

# Formulation of Value Enriched Yoghurt with Soy Milk and Mango Pulp

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## Abstract

The objectives of the study were aimed to develop novel value enriched yoghurt with soy milk and mango pulp. In the first stage, soy milk inclusion in yoghurt were tried at 0, 10, 20 and 30 percent and optimized that upto 30% can be included to improve the protein value of yoghurt without affecting the other physico-chemical and sensory quality of the yoghurt. In the second stage, the level and method of mango pulp addition was optimized. Mango pulp @ 5, 10 and 15% was incorporated at the time of inoculation and after setting up of the yoghurt. It is concluded that 15% of mango pulp could be added after setting up of the yoghurt and stirred type of value enriched yoghurt could be manufactured. There were significant changes in protein and total solids content in control yoghurt and value enriched yoghurt. Highest values for protein and SNF of yoghurt with 30% soy milk and 15% mango pulp were 7.12 and 14.31% respectively. Dried mango pulp addition was tried to incorporate at the time of culture inoculation. Physico-chemical and sensory evaluation of dried mango incorporated yoghurt revealed that it cannot be stored beyond 5 days at refrigeration temperature due to high acidity, syneresis, flavor and overall acceptability.

**Keywords:** Yoghurt; Sensory quality; Physico-chemical properties; Mango (*Mangifera indica*)

## Introduction

Yoghurt is a product obtained by the lactic fermentation of whole, skimmed or standardized milk by action of *Lactobacillus delbrueckii* ssp. *bulgaricus* and *Streptococcus thermophilus*, and can be accompanied by other lactic bacteria which, for their part, contribute to the characteristics of the final product [1]. Yoghurt can be enriched with milk powder, proteins, vitamins, minerals or fruits.

Soy milk is richer in protein that is up to 40%. In addition to the high protein in soy milk, it contains a considerable amount of isoflavone compounds which have been known as a natural substance to replenish the female hormone oestrogen in order to relieve the menopausal symptoms. Soy milk can be incorporated in to yoghurt due to their reduced level of cholesterol and saturated fat (Table 1).

However, consumption of soy milk is undesired due to the presence of unpleasant off-flavors carried over from soy beans and anti-nutritional factors, such as phytic acid, oligosaccharides, trypsin inhibitor etc., Fermentation with GRAS (generally recognized as safe) microorganisms has been used to help degrade these anti-nutritional factors and the nutritional value of soy milk can be largely enhanced by fermentation. With the advent of health foods, there has been an increasing trend to fortify the milk product with fruits [2] (Table 2). India is the second largest producer of fruits in the world, and about 40 percent of the world's mangoes and 30 percent of the world's bananas and papayas are produced in India. Hence, use of fruits in the preparation of value added dairy products is inevitable.

It will be advantageous to fortify fruits in protein enriched yoghurt to mask the beany flavour of soy milk and to get maximum nutritional value. The flavourings and their dosage are usually regulated according to the regulations say by each country. The FAO/WHO recommendations for fruit yoghurt are a fruit content between 5 and 15%. Tarakci and Kucukoner [3] prepared the fruit yoghurt with 7% w/w of different fruits and studied the physical, chemical and microbiological quality of the yoghurt. They observed that there were increase in protein content, total dry matter content and high syneresis value (Table 3).

With consideration of the above points, this project is aimed to

study the following objectives to prepare the novel value enriched stirred yoghurt with soy milk and fruit pulps.

## Materials and Methods

### Ingredients

Fresh cow's milk obtained from the Dairy farm at Veterinary College and Research Institute, Orathanadu, Thanjavur, Tamilnadu, India. Skim Milk powder of Aavin (Tamilnadu Milk Producers Cooperative Federation) has been purchased from local market. Soy, fruits and commercial grade cane sugar were also purchased from local market of Thanjavur (Table 4).

### Starter cultures

Yoghurt starter culture contains *Streptococcus thermophilus* and *Lactobacillus delbrueckii* subsp. *bulgaricus* obtained from Chr. Hansens Laboratories, Denmark and activated at 42°C using 12% sterilized reconstituted skim milk. After incubation at 42°C for 4-5 h, the working culture was freshly used for every trial (Table 5).

