

# DEVELOPMENT AND PERFORMANCE EVALUATION OF SYNBIOTIC RED BANANA YOGHURT

## ABSTRACT

**Aims:** The present study aimed at the production of yoghurt with red banana pulp at 5, 7.5, 10, 12.5, 15% concentrations.

**Study design:** Development of red banana pulp incorporated probiotic yoghurt and its analysis

**Place and Duration of Study:** Department of Dairy Microbiology, Dairy Science College, Hebbal, Bengaluru  
Karnataka Veterinary, Animal and Fisheries Sciences University, Bidar,  
Karnataka, India. Between June 2022 and March 2023.

**Methodology:** The probiotic red banana pulp incorporated yoghurt was developed and subjected to sensory analysis by the panel of judges using 9-point hedonic scale, analysed for milk set time, acidity and viability and the best combination was selected.

**Results:** The 10% concentration of red banana pulp was selected which showed 2.3 h of milk set time, acidity of 0.74% LA, viable log count/g was 9.50 and overall acceptability score was 8.25. The contaminants like coliforms and yeast and mold were absent. The 10% concentration showed no significant difference ( $P = .05$ ) in milk set time and acidity compared with the control sample while significant difference was observed in viability among the different concentrations. The sample was analyzed for syneresis which was 9.30%, water activity was 0.939, viscosity was 6.08cP and color intensity  $L^*$  was 80.17,  $a^*$  was -0.85 and  $b^*$  was 8.68.

**Conclusion:** The developed product improves the acceptability and provides benefits of both probiotics and red banana for the consumers.

**KEY WORDS:** Kamalapur Red Banana; Probiotic; Yoghurt; GI tag; *Lactobacillus acidophilus*

## 1. INTRODUCTION

Milk is considered as a very good culture media for the growth of microorganisms due to its balanced nutrition and intrinsic environment. India stands first in milk production with 230.58 million tonnes and the percapita availability of 459 g per day in the year 2022 - 2023 (1). Milk is a perishable commodity, there is a need to preserve the milk to make it available for a longer period. It can be preserved by the treatments like pasteurization and sterilization. Fermentation serves as an alternate and age old method practiced for the preservation of milk nutrients against spoilage. It improves bioavailability of nutrients, sensory qualities and

acceptability of the milk. It is carried out by starter cultures, many of these are Lactic Acid Bacteria (LAB) like *Lactococcus* spp., *Streptococcus thermophilus*, *Lactobacillus* spp., *Leuconostoc* etc. Yoghurt is the most popular and widespread fermented milk product in the world which is fermented with *Lactobacillus bulgaricus* and *Streptococcus thermophilus* is regarded as standard. The functionality of yoghurt increases with addition of probiotic cultures and incorporation of varieties of fruits in yoghurt boosts the consumption among people of all age groups.

Red banana, a special variety of banana with a red skin and creamish coloured pulp with an enjoyable taste. It is a monocotyledonous perennial, giant herb belonging to family musaceae and genus *musa*. These are grown in Kamalapur taluk in Kalaburagi district, Karnataka, India which has been recognized under the Geographical Indication (GI) Certification and has got its GI tag in 2009 with a tag number of 133. It is also known as the 'Rich man's fruit' as it is marketed at a higher price than other varieties of banana, as mentioned in Draft District Export Action plan: Kalaburagi (Gulbarga), 2021 (2). A Geographical Indication is a designation or sign used on particular products which refers to a particular geographic area or origin, it serves as a certification that a product has particular characteristics or has a particular reputation that is largely due to their geographic origin. Milk is devoid of dietary fibers, the addition of red banana serves as a prebiotic component by supplying dietary fibers in the form of Fructo Oligo Saccharides (FOS), it contains about 40g per 100g (3). As per a study reported (4), taking 8g of FOS per day for 2 weeks increases the beneficial gut bacterial population by 10 times. It may help manage type-2 diabetes by inhibiting the alpha-amylase enzyme (5), may stop the growth of breast cancer cells (6), the richness of potassium and magnesium helps in relaxing the blood vessels and thus reduce blood pressure (7), presence of antioxidants like lutein and zeaxanthin protects the eyes from damage, due to age related muscular degeneration. Synbiotic foods have gained popularity in recent years due to their functional, nutritional, physiological and therapeutic characteristics. The current trend of health-conscious consumers and healthy food habits prompts researchers to explore developing food products with synbiotic benefits. It is essential to assess the characteristics of a newly developed food product. The purpose of this research is to optimize the levels of red banana pulp in the probiotic yoghurt based on sensory, milk set time, acidity and viability.

