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## Physicochemical and sensory characteristics of symbiotic fruit flavoured yoghurt fortified with calcium and vitamin D

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### Abstract

The present study aimed to evaluate the effect of Calcium and vitamin D on its physical and sensory characteristics of symbiotic drinkable fruit flavoured yoghurt. In present claim for foods with specific functional uniqueness and nutritional balance is increasing as well consumer demand. Work was carried out to analyze the effect of calcium and vitamin D inclusions with different levels of fruits yoghurt thus optimizing the composition of fortified synbiotic drinkable yoghurt. The moisture, protein, fat and ash contents were in increasing array as compared to control sample viz., 76.53 to 87.82, 3.21 to 3.97, 3.35 to 3.39 and 0.81 to 0.93 respectively. Sensory evaluation was conducted to assess the optimum inclusion levels of the above ingredients in the fortified synbiotic drinkable fruit flavoured yoghurt. The statistical analysis was done and significance of difference among the fortified synbiotic drinkable yoghurt were analysed.

**Keywords:** Yoghurt, synbiotic, calcium, vitamin D, *Lactobacillus brevis* etc.

### 1. Introduction

The global development is driven by a shift in consumption habits. People with busy lifestyles increasingly prefer to consume smaller meals on the go thus making dairy products in convenient packaging as an appealing option. Consumers also want more products that support a healthy lifestyle. A convenient, mobile breakfast or lunch should still be nutritionally balanced and beneficial. Therefore, every opportunity can be seized to produce fruit flavoured drinking yoghurts (mango and banana) including fructo-oligosaccharides and honey as prebiotic fortified with calcium and vitamin D that meet these needs.

Vitamin-D deficiency is an unrecognized epidemic among all age groups throughout the world and is now recognized as pandemic. It has been estimated that worldwide about 1 billion people have Vitamin D deficiency. Vitamin D is photosynthesized in the skin on exposure to UVB rays. Sun exposure alone ought to suffice for vitamin D sufficiency. However, vitamin D deficiency is widely prevalent despite plentiful sunshine even in tropical countries like India. In India, despite of ample sunlight (required for the synthesis of vitamin D endogenously), Vitamin D Deficiency prevalence has been documented to be in range of 50-90% among all the age groups. Studies from India also report a widespread prevalence of varying degrees of Vitamin D deficiency (Zahid Naeem, 2010) [17]. The Institute of Medicine (2012) recommended that vitamin D requirements are 400 IU/day in infants (0-1 year), 400 IU/day in children and adults (1-70 years), and 800 IU/day in elderly (800 IU/day).

Calcium and vitamin D play important roles in bone homeostasis. Calcium is a major constituent of bones and a second messenger in cell signaling pathways. Obtaining sufficient calcium is important to decrease the risk of osteoporosis, hypertension, colorectal cancer, gastric cancer, nephrolithiasis, neurodegenerative disease, and degenerative joint disease Fujita T (2000) [10], Keum *et al.*, (2014) [15], Beto *et al.*, (2015) [5]. The recommended daily allowance of calcium varies for different age groups and ranges from 700 to 1300 mg/day.

Akalin *et al.*, (2007) [1] described that the processing of milk into yoghurt, the addition of FOS alone and storage for 28 days did not affect CLA (conjugated linoleic acid) isomer formation in yoghurts. Guarner *et al.*, (2008) [12] reported that prebiotic compounds include fructo-oligosaccharides (FOSs) such as inulin, galacto-oligosaccharides (GOSs), lactitol and

lactulose, among others. Fructo-oligosaccharides (FOSs) are among the most important natural prebiotics. It fructose components may reduce blood sugar and cholesterol levels and improve calcium absorption for healthy bone. FOSs has been added to different foods since 1990, resulting in improved mouth feel, creaminess, reduced fat, improved texture and increased viscosity especially in yogurt.

Gardiner (2002) [11] reported some Ca salts that had been widely used in food industry were calcium carbonate, calcium phosphate, calcium lactate, calcium gluconate, and calcium lactate gluconate. Calcium lactate gluconate (CLG) contains 12.74% calcium, has neutral taste, great bioavailability, and the best solubility characteristic compared to other calcium salts. Inadequate dietary calcium has long been associated with osteoporosis. Biancuzzo *et al.*, (2010) [6] studied that Vitamin D2 and D3 found to be stable in fortified orange juice. Vitamin D is also essential for bone health. The Institute of Medicine (2012) recommended that vitamin D requirements are 400 IU/day in infants (0-1 year), 400 IU/day in children and adults (1-70 years), and 800 IU/day in elderly (800 IU/day).