### Preparation of mango pulp

Fresh mangoes were washed, peeled and mashed using an electrical mixer grinder without addition of any water. Then the homogenate was pasteurized for 90°C for 5 minutes and cooled immediately. This pasteurized pulp stored at refrigeration temperature (Table 6).

### Preparation of soymilk

Soy milk was prepared by soaking soybeans into potable water for

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Properties	SMY0	SMY1	SMY2	SMY3	F value
Fat (%)	3.40 <sup>a</sup> ±0.02	2.51 <sup>b</sup> ±0.05	2.62 <sup>c</sup> ± 0.03	2.65 <sup>cd</sup> ±0.22	4.58**
SNF (%)	12.00 <sup>a</sup> ±0.50	12.62 <sup>b</sup> ± 0.12	13.21 <sup>c</sup> ± 0.02	14.45 <sup>d</sup> ± 0.31	13.62**
Protein (%)	3.70 <sup>a</sup> ± 0.15	6.20 <sup>b</sup> ± 0.15	6.53 <sup>c</sup> ± 0.13	7.23 <sup>d</sup> ± 0.21	20.23**
Acidity (%)	1.00 <sup>a</sup> ± 0.01	1.20 <sup>b</sup> ± 0.03	1.40 <sup>c</sup> ± 0.01	1.60 <sup>d</sup> ± 0.02	5.20**
pH	4.62 <sup>a</sup> ± 0.12	4.51 <sup>a</sup> ± 0.21	4.32 <sup>b</sup> ± 0.15	4.21 <sup>c</sup> ± 0.11	4.84**
Syneresis (%)	20.15 <sup>a</sup> ± 0.30	20.25 <sup>a</sup> ± 0.20	20.40 <sup>a</sup> ± 0.25	21.01 <sup>a</sup> ± 0.25	1.20**

\*(Values given are mean values of three trials); SMY0 – Soy milk inclusion @0% (Control); SMY1-Soymilk inclusion @10%; SMY2- Soymilk inclusion @20% SMY3- Soymilk inclusion @30.

Table 1: Physico-Chemical Properties of Yoghurt With Soy Milk\*.

Properties	SMY0	SMY1	SMY2	SMY3	F value
Colour and appearance	8.51 <sup>a</sup> ± 0.35	8.52 <sup>a</sup> ± 0.31	8.55 <sup>a</sup> ± 0.17	8.45 <sup>a</sup> ± 0.15	0.87 <sup>NS</sup>
Body and Texture	8.41 <sup>a</sup> ± 0.15	8.54 <sup>a</sup> ± 0.32	8.45 <sup>a</sup> ± 0.25	8.48 <sup>a</sup> ± 0.12	1.02 <sup>NS</sup>
Flavour	8.50 <sup>a</sup> ± 0.22	8.15 <sup>b</sup> ± 0.23	8.01 <sup>b</sup> ± 0.21	8.14 <sup>b</sup> ± 0.32	4.67**
Sourness	8.52 <sup>a</sup> ± 0.21	8.35 <sup>a</sup> ± 0.02	8.42 <sup>a</sup> ± 0.13	8.51 <sup>a</sup> ± 0.35	0.54 <sup>NS</sup>
overall acceptability	8.54 <sup>a</sup> ± 0.42	8.52 <sup>a</sup> ± 0.32	8.48 <sup>a</sup> ± 0.12	8.51 <sup>a</sup> ± 0.22	1.14 <sup>NS</sup>

\*(Values given are mean values of three trials); SMY0 – Soy milk inclusion @0% (Control); SMY1-Soymilk inclusion @10%;SMY2- Soymilk inclusion @20% SMY3- Soymilk inclusion @30%.

Table 2: Sensory Evaluation of Yoghurt With Soy Milk\*.