## 2. MATERIALS AND METHODS

All the experiments were conducted at the post graduate laboratory of Dairy Microbiology Department, Dairy Science College, Hebbal, Bengaluru, Karnataka Veterinary, Animal and Fisheries Sciences University, Regional Campus.

### 2.1 Materials

**2.1.1 Raw milk:** The raw milk with 3.5% fat and 8.5% SNF was procured from ILFC (Institutional livestock farm complex), KVAFSU, Hebbal, Bengaluru.

**2.1.2 Starter cultures:** The starter cultures *Streptococcus thermophilus*, *Lactobacillus bugarius* and probiotic culture *Lactobacillus acidophilus* maintained in the department of Dairy Microbiology, Dairy Science College, Hebbal, Bengaluru, were used.

**2.1.3 Red banana:** The ripened red banana was procured from Kamalapur market, Kalaburagi, Karnataka, India.

**2.1.4 PET cups:** Disposable Polyethylene Terephthalate (PET) cups of 50 ml capacity with lid procured from local market were used for serving samples to panel of judges during sensory evaluation.

- Lamy viscometer (Viscosity), LabSwift- $a_w$  instrument (water activity), Spectrophotometer -3nh (Colour)

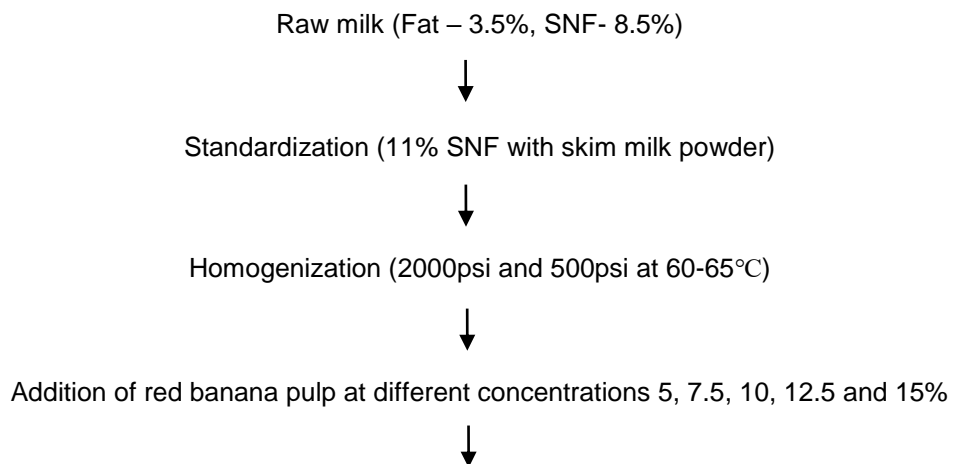
### 2.2 Methods:

