1990) and titratable acidity (Ranganna, 1979). The pH of the samples was measured by using digital pH meter (Century Digital pH meter, India). The carrot juice had 6.82 per cent total solids, 2.67 (% of citric acid) titratable acidity and a pH of 5.79.

Preparation of low-fat frozen yoghurt (LFFY) :

Mix was prepared by using skim milk with standardization of fat 0.5 per cent (F_1), 1.5 per cent (F_2) and 3.0 per cent (F_3) and 12 per cent milk solid not fat, with the addition of 12 per cent sweetening agent and 0.5 per cent stabilizer in different concentration. The mix was standardized to a total solid content of up to 12 per cent by addition of skim milk powder. The mix was homogenized and then pasteurized and cooled to 42^0C. Yogurt starter culture was added at the rate of 2 per cent and carrot pulp was added in 2 per cent (T_1), 3 per cent (T_2), 4 per cent (T_3) and 5 per cent (T_4) concentration. The mix was incubated at 42^0C till acidity achieved to 0.45 per cent. The mix was aged at 5^0C and frozen in a batch freezer to overrun of 70 per cent.

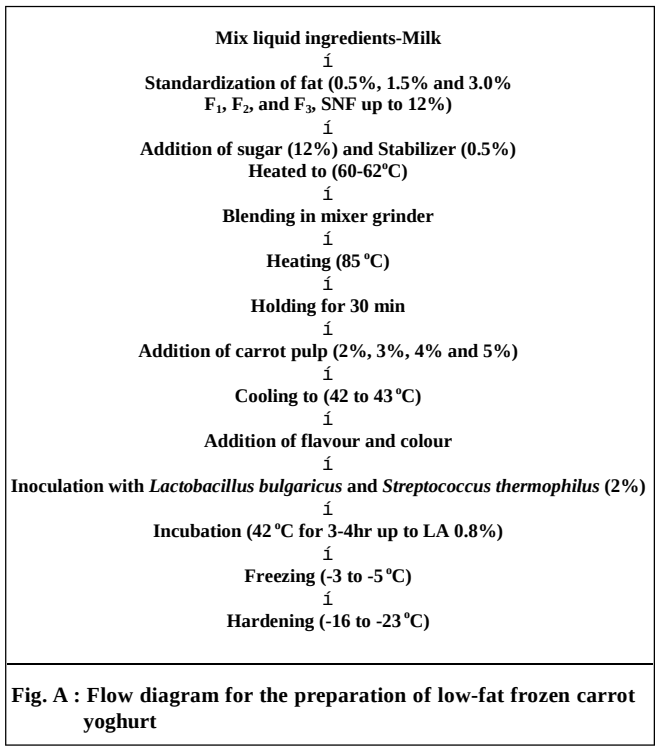

Fig. A : Flow diagram for the preparation of low-fat frozen carrot yoghurt

Treatments :

Carrot pulp :

T_1: Addition of 2 per cent of carrot pulp
T_2: Addition of 3 per cent of carrot pulp
T_3: Addition of 4 per cent of carrot pulp
T_4: Addition of 5 per cent of carrot pulp

Fat :

F_1: 0.5 per cent fat
F_2: 1.5 per cent fat
F_3: 3.0 per cent fat

Nutritional analysis of prepared yoghurt :

Fat, total solids, protein (kjeldahl method), calcium and total carotene of the samples were determined as per AOAC (1980). The total solid content of samples was determined by gravimetrically. Energy value of the product was estimated on the basis of nutritional composition of the product.

Determination of cost of the product :

The cost of the prepared product was calculated at the prevailing prices of raw materials purchased from the local market of Allahabad.

Statistical analysis :

The data obtained for different parameters were analysed statistically using factorial randomized design (ANOVA) and critical difference technique with three replications (Imran and Coover, 1983).

OBSERVATIONS AND ASSESSMENT

The findings of the present study as well as relevant discussion have been presented under the following heads :

Protein :

The frozen yoghurt (T_3F_3) contained 3.28 per cent protein (Table 1). The value compares well with that reported by Tamine and Robinson (1985) who reported 3.9 per cent protein for the typical full fat plain yoghurt and Bakhru (1986) stated 3.4 per cent protein in good quality yoghurt made of whole milk. Laxminarayana and Shankar (1980), Kosikowski (1981), Sharma (1981), Speak and Hansen (1983), Uzonyl and Gyetare (1983) reported protein content of 2.25 to 5.5 per cent in yoghurt.

The critical examination of Table 1 indicates that addition of carrot pulp and fat resulted in significant decreased in protein content of yoghurt from 4.29 – 2.89 per cent at per cent level of carrot pulp.