Properties	Mango			F value
	SMMY1	SMMY2	SMMY3	
Fat (%)	2.45 <sup>a</sup> ±0.01	3.11 <sup>ab</sup> ± 0.02	3.41 <sup>b</sup> ± 0.03	16.58**
SNF (%)	12.42 <sup>a</sup> ± 0.05	13.35 <sup>b</sup> ± 0.13	14.31 <sup>c</sup> ± 0.25	18.12**
Protein (%)	7.12 <sup>a</sup> ± 0.02	6.83 <sup>ab</sup> ± 0.03	6.58 <sup>b</sup> ± 0.04	14.15**
Acidity (%)	1.18 <sup>a</sup> ± 0.11	1.20 <sup>a</sup> ± 0.13	1.35 <sup>b</sup> ± 0.14	5.14*
pH	4.15 <sup>a</sup> ± 0.01	4.01 <sup>a</sup> ± 0.03	3.67 <sup>b</sup> ± 0.03	12.08**
syneresis (%)	22.02 <sup>a</sup> ± 0.15	23.31 <sup>b</sup> ± 0.15	24.13 <sup>c</sup> ± 0.25	24.26**

SMMY1-Soymilk mango yoghurt with 5% mango pulp; SMMY2- Soymilk mango yoghurt with 10% mango pulp; SMMY3- Soymilk mango yoghurt with 15% mango pulp @ (Values given are mean values of three trials)N.S Not significant; \* Significant at 95 % level; \*\* Significant at 98% level.

Table 3: Physico-Chemical Properties of Yoghurt With 30% Soy Milk And Mango Pulp\*.

Properties	Mango			F value
	SMMY1	SMMY2	SMMY3	
Colour and appearance	8.53 <sup>a</sup> ± 0.00	8.58 <sup>a</sup> ± 0.12	8.65 <sup>ab</sup> ± 0.02	5.26*
Body and Texture	8.52 <sup>a</sup> ± 0.10	8.56 <sup>a</sup> ± 0.12	8.65 <sup>a</sup> ± 0.12	0.17 <sup>NS</sup>
Flavour	8.70 <sup>a</sup> ± 0.02	8.95 <sup>a</sup> ± 0.11	9.50 <sup>b</sup> ± 0.10	8.32**
Sourness	8.50 <sup>a</sup> ± 0.24	8.75 <sup>b</sup> ± 0.25	8.82 <sup>c</sup> ± 0.20	6.51*
overall acceptability	8.50 <sup>a</sup> ± 0.11	8.80 <sup>ab</sup> ± 0.12	9.20 <sup>b</sup> ± 0.14	14.15**

SMMY1-Soymilk mango yoghurt with 5% mango pulp; SMMY2- Soymilk mango yoghurt with 10% mango pulp; SMMY3- Soymilk mango yoghurt with 15% mango pulp @ (Values given are mean values of three trials)N.S Not significant; \* Significant at 95 % level; \*\* Significant at 98% level.

Table 4: Sensory Evaluation of Yoghurt With Soy Milk And Fruit Pulp\*.

Storage periods	Fat (%)	SNF (%)	Protein (%)	Lactose (%)	Acidity (%)	pH	syneresis (%)
0	3.41 <sup>a</sup> ± 0.05	14.31 <sup>a</sup> ± 0.12	6.58 <sup>a</sup> ± 0.11	4.42 <sup>a</sup> ± 0.04	1.35 <sup>a</sup> ± 0.15	3.67 <sup>a</sup> ± 0.01	24.13 <sup>a</sup> ± 0.02
5	3.41 <sup>a</sup> ± 0.05	14.25 <sup>a</sup> ± 0.11	6.55 <sup>a</sup> ± 0.14	4.45 <sup>a</sup> ± 0.01	1.65 <sup>ab</sup> ± 0.12	3.51 <sup>a</sup> ± 0.11	24.05 <sup>a</sup> ± 0.03
10	3.42 <sup>a</sup> ± 0.02	14.15 <sup>a</sup> ± 0.14	6.48 <sup>a</sup> ± 0.12	4.35 <sup>a</sup> ± 0.01	1.72 <sup>b</sup> ± 0.02	3.42 <sup>b</sup> ± 0.02	24.52 <sup>b</sup> ± 0.04
15	3.38 <sup>a</sup> ± 0.09	14.12 <sup>a</sup> ± 0.12	6.40 <sup>a</sup> ± 0.12	4.38 <sup>a</sup> ± 0.02	1.78 <sup>b</sup> ± 0.02	3.15 <sup>c</sup> ± 0.05	24.65 <sup>b</sup> ± 0.02
20	3.37 <sup>a</sup> ±0.04	14.08 <sup>a</sup> ± 0.11	6.45 <sup>a</sup> ± 0.15	4.42 <sup>a</sup> ± 0.03	2.10 <sup>c</sup> ± 0.05	2.20 <sup>d</sup> ± 0.11	25.65 <sup>c</sup> ± 0.01
F value	0.16 <sup>NS</sup>	1.21 <sup>NS</sup>	1.52 <sup>NS</sup>	2.5 <sup>NS</sup>	12.50**	15.16**	12.82**

