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Process Optimization of Fruit Yoghurt by using Kamalapur Red Banana (GI Tag No: 133-2009)

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ABSTRACT: Milk contains lactose, protein and lipids along with minerals and vitamins. The milk when converted to fermented milk products the bioavailability of the milk nutrients improves. Yoghurt is one of the fermented milk products which can be prepared using fruits such as Mango, Strawberry, Blackberry and Banana for value addition. One such attempt has been carried out using Red Banana (*Musa acuminate*; GI Tag No 133-2009) as one of the additional ingredients of value addition. The Red Banana is a tropical fruit of Kamalapur region rich in calcium and potassium and dietary fiber. In order to present the fruit in an appealing manner, the yoghurt incorporated with red banana having both sour and sweet taste that go hand in hand attracting the consumers instead of only fruit or plain yoghurt as such. Red banana pulp incorporated yoghurt was prepared using *Streptococcus thermophilus* and *Lactobacillus delbruckii* ssp. *bulgaricus* as starters that promote consumers gut health by inhibiting putrefactive microorganisms through lactic acid production and bacteriocins. The banana incorporated yoghurt had improved protein content and reduced lactose content. Among the yoghurt samples prepared with added banana pulp at different concentrations such as 5%, 7.5%, 10% and 12.5% along with a control (without banana pulp), sample with 10% of banana pulp was more accepted by the panelists. The selected product had acidity of 0.72% lactic acid with acceptable microbiological standards. The aim of the study was to utilize the locally available red banana for enriching the yoghurt, a fermented product that improve the gut microflora of consumers with prebiotic component of banana and also prevent post harvest losses.

Keywords: Red Banana, Potassium, Calcium, Dietary Fiber, Yoghurt.

INTRODUCTION

Milk is nature's almost complete food with essential nutrients in adequate quantity. These nutrients are utilized by humans to meet the nutritional requirements and so the microorganisms. The beneficial bacteria like starters normally the lactic acid bacteria act on the milk components, degrade them increasing the bioavailability when product was consumed. Fermentation is one of the easy methods to preserve the milk that included fermented dairy products in the form of dahi, lassi, yoghurt, ripened cream butter and so on, Fermented milk products are popular in view of characteristic flavour, refreshing taste and improved digestibility. The production of fermented milks is based on the use of starter cultures, such as lactic acid bacteria that initiate rapid acidification of heat treated, cooled milk (Shiby & Mishra 2013). The composition of fermented milks can be easily tailored to meet various dietary requirements especially in the production of low-calorie fermented milks such as yoghurt using selected lactic cultures that extend potential health benefits such as control of intestinal infections, improved digestion of lactose, calcium absorption, control of colon cancer and decrease in serum cholesterol levels to reduce the risk of cardiovascular diseases. Yoghurt can be defined as a cultured product obtained by using *Streptococcus thermophilus* and *Lactobacillus delbrueckii* ssp. *bulgaricus*. The product should contain 0.8% lactic acid with coli form count not more than 10 per gram and yeast & mold count not exceeding 100 per gram (IS12898:1989). The acidic pH of yoghurt ionizes calcium and thus facilitates intestinal calcium absorption (Fernandez *et al.*, 2016) and high dietary calcium intake and its bioavailability are associated with the reduced risk of osteoporosis, hypertension, colon cancer, kidney stones, stroke, obesity and lead absorption (Aryana & Olson 2017). About 227 g of yoghurt contains calcium equivalent to 30% of