## 2. Materials and Methods

Calcium (calcium citrate and calcium gluconate) was obtained from M/s. Hi Media Laboratories Pvt. Ltd., Mumbai, India. Vitamin D (Cholecalciferol) was purchased from Hi Media, Mumbai, India. Drinkable yoghurt mix was prepared to contain a final composition of 3.5% fat, 8.5% SNF and 5% sugar in the drinkable yoghurt, as per BIS (IS: 12898, 1989) specification (Sukumar De, 2015). In each treatment, mix was preheated to 60 °C and ingredients were homogenized as described in Arbuckle (1986) and then heated to 85 °C for 30mins as suggested by Lee and Lucy (2010) [16]. Mixes were cooled to 42 °C and inoculated with yoghurt culture and *Lactobacillus brevis* at the rate of 1 per cent each and incubated for 3 to 5 hours in the incubator or till the titrable acidity reaches 0.75 per cent and cooled to 20 to 25 °C. The minerals and vitamins like calcium citrate, calcium gluconate and vitamin D were added at the rate of 1per cent, 1 per cent and 80 IU respectively with continuous stirring before cooling to a final temperature of 5 °C. The different treatments carried out are shown in the following table. After cooling to 5 °C the fortified symbiotic drinkable yoghurt was packed in sterile food grade in polypropylene (91.4×61 cm) bags and sealed with hand sealing machine and stored at 5 °C for 7 days in refrigerator.

**Table 1:** List of various proportions of synbiotic yoghurt preparations

TC	Control drinkable yoghurt (yoghurt culture + <i>Lactobacillus brevis</i> )
T1	Drinkable yoghurt + Calcium citrate (1%)
T2	Drinkable yoghurt + Calcium citrate (2%)
T3	Drinkable yoghurt + Calcium citrate (3%)
T4	Drinkable yoghurt + Calcium gluconate (1%)
T5	Drinkable yoghurt + Calcium gluconate (2%)
T6	Drinkable yoghurt + Calcium gluconate (3%)
T7	Drinkable yoghurt + Vitamin D (80 IU)
T8	Drinkable yoghurt + Vitamin D (90 IU)
T9	Drinkable yoghurt + vitamin D (100 IU)

### 2.1 Estimation of calcium (Pirkul *et al.* (1997) [18])

Calcium was measured by atomic absorption spectroscopy in a Perkin Elmer Analyst 200 spectrophotometer (Shelton, USA) using a hollow cathode lamp for calcium (422.7 nm) and an acetylene-air flame. Calcium standard solution (1000

mg L<sup>-1</sup>) (Sigma) was diluted with 2% (v/v) HNO<sub>3</sub> (Sigma) to obtain working standards varying from 0.5 to 5 mg L<sup>-1</sup>. Instrumental parameters and sample preparation were made according to Boen *et al.*, (2008) with some modifications. The samples (~1.0 g) were mixed with 4 ml of 69% HNO<sub>3</sub> and heated in a digestion block at 110 °C for two hours. After cooling, 2ml of 69% HNO<sub>3</sub> and 2 ml of 30% H<sub>2</sub>O<sub>2</sub> were added to tubes containing the dehydrated fortified drinkable yoghurt samples, while 1ml of 30% H<sub>2</sub>O<sub>2</sub> was added to tubes containing yoghurt.

These samples were heated at 130 °C for two hours. These conditions led to a complete mineralization of the samples. Mineralized samples were quantitatively transferred to volumetric flasks of 10 ml (yoghurt) and 25 ml (for dehydrated fortified drinkable yoghurt) and the volumes completed with ultra-pure deionized water (Ariumcomfort I ultra-pure water system, Sartorius, Gottingen, Germany). When necessary, samples were diluted with ultra-pure water to obtain absorbance readings between 0.1 and 0.2.

