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STANDARDISATION AND QUALITY EVALUATION OF FRUIT PULP BASED YOGHURTS

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ABSTRACT

Nutritious and palatable yoghurts with diversified flavours were prepared by adding sapota and guava fruit pulps. Incorporation of 10-20% fruit pulp has imparted acceptable organoleptic qualities to yoghurts, with the moisture, pH and total acidity levels unaltered. During fortnight storage, the water holding capacity of sapota pulp-based yoghurt has only slightly changed from 50.46% to 53.00% whereas, it was 50.34% to 52.80% in guava pulp-based yoghurt. Syneresis initiated on the tenth day of storage was at 0.5% and 1.0% level in the fruit pulp-based yoghurts and plain yoghurt, respectively, which increased to 0.6% and 1.02% on fifteenth day. Energy and fat contents were higher in plain yoghurt. Fruit yoghurts were found to have higher amounts of â carotene, vitamin C, iron and potassium compared to the plain yoghurt. Thus, the enrichment with sapota and guava pulps made the yoghurts healthier and opened the possibility for product diversification.

INTRODUCTION

Yoghurt is an acidified, custard like semi-solid dairy product developed by fermenting pasteurised milk with starter culture containing a synbiotic blend of *Streptococcus thermophilus* and *Lactobacillus delbruckii* sub spp. *Bulgaricus* (Vasiljevic and Shah, 2008). Yoghurt is well known for its nutritional value, therapeutic effects and functional properties and is an excellent source of protein, calcium, potassium, vitamin B_2, B_6, and B_{12} (Wang *et al*., 2013). Yoghurt is easily digested, has high nutritional value, and is a rich source of carbohydrates, protein, fat, vitamins, calcium and phosphorus. Its effectiveness against curing diarrhoea, dysentery, constipation, high blood cholesterol and carcinogenesis are known (Roy *et al*., 2015).

Yoghurt is a safer product with unique flavour and consumer preference. Hence, consideration is given by nutritionists to incorporate inexpensive source of nutrients to make it an almost complete food. Fruits and vegetables are rich sources of vitamins, minerals, fibres and antioxidants, therefore, can be used in making value added products. Fruit yoghurts is widely popular due to its partially masked acetaldehyde flavour compared to plain yoghurt. A fruit concentration of 5% to 15% is

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recommended for making fruit yoghurts (Farahat and Bataway, 2013).

MATERIALS AND METHODS

Collection of raw materials:Standardised milk with fat and SNF content of level of 3.5 and 8.5%, respectively were found to be best for the preparation of yoghurt. The cultures *Lactobacillus bulgaricus*and *Streptococcus thermophilus*required for the study were purchased from College of Dairy Science and Technology, Kerala Veterinary and Animal Sciences University (KVASU), Thrissur, India. The study was conducted in the Department of Community Science, College of Agriculture between 2018 and 2020.

Optimization of fruit pulps: The fruit pulp was filled in conical flasks and then pasteurized at 70^{0} C for 30 seconds. The milk was pre-heated to 55^{0} C and 1.0% skimmed milk powder and 6.0% sugar were added. It was then pasteurized, cooled to 55^{0}C and fruit pulp added. At 42^{0}C, the mixture was inoculated with 2% yoghurt culture, gently homogenized and incubated for 4 h in an incubator to maintain the temperature. Subsequently, the yoghurts werepacked in food grade containers and refrigerated at $4^{Ë\%}$C.

The treatments used for standardization of fruit pulp-based yoghurts includedT_0/Control: M 100% (plain yoghurt), T_1: M 90% + SP 10%, T_2: M 85% + SP 15%, T_3: M 80% + SP 20%, T_4: M 75% + SP 25%, and T_5: M 70% + SP 30%, in which, M - milk and SP - sapota pulp. Experiments were repeated by substituting sapota pulp with guava pulp.

Organoleptic evaluation: Organoleptic evaluation of fruit pulp-based yoghurts including control was conducted by using score cards by a panel of 20 judges. Based on the organoleptic scores, the best treatments most suitable for yoghurt with sapota pulp and guava pulp were selected for further studies.