Reference Daily Intake (RDI) of 1000 mg calcium per day for adults in USA (Singh and Muthukumarappan 2008). The low pH of yoghurt may also reduce the inhibitory effect of dietary phytic acid on calcium bioavailability (Maria *et al.*, 2020). The recent trend in developed countries is the use of value added functional fermented dairy products like enriched yoghurt with increased health awareness among consumers (Sadighbathi *et al*., 2023). A combination of yoghurt and fruit intake could provide high quality protein, important fatty acids, a mixture of vitamins and minerals. The fruit yoghurt bestows prebiotic content that exert synergistic effects on gut health of consumers (Kamber & Harmankaya 2019). Tuhumury *et al*. (2021) incorporated pulp of "Ambon kuning", Indonesian banana variety (*Musa paradisiaca* L. var. *sapientum*) of 25% in the formulation resulted in frozen yoghurt with better characteristics with pH, protein, vitamin C, total sugar and overall sensory score (5 point) of 5.65, 2.82%, 41 mg/100 mL, 45.85% and 3.95, respectively. According to Owolade *et al.* (2022), it is possible to fortify yoghurt with African variety banana Paranta (obtained from National Horticultural Research Institute, Nigeria) of 10% slurry to enhance protein (3.93%), energy (207.06 kcal/100 g), vitamin C (21.6 mg/100 g) and overall sensory acceptability (6.1 for 7 scale). The inclusion of banana in yoghurt production is a potential and viable option at reducing post harvest losses of banana fruits. An attempt has been made in the present study to incorporate the pulp of Kamalapur red banana as value addition in yoghurt. Red banana (*Musa acuminate*), known as Red Dacca is grown in and around Kamalapur taluk region of Kalaburagi district, Karnataka, India. The cultivation in red soils make the fruits rich in minerals such as calcium, iron, potassium along with dietary fiber and vitamins C and B6. The banana plants are 20-25 feet tall with peel of fruit red while pulp is cream in colour having sweet taste. The aim of the study was to optimize the red banana pulp addition in the preparation of yoghurt and its impact on physico-chemical and microbiological characteristics of fruit yoghurt.

MATERIAL AND METHODS

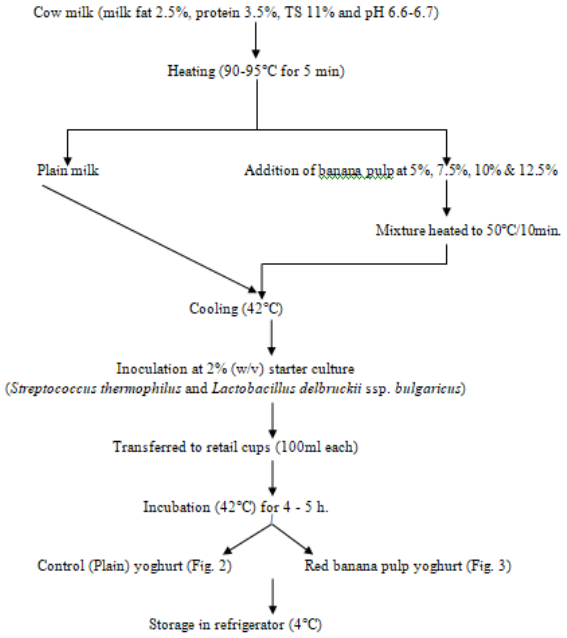
Toned milk, red banana, direct vat inoculum (DVI) of yoghurt culture were used in the present study.

Banana Fruit: A fully ripened Red Banana (Fig. 1) was collected in and around the Kamalapur village limits. The fruits were washed well, cut into pieces, mashed to obtain pulp which is then used for optimization in preparation of fruit yoghurt at different levels.

DVI Culture: Direct vat inoculum of yoghurt culture was procured from Christian Hansen, Bengaluru. The culture was propagated for a week to get the pure starter inoculum containing *Stereptococcus thermophilus* and *Lactobacillus delbruckii* ssp. *bulgaricus.* The culture was added at 0.6 – 1.0% to milk for yoghurt preparation. The inoculated samples were incubated at 42-45°C/4-6hr. till it is set to a firm body. Incubation was terminated at acidity 0.7-0.8% Lactic acid and then, the banana fruit yoghurt was stored in a refrigerator (4°C) for storage.