### 2.2 Estimation of vitamin D (Kazmi, 2007)

Cholecalciferol was evaluated by a method described by kazmi *et al.*, (2007). Saponification was performed by mixing 1 g diluted drinkable yoghurt sample (1:3) with 0.5 ml 60% KOH before extraction by high-performance liquid chromatography (Shimadzu LC-10A, Shimadzu, Kyoto, Japan) using a C18 column (Water Spheris orb ODS2 10 µm 4.6 × 250 mm, Ireland). Methanol:acetonitrile:water (45:45:10) was used as a mobile phase. The sample injection volume was 50 µl. A flow rate of 1.0 ml/min was maintained throughout the test period (5 min, T = 26 °C). The elution of vitamin D3 was detected at 254 and 228 nm on an ultraviolet detector at 2.7 min.

### 2.3 Sensory evaluation

The sensory assessments were conducted in the Department of Food Science and Technology laboratory with sensory panelist at College of Food and Dairy Technology, Koduvalli, Chennai. A sensory score card to evaluate colour and appearance, flavor, body and texture, sweetness, sourness and overall acceptability using 9 point hedonic scale was prepared and given to the sensory panelist.

## 3. Result and Discussion

### 3.1 Proximate characteristics of different types of synbiotic drinkable yoghurt

The proximate compositions of various types of fortified synbiotic drinkable yoghurt were shown in Table 1. The mean moisture, protein, fat and ash contents were in increasing array as compared to control sample viz., 76.53±0.003 to 87.82±0.004, 3.21±0.006 to 3.97±0.009, 3.35±0.002 to 3.39±0.005 and 0.81±0.001 to 0.93±0.006 respectively. The mean nitrogen free extract content drastically decreased compared to control from 16.10±0.017 to 4.17±0.008. This was in agreement with the findings of Pushkaraj Sawant *et al.*, (2015) [19] who reported that the fresh yoghurt contained 3.21 per cent protein and 3.35 per cent fat. As the mango pulp contains lower fat than milk, the decrease is very apparent and understandable. These results were in accordance with findings of Sengupta *et al.*, (2014).

The addition of fruit has caused the increase in protein content of yoghurt as proved by Anna Mahmood *et al.* (2008) [2]. As per the Codex standards (2003) for fermented milk, there should be a minimum of 2.7 per cent of milk protein and less than 10 per cent of milk fat. The fortified synbiotic yoghurt in the present study had met the Codex requirement.

### 3.2 pH value of different types of synbiotic drinkable yoghurt during storage

The pH value of various types of fortified synbiotic drinkable yoghurt was analyzed on during storage is shown in Table 2. The pH values of samples analyzed during 7 days of storage which is ranged viz., 4.65 to 4.52, 4.48 to 4.44, 4.49 to 4.43, 4.52 to 4.45, 4.38 to 4.36 of control, FFM, FHM, FFB and FHB respectively. The pH values decreased as the days of storage increased. This was in agreement to the requirements of IDF (1981) for fermented milk products. This range of pH observed in the present study was also in agreement with the findings of Haully *et al.*, (2005) who reported a final pH value of 4.63 in soy yoghurt manufactured with inulin. They also reported a decline in pH with increase in storage time. The results of the present study also showed a significant decrease in pH during storage and this was in agreement with the findings of Akalin *et al.*, (2007) [1] who reported slightly increased titratable acidity and decreased pH values due to the inclusion of honey.

The range of pH values for FFB and FHB were observed as  $4.52 \pm 0.409$  to  $4.45 \pm 0.005$  and  $4.38 \pm 0.006$  to  $4.36 \pm 0.005$  for 0 to 7 days, respectively. This was in accordance with the values of 3.73 to 4.19 obtained by Stan and Popa (2013) for banana and apple smoothies, respectively.

The pH in the present study during storage at refrigeration temperature from 0 to 7 days varied from  $4.48 \pm 0.405$  to  $4.44 \pm 0.405$  for FFM,  $4.49 \pm 0.405$  to  $4.43 \pm 0.405$  for FHM,  $4.52 \pm 0.005$  to  $4.45 \pm 0.405$  for FFB and  $4.38 \pm 0.005$  to  $4.36 \pm 0.405$  for FHB. This was in accordance to the findings of Pirkul *et al.*, (1997) [18] who also reported the pH range of 4.41 to 4.28 in varying inclusion of calcium salts to yoghurt.