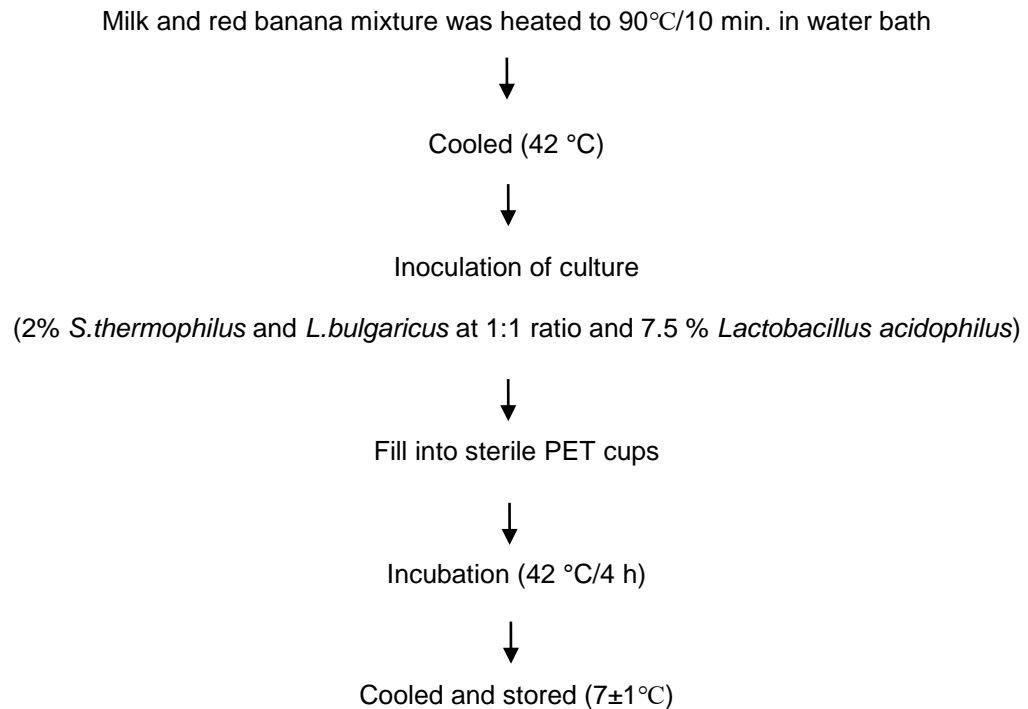
#### 2.2.1 Preparation of red banana pulp:

The pulp was obtained by peeling the ripened red banana and blending it in a sterile blender (UV sterilization) and filtered through a sterile muslin cloth.

#### 2.2.2 Preparation of red banana incorporated probiotic yoghurt:

##### Flow chart 1. Preparation of red banana





### **2.2.3 Analysis of red banana pulp incorporated probiotic yoghurt:**

The prepared red banana pulp incorporated probiotic yoghurt was analyzed for titratable acidity, sensory, viability and milk set time was noted. The titratable acidity was determined by titration method as per FSSAI 01.035:2022 (8). A 9-point hedonic scale was used by the selected panel of trained judges to evaluate the generated study sample's sensory qualities, including colour and appearance, body and texture, flavour, and overall acceptability. The viability of the cultures was determined using pour plate method (9). Viscosity was evaluated by Lamy viscometer (B-one plus LR module), Water activity was determined by LabSwift- $a_w$  instrument, Colour of the sample was determined by a Spectrophotometer (3nh), a light-sensitive instrument in Rheology laboratory, Department of Dairy Technology, Dairy Science college, Hebbal, Bengaluru, Karnataka, India.

## **3. RESULTS AND DISCUSSION**

The results obtained for the prepared red banana pulp incorporated probiotic yoghurt analyzed for acidity, viability, sensory and milk set time were tabulated and discussed.