Red Banana Yoghurt preparation: Cow milk was used for yoghurt preparation. Milk was heated to 90-95°C for 5min and then banana fruit pulp was added at different levels for optimization of standard product. Heat the mixture (milk & banana) at low flame to remove raw banana flavour for 10 min followed by rapid cooling to 42°C. Starter culture (containing *Streptococcus thermophilus* and *Lactobacillus delbruckii* ssp. *bulgaricus*) at 2% (w/v) was added to the mixture. The product samples were incubated at 42-45°C / 4 hr. and stored in a refrigerator (4°C). The developed yoghurt having red banana pulp at different levels were served to a panel of judges along with control to evaluate the sensory characteristics (Flavour, body & texture) based on 9 point hedonic scale.

Flow chart for yoghurt preparation (Vahedi *et al.*, 2008)



Chemical, Microbiological and Sensory Analysis. The samples were analyzed in triplicate for acidity, fat and protein in chemical parameters (IS12898:1989); coliforms using Violet Red Bile Agar (HiMedia) and yeast & mold using Malt Extract Agar (Himedia) in microbiological quality (IS:SP: 18, Part II, 1981) while appearance, body & texture, flavour and overall acceptability in sensory evaluation of the product using 9-point hedonic scale (Lim, 2011).

Statistical Analysis: All the values obtained in the result of the present study were average of three trials. The data was analysed using R software (R-4.3.1 for Windows) for statistical computing. ANOVA tables were prepared to analyse the data and the critical difference was calculated (P=.05) and used to identify the significant differences that are indicated in the result tables through superscripts. The formula for the critical difference (CD) was

CD = $\sqrt{2} \times \text{MSS (E)} \times t\alpha$ @ 0.05 level of significance

Where, MSS (E) = Mean Sum of squares of the error; r = number of replications; tα = table t from value at α level of significance.

RESULTS AND DISCUSSION

Chemical, microbiological and sensory parameters were analysed for red banana yoghurt and results tabulated and discussed.

Effect of incorporation of red banana pulp to yoghurt on acidity, fat and protein content

The yoghurt samples such as T1 - control, T2 – 5% banana pulp, T3 –7.5% banana pulp, T4 - 10% banana pulp and T5 –12.5% banana pulp containing yoghurt samples were analyzed for titratable acidity, fat and protein content. Among all the banana yoghurt samples T4 & T5 had acidity of 0.72% Lactic acid, T2 had highest acidity of 0.79% LA than control sample ie., 0.71%. Fat content of T5 was slightly low (3.77%) when compared to other samples while control had 3.75% fat. The protein content was higher in T5 (5.25%) whereas control had 5.10 %, as the pulp of banana addition increased, that sample showed improvement in protein content on an average of 0.03% (Table 1).

Microbiological quality of Yoghurt types. The developed red banana yoghurt when subjected to microbiological quality for coliform and yeast and mold counts, all the yoghurt samples such ss control or plain yoghurt and banana incorporated yoghurts did not show the presence of coliforms (Table 2) indicating hygiene practices followed in the preparation. Yeast and mold count was in the range of 1.10 to 1.70 $\log_{10}$ cfu/g. Slightly higher counts of yeast molds compared to control may be assumed due to incorporation of starch of banana in the yoghurt added with red banana pulp.

Sensory evaluation of yoghurt samples incorporated with red banana pulp. The developed yoghurt samples with added banana pulp at different concentrations such as 5%, 7.5%, 10% and 12.5% along with a control (without banana pulp) were subjected for sensory evaluation by serving to panel of judges for appearance, body & texture, flavor and over all acceptability of the product. By considering the average score of all samples T4 yoghurt sample with 10% of banana pulp was accepted as best by the panelists when compared to other samples (Table 3). Statistically, significant differences were noticed in sensory scores among the red banana pulp yoghurt compared with control or plain yoghurt without banana pulp.

On par with the present study, Tuhumury *et al*. (2021) also incorporated 25% pulp of Indonesian banana variety (*Musa paradisiaca* L. var. *sapientum*) in frozen yoghurt with better characteristics of pH, protein, vitamin C, total sugar and overall sensory score (5 point) of 5.65, 2.82%, 41 mg/100 mL, 45.85% and 3.95, respectively. Similarly, Owolade *et al.* (2022), fortified yoghurt with 10% slurry of African variety banana Paranta that improved protein (3.93%), energy (207.06 kcal/100 g), vitamin C (21.6 mg/100 g) and overall sensory acceptability (6.1 for 7 scale). They also did not find any coliforms in the product but total fungi count was around 3 $\log_{10}$cfu/g which was on the higher side compared with the present study. They suggested that the inclusion of banana in yoghurt production is a potential and viable option at reducing post harvest losses of banana fruits.