Fat :

Fat content of frozen yoghurt (T_3F_3) was 2.57 per cent. The results are more or less in agreement with the values

Table 1 : Effect of nutritional analysis of fat and carrot juice incorporated in low fat frozen carrot yoghurt

Level of fat	Level of carrot pulp				
	T_1	T_2	T_3	T_4	Mean
Protein					
F_1	4.2	3.96	3.24	2.89	3.57
F_2	4.26	3.94	3.24	2.94	3.59
F_3	4.29	3.96	3.28	2.96	3.62
Mean	4.25	3.95	3.25	2.93	3.59
C.D. (P = 0.05) Carrot pulp : 0.403 : S, Fat : 0.349: S					
Fat					
F_1	0.43	0.42	0.43	0.43	0.42
F_2	1.23	1.2	1.32	1.28	1.25
F_3	2.45	2.58	2.57	2.6	2.55
Mean	1.37	1.4	1.44	1.43	1.88
C.D. (P = 0.05) Carrot pulp : NS, Fat : 0.25: S					
Total carotene					
F_1	214	230	252	302	249.5
F_2	210	240	260	306	254
F_3	220	250	270	309	262.25
Mean	214.6	240	260.6	305.6	255.25
C.D. (P = 0.05) Carrot pulp : 1.192 : S, Fat : 1.376 : S					
Calcium					
F_1	160	160	150	170	160
F_2	165	180	170	160	168.75
F_3	160	170	190	180	162.5
Mean	161.66	170	153.33	170	163.73
C.D. (P = 0.05) Carrot pulp : 17.454 : S, Fat : 15.11: S					
Energy value					
F_1	127	114	99	81	105.25
F_2	134	119	103	84	110
F_3	146	130	110	93	119.7
Mean	135.6	121	104	86	111.66
C.D. (P = 0.05) Carrot pulp : 3.052 : S, Fat : 2.643: S					

Table 2 : Cost of production in low fat frozen carrot yoghurt

Level of fat	Level of carrot pulp				
	T_1	T_2	T_3	T_4	Mean
F_1	43.88	44.28	44.68	45.08	44.48
F_2	51.88	52.28	52.68	53.08	52.48
F_3	59.88	60.28	60.68	61.08	60.48
Mean	51.88	52.28	52.68	53.08	

reported by Tamine and Robinson (1985), Bakhru (1986), Desai *et al.* (1994) and Baig and Prasad (1996). The perusal of Table 1 reveals that the addition of carrot pulp at different levels decreased the fat content of frozen yoghurt. The variation due to carrot pulp was non-significant.

Calcium :

Yoghurt is a good source of calcium. In low fat frozen yoghurt can fulfil half of the daily requirement of calcium (Yadav *et al.*, 2010; Skillda and Dubey, 2010). The frozen yoghurt (T_3F_3) contained 190 mg/100g calcium (Table 1). There was significant variation due to fat and carrot pulp on calcium content of yoghurt.

Total carotene :

The frozen yoghurt (T_4F_3) contained 309 µg/100g total carotene (Table 1). Total carotene content increased due to increased level of carrot pulp. Total carotenoid levels in purple and yellow carrots vary from 469 to 605 µg/100 g, whereas 10 times more carotenoids were found in orange carrot (Heinonen, 1990; Simon and Wolff, 1987). In fact carotenoids are present in much higher concentrations, is routinely used to fight vitamin A deficiency world-wide.

Energy value :

Energy value of product (kcal/100g) is decreased due to increased level of carrot pulp (Singh *et al.*, 2008; Skillda and Dubey, 2010). The frozen yoghurt (T_4F_1) contained 81 kcal/ 100g energy value (Table 1). The critical examination of Table 1 indicates that addition of carrot pulp and fat resulted in significant decreases in energy value of yoghurt from 81–127 kcal/100g level of carrot pulp and fat.

Cost of production :

The cost of production (Rs./lt) of low-fat frozen yoghurt sample T_1F_1 (43.88) was much less than other samples. Result obtained after the analysis of ingredients cost of low fat frozen yoghurt incorporated with carrot pulp was in reasonable rates and it will be available in the market at reasonable prices. Similar findings were reported by Yadav *et al.* (2008) and Singh *et al.* (2008).

It is concluded that the low-fat frozen yoghurt containing 3 per cent fat and 4 per cent carrot pulp (T_3F_3) was high as comparable with other treatments in nutritional characteristics. T_3F_3 showed significant difference in nutritional characteristics (protein, fat, calcium, total carotene), when the highest amount of fat and carrot pulp were added. It is quite obvious from the results that the total solids per cent significantly increased with the increase in fat and carrot pulp. The quality of sample T_3F_3 (3% fat and 4% carrot pulp) was very well comparable to that of the other treatments. The energy wise low-fat frozen yoghurt treatment combinations were more acceptable as compared to high-fat frozen yoghurt. The cost of low fat frozen yoghurt incorporated with carrot pulp was 61.42 Rs/lt. Its cost is low and this may be available in the market for the consumers at reasonable prices.

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