Table 5: Physico-Chemical Properties of Yoghurt with Soy Milk And Mango Pulp In Storage Periods\*.

16-18 h, drained, washed with tap water, grinded, steeped for 4-5 h in water (100 g soybean mixed with 100 ml water) and filtrated through cheese cloth to obtain the soymilk. The prepared soy milk should be pasteurized at 85°C for 10 minutes and stored until use (Table 7).

## Experimental Design

### Production of yoghurt with soy milk

Milk was heated to 90-95°C for 5 min and then rapidly cooled to

Storage periods	Colour and appearance	Body and Texture	Flavour	Sourness	Overall acceptability
0	8.65 <sup>a</sup> ± 0.10	8.85 <sup>a</sup> ± 0.14	9.57 <sup>a</sup> ± 0.14	8.80 <sup>a</sup> ± 0.01	9.20 <sup>a</sup> ± 0.01
5	8.62 <sup>a</sup> ± 0.14	8.45 <sup>b</sup> ± 0.13	9.10 <sup>b</sup> ± 0.12	8.50 <sup>a</sup> ± 0.00	9.05 <sup>a</sup> ± 0.15
10	8.40 <sup>ab</sup> ± 0.23	8.21 <sup>b</sup> ± 0.16	8.75 <sup>b</sup> ± 0.11	7.75 <sup>b</sup> ± 0.10	8.54 <sup>b</sup> ± 0.11
15	7.75 <sup>c</sup> ± 0.12	7.50 <sup>c</sup> ± 0.15	8.11 <sup>c</sup> ± 0.15	7.52 <sup>b</sup> ± 0.11	8.11 <sup>b</sup> ± 0.14
20	6.85 <sup>d</sup> ± 0.11	6.25 <sup>d</sup> ± 0.13	6.50 <sup>d</sup> ± 0.01	6.52 <sup>c</sup> ± 0.12	6.53 <sup>c</sup> ± 0.15
F value	42.01 <sup>**</sup>	67.82 <sup>**</sup>	48.21 <sup>**</sup>	40.23 <sup>**</sup>	69.51 <sup>**</sup>

Table 6: Sensory Evaluation of Yoghurt with Soy Milk and Mango Pulp in Storage Periods\*.

Properties / Storage periods	0 day	5 days	10 days	F value
Fat (%)	3.45 <sup>a</sup> ± 0.12	3.38 <sup>a</sup> ± 0.21	3.48 <sup>a</sup> ± 0.15	0.16 <sup>NS</sup>
SNF (%)	14.25 <sup>a</sup> ± 0.22	14.18 <sup>a</sup> ± 0.15	14.31 <sup>a</sup> ± 0.24	1.45 <sup>NS</sup>
Protein (%)	6.52 <sup>a</sup> ± 0.01	6.55 <sup>a</sup> ± 0.04	6.57 <sup>a</sup> ± 0.04	0.97 <sup>NS</sup>
Acidity (%)	1.60 <sup>a</sup> ± 0.11	1.85 <sup>b</sup> ± 0.11	2.10 <sup>c</sup> ± 0.15	8.69 <sup>**</sup>
pH	3.81 <sup>a</sup> ± 0.02	3.52 <sup>b</sup> ± 0.03	2.72 <sup>c</sup> ± 0.01	14.27 <sup>**</sup>
syneresis (%)	24.12 <sup>a</sup> ± 0.02	25.12 <sup>b</sup> ± 0.03	25.57 <sup>c</sup> ± 0.07	14.28 <sup>**</sup>

Table 7: Physico-Chemical Properties of Yoghurt with Soy Milk and Dried Mango Pulp on Storage Periods\*.