### **3.1 Performance of red banana pulp incorporated probiotic yoghurt:**

The red banana pulp incorporated probiotic yoghurt was prepared at different levels of red banana pulp of 5, 7.5, 10, 12.5 and 15% were added and heat treated to 90°C in water bath for 10 min. and probiotic culture *L. acidophilus* along with 2% yoghurt cultures were inoculated and incubated at 42°C till milk gets set. The milk set time noted was 2.30 h for 10% added red banana pulp. The acidity was highest for sample with 5% added pulp which was 0.75% LA while for 10% added red banana pulp it was 0.74% LA and the viable log count/g was 9.50 for the 10 % added red banana pulp which was highest among all the other samples (Table 1). The coliforms and yeast and molds which are regarded as contaminants were absent in the final product. There was no significant difference observed in the acidity among the samples whereas there was a statistical significance ( $P = .05$ ) in the viable counts among the samples. The results were in line with the study reported (10) where kamalapur red banana was added at different levels of 5, 7.5, 10 and 12% along with control (without banana pulp) and 2% of the yoghurt cultures were inoculated to the heat treated milk with 11% total solids. The acidity of yoghurt with 10% banana pulp was optimum (0.72% LA) compared to other levels which were 0.71 % LA for control, 0.79 % LA for 5% banana pulp, 0.72 % LA for 12.5% banana pulp. The coliform counts were absent in all the samples and yeast and mold counts were 1.10 cfu/g in control, 1.30 cfu/g in 5% banana pulp, 1.47 cfu/g in 7.5 % banana pulp, 1.60 cfu/g in 10% banana pulp and 1.70 cfu/g in 12.5% banana pulp. Among these 10% of red banana pulp was optimized. As per BIS for yoghurt (11), coliforms should be 10 cfu/g (1 log cfu/g) and yeast and molds should be 100 cfu/g (2 log cfu/g). The coliforms and yeast and molds of the tested samples met the standard requirements. In accordance with the study done (12) on probiotic properties of banana yoghurts made with 15% of banana puree and equal quantity of sucrose along with probiotic cultures *L. acidophilus* and *Bifidobacterium bifidum* at 3% level. It was inoculated at 37°C and were incubated at 43±1°C. The yoghurt with *L. acidophilus* had acidity of 0.85% LA and with *L. acidophilus* and *Bifidobacterium bifidum* had 0.85% LA. The yoghurt with *L. acidophilus* had average viable log counts/g of 7.20 and the yoghurts mixed with *L. acidophilus* and *Bifidobacterium bifidum* had *L. acidophilus* log counts/g of 8.04.

**Table1: Performance of red banana pulp incorporated probiotic yoghurt**

Red banana pulp (%)	Milk set time (h)	Acidity (% LA)	Viability	Contaminants	
				Coliforms	Yeast and mold
$\log_{10}$ cfu/g					

Control	2.53 <sup>a</sup>	0.67 <sup>a</sup>	8.60 <sup>a</sup>	Nil
5	2.45 <sup>a</sup>	0.75 <sup>a</sup>	9.10 <sup>ab</sup>	
7.5	2.40 <sup>ab</sup>	0.73 <sup>a</sup>	9.03 <sup>ab</sup>	
10	2.30 <sup>abc</sup>	0.74 <sup>a</sup>	9.50 <sup>b</sup>	
12.5	2.15 <sup>bc</sup>	0.72 <sup>a</sup>	8.56 <sup>a</sup>	
15	2.05 <sup>c</sup>	0.74 <sup>a</sup>	9.23 <sup>b</sup>	
<b>CD (P=.05)</b>	<b>0.29</b>	<b>0.09</b>	<b>0.54</b>	

- All the values are average of three trials, CD - Critical Difference, Same superscripts within the column indicate no significant difference, Different superscripts in the same column indicates significant difference.

### 3.2 Sensory scores of red banana pulp incorporated probiotic yoghurt:

The red banana pulp incorporated probiotic yoghurt samples were subjected to sensory analysis using 9-point hedonic scale by the panel of judges. The sample with 10% red banana pulp was awarded highest score for overall acceptability of 8.25 whereas for control it was 7.25 compared to other levels (Table 2). The significant differences were observed among the sensory scores of red banana pulp incorporated probiotic yoghurt. The results obtained were in accordance with the study reported (13), the yoghurt was prepared using different varieties of banana at different levels of 10, 15 and 20% and were subjected to sensory analysis using seven point hedonic scale. The sample with 10% banana (paranta variety) had the score of 5.8 for taste which was higher compared to control which was 3.1, it also had highest overall acceptability of 6.1 among the samples while control had 4.1 out of 7. On conformity with (10), the yoghurt samples added with 5, 7.5, 10 and 12.5% of red banana pulp along with the control were subjected for sensory evaluation by 9-point hedonic scale. The sensory score awarded for control was 7.9 for appearance, 7.8 for body and texture and flavor and it scored 8.00 for overall acceptability whereas the 10% banana pulp added sample was awarded 7.5 for appearance, 7.44 for body and texture, 7.50 for both flavor and overall acceptability. On comparing the average scores of all the samples, 10% banana pulp incorporated sample was accepted by the panelists compared to other samples.