### 3.3 Titrable acidity value of different types of synbiotic drinkable yoghurt during storage

The titrable acidity value of various types of fortified synbiotic drinkable yoghurt was analyzed on during storage is shown in Table 3. The titrable acidity values of samples analyzed during 7 days of storage which is ranged viz., 0.72 to 0.83, 0.92 to 1.014, 0.92 to 1.02, 0.83 to 0.87, 0.87 to 1.01, of control, FFM, FHM, FFB and FHB respectively. In general the mean titrable acidity was lower at the earlier days of storage and increased slowly. It is evident that titrable acidity was highest in different types of drinkable yoghurt over the increasing period of storage (from 0 to 7 days) at refrigeration temperature. Blending of yoghurt drink with increased level of pulp increased titratable acidity, similar to the total solids.

The reason behind the increase of acidity was the acidic nature of mango pulp. Similar results have also been reported by Chougrani *et al.*, (2009).

The mean acidity values of the samples during storage at refrigeration temperature varied from  $0.72 \pm 0.043$  to  $0.83 \pm 0.021$  per cent,  $0.92 \pm 0.043$  to  $1.01 \pm 0.043$  per cent,  $0.92 \pm 0.043$  to  $1.02 \pm 0.005$  per cent,  $0.83 \pm 0.005$  to  $1.00 \pm 0.043$  and  $0.87 \pm 0.43$  to  $1.01 \pm 0.005$  for control, FFM, FHM, FFB and FHB, respectively. This was in agreement with Pirkul *et al.*, (1997) [18], also reported a similar increasing trend in acidity of control and calcium lactate fortified plain yoghurt during storage. The range of acidity values throughout storage in the present study for control and different types of fortified synbiotic drinkable yoghurt complied with the consumer acceptance and preference. Acidity values of control, FFM, FHM, FFB and FHB samples obtained in the present study were more than 0.31 to 0.29 per cent for a mixture of sapota, pomegranate and grape drinkable yoghurt as reported by Balaswamy *et al.*, (2013). However, the values in the given table were in accordance to the range of 0.528 and 0.984 per cent/100g for banana and apple based drinkable yoghurt as observed by Stan and Popa (2013).

### 3.4 Viscosity (cP) value of different types of synbiotic drinkable yoghurt during storage

The Viscosity value of various types of fortified synbiotic drinkable yoghurt was analyzed on during storage is shown in Table 4. The Viscosity values of samples analyzed during 7 days of storage which is ranged viz., 125.14 to 122.40, 195.13 to 192.42, 232.08 to 230.09, 299.38 to 296.13 and 388.60 to 337.10, of control, FFM, FHM, FFB and FHB respectively. In general the mean viscosity values of FHB sample were higher than the mean viscosity values of the other treatment samples. The viscosity values decrease as the days of storage increased. It is evident that viscosity was highest during zero<sup>th</sup> day and decreased during storage at refrigeration temperature for all the treatments. According to European patent standards, the viscosity of drinkable yoghurt at 10°C should be in the range of 50 to 400 centipoise (cP) and the viscosity estimates of developed yoghurts fall within this range.

The decreased viscosity of fortified synbiotic drinkable yoghurt in the present study was in accordance with the findings of Serafettin and Ihsan (2003) where in addition of mulberry pekmez (concentrated juice) led to an increase in the fermentation time and a decrease in the viscosity of yoghurt.

**Table 1:** Proximate compositions of different types of synbiotic drinkable yoghurt<sup>®</sup> (Mean± SE)

Treatments	Proximate composition				
	Moisture	Protein	Fat	Ash	Nitrogen Free Extract
Control	76.53±0.003	3.21±0.006	3.35±0.002	0.81±0.001	16.10±0.017
FFM	87.61±0.004	3.91±0.002	3.37±0.002	0.89±0.07	4.22±0.008
FHM	87.82±0.004	3.71±0.009	3.39±0.005	0.91±0.006	4.17±0.008
FFB	87.41 ±0.005	3.97±0.009	3.35±0.008	0.93±0.006	4.34±0.007
FHB	87.57±0.009	3.82±0.015	3.36±0.009	0.95±0.006	4.30±0.009