Table 1: Effect of incorporation of banana pulp on acidity, fat and protein of red banana yoghurt.

Parameters (Per cent)	Control yoghurt	Red banana yoghurt types			
	T1	T2	T3	T4	T5
Acidity (lactic acid)	0.71	0.79	0.73	0.72	0.72
Fat	3.75	3.78	3.78	3.78	3.77
Protein	5.10	5.16	5.19	5.22	5.25

Note: All the values are average of three trials; T1 – Control yoghurt; T2- product with 5 % of banana pulp; T3 - product with 7.5 % of banana pulp; T4- product with 10 % of banana pulp; T5 - product with 12.5 % of banana pulp

Table 2: Microbiological quality of developed red banana yoghurt.

Counts ($\log_{10}$cfu/g)	Control yoghurt	Red banana yoghurt types			
	T1	T2	T3	T4	T5
Coliform	Nil	Nil	Nil	Nil	Nil
Yeast & Mold	1.10	1.30	1.47	1.60	1.70

Note: All the values are average of three trials

T1 – Control yoghurt; T2- product with 5 % of banana pulp; T3 - product with 7.5 % of banana pulp; T4- product with 10 % of banana pulp; T5 - product with 12.5 % of banana pulp; Sterile VRBA maintained at 50ºC was used as medium for Coliform count and incubated; at 37°C for 24-48h; Sterile MEA maintained at 50°C adjusted to pH 3.5 using filter sterile 10% lactic acid was; used as medium for yeast and mold count and incubated at 30°C for 3-5 days; As per BIS for yoghurt (IS12898:1989), coliforms should be 10 cfu/g (1$\log_{10}$cfu/g) and yeast & molds 100/g (2 $\log_{10}$cfu/g)

Table 3: Sensory scores of developed red banana yoghurt.

Parameters	Control yoghurt	Red banana yoghurt types				CD (P=.05)
	T1	T2	T3	T4	T5	
Appearance	7.90[a]	7.00[b]	7.10[ca]	7.50[d]	7.10[ea]	0.20
Body & Texture	7.80[a]	7.11[b]	7.33[c]	7.44[da]	7.10[e]	0.12
Flavour	7.80[a]	7.00[b]	7.30[c]	7.50[d]	7.20[e]	0.12
Over all acceptability	8.00[a]	7.25[b]	7.00[ca]	7.50[da]	7.12[ea]	0.33

Note:
All the values are average of three trials
T1 – Control yoghurt; T2- product with 5 % of banana pulp; T3- product with 7.5 % of banana pulp; T4- product with 10 % of banana pulp; T5- product with 12.5 % of banana pulp; CD – Critical difference; Different superscripts in rows indicate significant difference while same superscripts show non-significance at P=.05

Fig. 1. Kamlapur Red Banana.

Fig. 2. Yoghurt - Control sample.

Fig. 3. Yoghurt incorporated with Red Banana Pulp.

CONCLUSIONS

The red banana is a tropical fruit of Kamalapur region which is rich in minerals, mainly calcium and potassium along with its richness in dietary fiber. The incorporation of red banana yoghurt enriches the product with minerals, fiber and vitamins to meet dietary requirements of all age groups. The palatability of banana incorporated yoghurt is improved due to fermentation by having both sour (lactic acid) and sweet (starch) flavor. As the product is fermented, gut health of consumers is benefitted not only due to acidity but also with the abundant source of starch as prebiotic that stimulate probiotic microflora.

FUTURE SCOPE

Different fermented dairy products like dahi, shrikhand and probiotic milk products can be optimized using the red banana pulp. The effect of prebiotic components on probiotic flora may also be added as an important objective in further studies.

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Conflict of Interest. None.

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