By considering sensory, milk set time, acidity and viability, the 10% red banana pulp added yoghurt was optimized in the present study.

**Table 2: Sensory scores of red banana pulp incorporated probiotic yoghurt**

Red Banana pulp (%)	Sensory profiles			
	Colour and appearance	Body and texture	Flavor	Overall acceptability
Control	7.70 <sup>a</sup>	7.70 <sup>a</sup>	6.5 <sup>a</sup>	7.25 <sup>a</sup>
5	7.50 <sup>b</sup>	7.50 <sup>b</sup>	7.25 <sup>b</sup>	7.25 <sup>a</sup>
7.5	7.50 <sup>b</sup>	7.50 <sup>b</sup>	7.50 <sup>c</sup>	7.50 <sup>b</sup>
10	7.80 <sup>c</sup>	8.25 <sup>c</sup>	8.25 <sup>d</sup>	8.25 <sup>c</sup>
12.5	7.80 <sup>c</sup>	8.00 <sup>d</sup>	8.00 <sup>e</sup>	8.00 <sup>d</sup>
15	7.50 <sup>b</sup>	6.50 <sup>e</sup>	7.25 <sup>b</sup>	7.25 <sup>a</sup>
CD ( $P=0.05$ )	0.01	0.01	0.10	0.08

**Note:** Same superscripts within the column indicate no significant difference, Different superscripts in the same column indicates significant difference.

### 3.3 Physico – chemical characteristics of optimized red banana pulp incorporated probiotic yoghurt:

The physico chemical characteristics such as syneresis, viscosity, water activity and colour measurement were analyzed (Table 3). The syneresis of optimized red banana pulp incorporated yoghurt was 16.83% while for control yoghurt it was 27.71%. This shows that the addition of red banana pulp improved the syneresis percentage. The lower percentage of syneresis may be due to the increase in the total solids content. The decrease in syneresis in yoghurt added with 5% of green banana biomass (GBB) which was 14.26% whereas 16.66% for control, 17.34% for 3% GBB and 18.34% for 10% addition of GBB. The formation of firm clot which was capable of holding free water might have decreased the syneresis by drainage (14). On contrary the study reported (15), the syneresis of stirred yoghurts blended with banana puree and fortified with calcium increased. This may be due to the weakening of casein network when

fortified with calcium salt. It also found that fortification of 400mg of calcium lactate/100g resulted in the product with similar properties of non fortified yoghurt.

Viscosity of the product was 6.08 cP while the control had 7.01cP at 25°C, this indicates that the addition of red banana pulp decreased the viscosity of the red banana pulp incorporated probiotic yoghurt compared to control yoghurt. This was because the yoghurt is a gel made of casein micelles which are entrapped in water, viscosity decreases as the gel structure deteriorates. A study (16) reported, the viscosity (firmness) can be improved by use of proteolytic strains (*S. thermophilus* and *L. bulgaricus*). The yoghurt which was incorporated with maitake mushroom showed lower viscosity than control yoghurt samples. The possible reason for lower viscosity may be due to the breakdown of gel network by the particles of maitake mushroom powder in yoghurt. This result was similar to the present study.

The water activity of the control sample was 0.954 and red banana pulp incorporated probiotic yoghurt was 0.939 which were almost similar, while the red banana pulp incorporated probiotic yoghurt had slightly lower than the control. This may be due to the incorporation of the red banana pulp where the total solids increases which increases the water holding capacity their by decrease in the water activity. The results obtained (17) for water activity on yoghurts and probiotic bacteria were in line with the present study. The author prepared probiotic yoghurts using skim milk supplemented with 0, 4, 8, 12 or 16% sucrose. The water activity decreased, as the sugar level increased. A decrease in  $a_w$  inhibited acid production by both organisms (*S.thermophilus* and *L. bulgaricus*).