Properties / Storage periods	0 day	5 days	10 days	F value
Colour and appearance	8.65 <sup>a</sup> ± 0.14	8.22 <sup>b</sup> ± 0.13	7.54 <sup>c</sup> ± 0.25	22.45 <sup>**</sup>
Body and Texture	8.55 <sup>a</sup> ± 0.01	8.32 <sup>b</sup> ± 0.02	6.57 <sup>c</sup> ± 0.06	45.12 <sup>**</sup>
Flavour	9.15 <sup>a</sup> ± 0.15	8.45 <sup>b</sup> ± 0.19	6.25 <sup>c</sup> ± 0.15	22.65 <sup>**</sup>
Sourness	8.95 <sup>a</sup> ± 0.02	8.34 <sup>b</sup> ± 0.01	6.00 <sup>c</sup> ± 0.01	28.16 <sup>**</sup>
Overall acceptability	9.52 <sup>a</sup> ± 0.22	8.64 <sup>b</sup> ± 0.12	6.75 <sup>c</sup> ± 0.16	56.81 <sup>**</sup>

Table 8: Sensory Properties of Yoghurt with Soy Milk and Dried Mango Pulp on Storage Periods\*.

42°C. Three groups of yoghurt samples were prepared with different level of soy milk inclusion viz., 10%, 20% and 30%. Starter culture @ 2% (w/v) (containing *Sterptococcus thermophilus* and *Lactobacillus delbrueckii* subsp. *bulgaricus*) was added. The inoculated mix was filled into 100 g plastic cups.

All groups were incubated at 42-45°C. Incubation was terminated at acidity 1(% acid lactic) and then, yoghurts were stored in a refrigerator (4°C).

The incubation was terminated till pH 4.5. At this point, the yoghurt was stored in a refrigerator (5 ± 1°C) for the overnight.

### Production of yoghurt with soy milk and mango pulp

Milk was heated to 90-95°C for 5 min and then rapidly cooled to 42°C. Three groups of yoghurt were prepared with 30% soy milk @ 2% (w/v) Starter culture (containing *Sterptococcus thermophilus* and *Lactobacillus delbrueckii* subsp. *bulgaricus*) inoculation. The inoculated mix was filled into 2 kg plastic container.

All groups were incubated at 42-45°C. Incubation was terminated at acidity 1(% acid lactic). The three sets of yoghurt were then added with pre pasteurised fruit pulp at 5%, 10% and 15% and blended with electronic blender.

### Production of yoghurt with soy milk and dried mango pulp

**Preparation of dried mango pulp:** Osmo dehydration technique was used to dry the mango pulp Torreggiani. The fruit pulps were cut into small cubes with average size of 10 mm. Then they were dipped for 5 hrs in 70°C Brix sucrose syrup containing 1% ascorbic acid and 0.2% citric acid as antioxidants. Osmodehydrated cubes were dried using normal air. After complete syrup separation, cubes were freezed at -18°C and stored at freezer until use.

### Development of yoghurt with soy milk and dried mango pulp:

Yoghurt mix was prepared as follows. Milk was heated to 90-95°C for 5 min and then rapidly cooled to 42°C. Soy milk @ 30% and dried mango cubes @15% w/v were added in to the mix. Starter culture (*Sterptococcus thermophilus* and *Lactobacillus delbrueckii*subsp. *bulgaricus*) @ 2% (w/v) was inoculated in to the prepared mix. The inoculated mix was filled into 100 ml pre-sterilized plastic cups. All cups were incubated at 42-45°C. Incubation was terminated at acidity 1(% acid lactic) (Table 8).