<sup>®</sup>Average of eight trials

**Table 2:** pH value of different types of synbiotic drinkable yoghurt on storage<sup>®</sup> (Mean± SE)

Treatments	Storage period in days				Overall average
	0 <sup>th</sup> day	3 <sup>rd</sup> day	5 <sup>th</sup> day	7 <sup>th</sup> day	
Control	4.65±0.405	4.61±0.405	4.55±0.405	4.52±0.405	4.59±0.194 <sup>A</sup>
FFM	4.48±0.405	4.78±0.405	4.45±0.405	4.44±0.405	4.46±0.194 <sup>A</sup>
FHM	4.49±0.405	4.47±0.405	4.46±0.405	4.43±0.405	4.46±0.194 <sup>A</sup>
FFB	4.52±0.405	4.49±0.405	4.47±0.405	4.45±0.405	4.48±0.184 <sup>A</sup>
FHB	4.38±0.405	4.37±0.405	4.37±0.405	4.36±0.405	4.37±0.194 <sup>A</sup>
Overall average	4.51±0.174 <sup>a</sup>	4.49±0.174 <sup>a</sup>	4.46±0.174 <sup>a</sup>	4.44±0.174 <sup>a</sup>	

<sup>®</sup>Average of eight trials

**Table 3:** Titrable acidity value of different types of synbiotic drinkable yoghurt on storage<sup>@</sup> (Mean± SE)

Treatments	Storage period in days				Overall Average
	0 <sup>th</sup> day	3 <sup>rd</sup> day	5 <sup>th</sup> day	7 <sup>th</sup> day	
Control	0.72±0.043	0.74±0.043	0.78±0.043	0.83±0.043	0.77±0.021 <sup>A</sup>
FFM	0.92±0.043	0.95±0.043	0.97±0.043	1.01±0.043	0.96±0.021 <sup>C</sup>
FHM	0.92±0.043	0.95±0.043	0.98±0.043	1.02±0.043	0.96±0.021 <sup>C</sup>
FFB	0.83±0.043	0.84±0.043	0.86±0.043	1.00±0.043	0.96±0.021 <sup>C</sup>
FHB	0.87±0.043	0.87±0.043	0.89±0.043	1.01±0.043	0.91±0.021 <sup>BC</sup>
Overall Average	0.85±0.19 <sup>a</sup>	0.87±0.19 <sup>a</sup>	0.90±0.19 <sup>A<sup>b</sup></sup>	0.95±0.19 <sup>b</sup>	

<sup>@</sup>Average of eight trials**Table 4:** Viscosity (cP) value of different types of synbiotic drinkable yoghurt on storage<sup>@</sup> (Mean± SE)

Treatments	Storage period in days				Overall Average
	0 <sup>th</sup> day	3 <sup>rd</sup> day	5 <sup>th</sup> day	7 <sup>th</sup> day	
Control	125.14±17.07	124.07±17.07	123.91±17.07	122.40±17.07	123.88 ±8.19 <sup>A</sup>
FFM	195.13±17.07	194.76±17.07	192.52±17.07	192.42±17.07	193.71 ±8.19 <sup>B</sup>
FHM	232.08±17.07	232.60±17.07	231.10±17.07	230.09±17.07	231.84 ±8.19 <sup>C</sup>
FFB	299.38±17.07	298.52±17.07	297.65±17.07	296.13±17.07	297.95 ±8.19 <sup>D</sup>
FHB	388.60±17.07	340.70±17.07	339.20±17.07	337.10±17.07	351.40 ±8.19 <sup>E</sup>
Overall Average	237.34 ±7.33 <sup>a</sup>	237.54 ±7.33 <sup>a</sup>	223.28 ±7.33 <sup>a</sup>	236.10 ±7.33 <sup>a</sup>	

<sup>@</sup>Average of eight trials

### 3.5 Sensory values of various levels calcium citrate (CaC) fortified drinkable yoghurt

The mean sensory values of Calcium citrate added synbiotic drinkable yoghurt sample viz., one, two and three per cent were shown in Table 5. The overall average score for the control one, two and three per cent inclusion of calcium citrate were 6.91, 7.36, 6.66 and 6.49 respectively. From the table it may be noticed that the inclusion level of one per cent had the maximum overall score and was statistically similar to that of control samples. Hence the level of one per cent of calcium citrate was considered as optimum.

Selgas *et al.*, (2009) [20] revealed that the calcium salts at any form can be included at the lowest level which gives better sensory attributes and in the present study also one per cent inclusion level of calcium citrate in the preparation of fortified synbiotic drinkable yoghurt was found to be optimum and scored higher on sensory attribute than 2 and 3 per cent inclusions (Table 5).