The prepared red banana incorporated probiotic yoghurt showed  $L^*$  value of 80.17 where as control showed 81.38, the decrease in the lightness value in red banana pulp incorporated probiotic yoghurt may be due to addition of the pulp which is darker. Higher values of  $L^*$  in dairy products were due to the ability of casein micelles and fat globules to scatter light. The  $a^*$  value was -0.85 compared to control which was -0.90, the negative value for  $a^*$  corresponds to green.  $b^*$  value was 8.68 for red banana pulp incorporated probiotic yoghurt and control was 8.75, positive  $b^*$  corresponds to yellow. In corroboration with Costa (14) who developed prebiotic yoghurt with green banana biomass (GBB) at 3 different levels of GBB 3, 5 and 10% in yoghurt and a control, studied the changes in colour in the control and GBB yoghurt. The control sample showed  $L^*$  of 92.40 whereas 91.71, 91.82 and 90.76 for 3, 5 and 10% GBB respectively. The absence of GBB in control had high luminosity while the presence of GBB darkens the sample due to starch

with granular structure that increases the amount of light that is absorbed and decreases the reflected light. As the GBB concentration increases green colour was indicated ( $a^*$ ) it showed -2.08 for control, -1.57 (3%), -1.70 (5%) and -1.72 (10%), which is slightly similar to the present study. The  $b^*$  value for control was 10.11, for 3% it was 10.43, for 5% it was 10.02 and for 10% it was 10.41 indicates the yellowness of the samples. In accordance with (16) studied and reported the physico – chemical, microbiological and sensory characteristics of yoghurt by adding various ingredients (glutamine – 7mg/l, quercetin – 700mg/l, slippery elm bark - 210mg/l, marshmallow root – 1340mg/l, reducing sugar (NAG) – 210mg/l, licorice root – 210mg/l, maitake mushrooms – 42mg/l and zinc orotate – 70mg/l). The presence of reducing sugar reduces  $L^*$ , this is due to maillard reactions of yoghurt proteins during pasteurization. Casein micelles and fat globules have the ability to scatter light and hence there would be higher  $L^*$  values for dairy products.  $a^*$  values of mushroom added samples are higher than control samples, whereas quercetin added samples had lowest values. This may be due to the brown pigments in mushrooms that promoted higher redness colour in yoghurt. Quercetin is a yellow pigment and is responsible for high  $b^*$  values.  $b^*$  may also increase due to increase in syneresis values. Addition of powder to milk, destabilizes casein micelles during pasteurization that affect  $b^*$  values.

**Table 3: Physico – chemical characteristics of optimized red banana pulp incorporated probiotic yoghurt**

	Syneresis (%)	Viscosity (cp) 25°C	Water activity at 27 ± 3°C	Colour		
				$L^*$	$a^*$	$b^*$
<b>Control</b>	9.80	7.01	0.954	81.38	-0.90	8.75
<b>Red banana pulp incorporated probiotic yoghurt</b>	9.30	6.08	0.939	80.17	-0.85	8.68

**Note:**  $L^*$  - Lightness from black to white on a scale of zero to 100,  $a^*$  - Negative  $a^*$  corresponds with green, positive  $a^*$  corresponds with red,  $b^*$  - Negative  $b^*$  corresponds with blue and positive  $b^*$  corresponds with yellow.

#### 4. CONCLUSIONS

Fermentation helps in improving the bioavailability of nutrients present in the milk. Yoghurt, a fermented milk product can be prepared using different varieties of fruits available as a value addition. A similar venture has been taken up in this study, where Kamalapur's red banana (GI tag no. 133 – 2009) was used as the added component for value addition with the advantages of probiotic culture. The red banana pulp incorporated probiotic yoghurt has benefits of both red banana and also the probiotic culture (*L. acidophilus*) used in yoghurt. Instead of only offering fruit or plain yoghurt, the red banana pulp infused yoghurt, with its complementary sour and sweet flavours, draws in customers by presenting the fruit in an enticing way.

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