### Physico-chemical analysis

All the yoghurt samples were analyzed in duplicate for fat, protein and total solids. The micro-Kjeldahl method was used to determine total protein content of yogurt. Fat content was measured by the Gerber method and TS was determined using a drying oven [4].

pH, acidity and syneresis were done during storage period in different time intervals. The pH was measured with a pH meter. Acidity was titrated by 0.1 N NaOH solution and expressed in terms of % lactic acid. Degree of syneresis, expressed as proportion of free whey, was measured by method of Al-Kadamany et al. [5]. A 10 g sample of mixed fruit yoghurt was placed on a filter paper resting on the top of a funnel. After 10 min of drainage in vacuum condition, the quantity of remained fruit yoghurt was weighted and syneresis was calculated as follow:

Free whey (g/100 g)=(weight of initial sample-weight of sample after filtration/weight of initial sample)\*100.

### Sensory evaluation

Colour and appearance, flavor, body and texture, sourness and overall acceptability of all fruit yoghurt samples were evaluated by a semi trained personnels using nine-point hedonic scale system (9-7

good, 6-4 average and 3-1poor). The sensory profiles were conducted on numbered samples after 1, 7, and 14 days of storage.

### Statistical analysis

The results were analyzed using one way and two way ANOVA using software (VETSTAT).

### Results and Discussions

Soy milk incorporation increases the percentage of protein content with level of inclusion of yoghurt and mango pulp. Since the prepared soy milk is having the higher protein content (12%) it delivers the yoghurt with high protein. Burrington [6] noticed that, soy proteins are high in the amino acids glycine and arginine.

Hence total solids also have been increased in the yoghurt prepared with soy milk. The soymilk has desirable characteristics as an ingredient for making soy yoghurt because of its high solid content. Tuitemwong et al. [7] found high total solid content of processed soy yoghurt. Tamime and Robinson [8] reported the total solids content of soy yoghurt ranged from 34.2-44.4%. In this study total solids content is ranged from 15-16%, which is due to the level of soy milk inclusion is only upto 30%.

Likewise soy milk addition alters the pH and acidity of yoghurt. The level of inclusion of soy milk negatively correlates with acidity and pH of yoghurt; whereas addition of mango pulp positively correlates. The reason may be attributed to reduction of raffinose and stachyose in soymilk may vary from lactose which is present in cow milk.

Inclusion mango pulp also alters the pH and acidity of yogurt. Fruit pulp addition increase the acidity due to the nature of pulp's acidity. The observed acidity values in the present study are accorded with the results of Osman and Razig [9] and Mahmood, Abbas and Gilani [10].

Addition of fruit pulp also caused an increase in lactose content of yogurt. The results revealed that with the addition of mango fruit pulp, the lactose content increased most significantly. This may be due to the amount of reducing sugar (carbohydrate) present in mango fruit. The level of addition of fruit pulp also positively correlates with percentage of total solids of yogurt.

Amount of syneresis is volume of water oozed out on the surface of yogurt. Syneresis value of plain yogurt was 20%. The syneresis values were similar to the results of Farooq and Haque [11]. In addition, the syneresis degrees were lower than results of Katsiari et al. [12]. Flinger et al. [13] also reported the absence of syneresis which is deviated from the findings of the present study. It may be due to that sugar bound with water leading to the absence of syneresis. Another reason might be the preparation of yogurt under controlled condition.

When the value enriched yoghurt prepared with dried mangoes, there were no significant differences in fat, SNF, Protein in storage days. But there was highly significant difference ( $P < 0.01$ ) observed in acidity, pH and syneresis. Likewise sensory evaluation also revealed that it cannot be consumed beyond 5 days storage at refrigeration temperature. This results are supported by Vahedi et al. [14] who reported that high syneresis and acidity in yoghurt prepared with dried fruits at the time of inoculation.

### Conclusion

The value enriched yoghurt could be manufactured with 30% soy milk and 15% mango pulp. The protein value of yoghurt has been escalated from the normal value 3.7% to 7.23% by inclusion of 30% soy milk. Soy milk is influencing the flavour and the overall acceptability may decrease. Hence addition of 15% of mango pulp masks the flavour of soy milk and improved the palatability of the yoghurt. Though syneresis was higher in 15% mango pulp, it was in the acceptable range (<25%).

Likewise, while using dried mango pulp the chemical properties like fat, SNF and protein were not deviated from fresh pulp yoghurt. But it could not store beyond 5 days even at refrigeration temperature as increased acidity and syneresis and having very poor sensory quality.

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