### 3.6 Sensory values of various levels calcium gluconate (CaG) fortified drinkable yoghurt

The mean sensory values for fortified synbiotic drinkable yoghurt prepared by inclusion of calcium gluconate viz., one, two and three per cent were shown in Table 6. The overall average scores for the control, one, two and three per cent inclusion of calcium gluconate were 6.91, 7.18, 6.42 and 6.12 respectively. From the table it may be noticed that the inclusion level of one per cent had the maximum overall score and was statistically similar to that of control sample. Hence the level of one per cent of calcium gluconate was considered as optimum. In the present study one per cent inclusion level of calcium gluconate in the preparation of fortified synbiotic drinkable yoghurt was found to be optimum and scored maximum on sensory attribute. Similar to the present findings, Yonis *et al.*, (2013) [25] revealed that 1 to 2 per cent fortification of calcium gluconate in banana stirred yoghurt scored maximum without any negative influence on the sensory properties.

As stated by Black *et al.*, (1996) [7], 82% of patients with osteoporosis were taking less than the recommended daily

intake (1000mg) of calcium. This highlights the need for calcium supplementation in all patient populations. In fact, patients with osteoporosis are more likely to have a history of inadequate dietary calcium intake (NIH 1994).

### 3.7 Sensory values of various levels vitamin D fortified drinkable yoghurt

The mean sensory values of vitamin D added synbiotic drinkable yoghurt sample viz., one, two and three per cent were shown in Table 7. The overall average values scored by three levels of inclusion namely 80IU, 90IU and 100IU were 7.01, 6.86 and 6.72, respectively. The control sample had overall average score of 6.91 and all sensory characters were not statistically different from the sample prepared with 80IU vitamin D (Table 7). The results of the study showed that the vitamin D can be added with the synbiotic drinkable yoghurt mix at rate of 80IU.

It appears that vitamin D supplementation with calcium may prove more beneficial in reducing falls and increasing bone density in elderly women who have suffered a hip fracture (Harwood *et al.*, 2004) [13]. This vitamin is generally added at levels of 40-400 IU per serving of the fortified food and it has been estimated that people cannot earn <2µg (80 IU)/day of vitamin D dietary intake (Calvo *et al.*, 2004) [8]. In the present study as seen in Table 7, 80 IU inclusion level of vitamin D into yoghurt for the preparation of fortified synbiotic drinkable yoghurt was found to be optimum.

### 3.8 Calcium content of different types of synbiotic drinkable yoghurt

The mean sensory values of Calcium added synbiotic drinkable yoghurt sample viz., one, two and three per cent were shown in Table 8. The value for control was 0.133, for FFM the value was 1.212 for FHM the values was 1.227 for FFB the value was 1.016 for FHB the value was 1.015 respectively. The results of the present study were in agreement to the results of Singh and Muthukumarappan (2008) [22] who reported the calcium level in yoghurt as 131.66mg/100g.

**Table 5:** Sensory values of various levels calcium citrate (CaC) fortified drinkable yoghurt (Mean± SE)<sup>®</sup>

Inclusion level of CaC in yoghurt	Sensory attributes (9-point hedonic scale)					
	Colour and Appearance	Flavor	Body and Texture	Sweetness	Sourness	Overall acceptability
Control	6.88±0.237 <sup>a</sup>	7.18±0.102 <sup>a</sup>	6.96±0.137 <sup>a</sup>	7.03±0.090 <sup>ab</sup>	7.18±0.236 <sup>a</sup>	6.91±0.133 <sup>a</sup>
1%	7.34±0.268 <sup>a</sup>	7.33±0.408 <sup>a</sup>	6.96±0.137 <sup>a</sup>	7.65±0.243 <sup>b</sup>	7.18±0.236 <sup>a</sup>	7.36±0.270 <sup>a</sup>
2%	6.77±0.407 <sup>a</sup>	6.34±0.443 <sup>a</sup>	7.52±0.310 <sup>a</sup>	6.30±0.486 <sup>a</sup>	7.71±0.271 <sup>a</sup>	6.66±0.427 <sup>a</sup>
3%	6.48±0.345 <sup>a</sup>	6.61±0.399 <sup>a</sup>	6.85±.446 <sup>a</sup>	6.56±0.353 <sup>ab</sup>	7.01±0.406 <sup>a</sup>	6.49±0.343 <sup>a</sup>

<sup>®</sup> Average of eight trials**Table 6:** Sensory values of various levels calcium gluconate (CaG) fortified drinkable yoghurt (Mean± SE)<sup>®</sup>

Inclusion level of CaG in yoghurt (%)	Sensory attributes (9-point hedonic scale)					
	Colour and Appearance	Flavor	Body and Texture	Sweetness	Sourness	Overall acceptability
Control	6.88±0.237 <sup>a</sup>	7.18±0.102 <sup>a</sup>	6.96±0.137 <sup>a</sup>	7.03±0.090 <sup>ab</sup>	7.18±0.236 <sup>a</sup>	6.91±0.133 <sup>a</sup>
1%	7.29±0.348 <sup>a</sup>	7.33±0.286 <sup>a</sup>	7.14±0.247 <sup>a</sup>	6.99±0.363 <sup>a</sup>	6.82±0.54 <sup>a</sup>	7.18±0.306 <sup>a</sup>
2%	6.67±.375 <sup>a</sup>	6.97±0.545 <sup>a</sup>	7.17±0.432 <sup>a</sup>	6.54±0.445 <sup>a</sup>	6.21±0.566 <sup>a</sup>	6.42±0.449 <sup>a</sup>
3%	6.56±0.403 <sup>a</sup>	6.41±0.465 <sup>a</sup>	6.08±0.340 <sup>a</sup>	6.11±0.306 <sup>a</sup>	6.17±0.324 <sup>a</sup>	6.12±0.342 <sup>a</sup>

<sup>®</sup> Average of eight trials**Table 7:** Sensory values of various levels vitamin D fortified drinkable yoghurt (Mean± SE)<sup>®</sup>

Inclusion level of Vitamin D in yoghurt (%)	Sensory attributes (9-point hedonic scale)					
	Colour and Appearance	Flavor	Body and Texture	Sweetness	Sourness	Overall acceptability
Control	6.88±0.237 <sup>a</sup>	7.18±0.102 <sup>a</sup>	6.96±0.137 <sup>a</sup>	7.03±0.090 <sup>a</sup>	7.18±0.236 <sup>a</sup>	6.91±0.133 <sup>a</sup>
80IU	6.82±0.245 <sup>a</sup>	7.33±0.286 <sup>a</sup>	6.96±0.137 <sup>a</sup>	7.15±0.358 <sup>a</sup>	6.98±0.421 <sup>a</sup>	7.01±0.327 <sup>a</sup>
90IU	6.72±0.423 <sup>a</sup>	7.01±0.429 <sup>a</sup>	7.01±0.287 <sup>a</sup>	6.93±0.503 <sup>a</sup>	6.94±0.448 <sup>a</sup>	6.86±0.340 <sup>a</sup>
100IU	6.71±0.335 <sup>a</sup>	6.89±0.445 <sup>a</sup>	6.90±0.427 <sup>a</sup>	6.81±0.379 <sup>a</sup>	6.69±0.311 <sup>a</sup>	6.72±0.313 <sup>a</sup>

<sup>®</sup> Average of eight trials**Table 8:** Calcium content of different types of fortified synbiotic drinkable yoghurt

Treatments	Percentage of calcium
Control	0.133±0.005
FFM	1.212±0.214
FHM	1.227±0.005
FFB	1.016±0.005
FHB	1.015±0.014

<sup>®</sup> Average of eight trials

#### 4. Summary

A study was conducted for the development of fortified synbiotic drinkable yoghurt with calcium and vitamin enrichment. It can be concluded that fortified synbiotic drinkable yoghurt prepared by incorporating fruit pulp with 10 percentages is the highly acceptable product. All the other combinations remained acceptable till the 7<sup>th</sup> day of storage and hence commercialization of all these products will help in utilizing various perishable seasonal fruits into nutrient rich value added products which in turn would balance the economic aspects. Hereby the drinkable yoghurt might act as a good source of calcium, Vitamin D and other nutrients. The incorporation of fruits also enhances the flavour of yoghurt establishing the need to optimize the level of inclusion of these fruits in yoghurt. This study was carried out to analyze the effect of inclusion of different levels of fruits and prebiotic into yoghurt thus optimizing the composition of fortified synbiotic drinkable yoghurt.

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