Physicochemical properties: Moisture, acidity,pH content,water-holding capacity of fruit pulp-based yoghurts were estimated by standard procedures. Spontaneous syneresis and curd tension of undisturbed set curd was determined using siphon method. Total Soluble Solids, total sugar, reducing sugar, energy, carbohydrate, lactose, protein, fat, â carotene, vitamin C, calcium and iron were also determined using standard procedures.

RESULTS AND DISCUSSION

Yoghurt prepared using cow milk (control) got the highest score for all sensory attributes. The total score attained for control was 52.57 and 52.23 for sapota and guava pulp, respectively.Among different treatments tried for the preparation of sapota and guava pulp-based yoghurts the highest score was attained for the fruit yoghurts prepared using 90% milk and 10% fruit pulp. Yoghurt flavoured with orange juice was preferred over plain yoghurt (Ozdemir *et al.,* 2005). In the study,maximum organoleptic scores were attained for plain yoghurts when compared to fruit yoghurts (Table 1).

Changes in the physico-chemical properties of yoghurts with the days of storage are shown in Table 2. The initial moisture content of sapota yoghurtand guava yoghurtwas found to be 79.58% and 79.40% respectively. A decreasing trend in moisture content with storage was observed for all treatments. Sarabhai (2012) also reported a decrease in moisture content during storage of yoghurts. Warakaulle *et al.* (2014)

observed 79.37% moisture content in plain cow milk yoghurt and 79.35% moisture content in water melon enriched yoghurt. Amal *et al*. (2016) observed 87.64% moisture content in papaya yoghurt and 84.79% were found in cactus pear added yoghurts.

According to Tamime and Robinson (1999), a typical full fat yoghurt and fruit yoghurt should contain 81.9% and 77.00% moisture, respectively. This is in line with the result of this study.

Compared to fruit yoghurts pH value of control was found to be slightly higher than both sapota and guava pulp-based yoghurts throughout the storage period. The pH of 4.6 was reported to be optimum level for production of good quality yoghurts. This is in line with the present study in which the pH was in the range of 4.52 to 4.47.

Celik *et al*. (2006) also observed continued decrease in pH of the plain yoghurt and fruit yoghurts during storage. The decrease in pH can be attributed to the fermentation of sugar and the presence of lactic acid producing organisms. When, the sugar sources exhaust, microorganisms begin to consume proteins and the metabolites formed by microbial activity could increase the pH of the product (Tapsoba*et al*., 2014). The pH is inversely proportional to the acidity of products. The pH of yoghurts with storage, leads to an increase in acidity. Lactic acid produced during fermentation can increase the acidity or decrease the pH. In this study, also the acid content increased with storage. Results were also recorded by Amal *et al.* (2016).

The initial acidity of plain yoghurt was 0.68 which increased with every five days of interval, it reached up to 0.76 on 15 days of storage. Control yoghurt exhibited the highest value for acidity. Amal *et al*. (2016) reported that acidity was increased during storage period in papaya and cactus pear pulp added yoghurt. Sarabhai (2012) reported that acidity was increased throughout the storage period.

The water holding capacity in yoghurt determines the microstructure of the protein network. If the water binding is not sufficient, whey will be expelled on the surface of the product during storage (Mortensen *et al*., 2005). Initial water holding capacity of plain yoghurt was 47.30 and for T_1 and T_2 it was 50.46 to 50.34. An increased trend in water holding capacity was observed in all yoghurt samples. Lower WHC or whey separation refers to a weakness of gel network (Singh and Muthukun, 2008). Amal *et al*. (2016) also observed an increase in WHC throughout the storage period. The WHC of cactus pear yoghurt was found to be higher than that of papaya yoghurt.

The maximum curd tension was noticed in plain yoghurt which varied from 54.00 (initial) to 60.00 (15 days). Curd tension of sapota yoghurt and guava yoghurt,varied from 38.60 to 45.60 and 38.66 to 54.66 from the initial to 15th day of storage. El-Boraeyet *et al*. (2015) reported the curd tension of cow milk as35.41 in freshly prepared yoghurts and 36.15 after 7 days of storage. A high curd tension of 70.87 was observed in the yoghurt prepared with buffalo milk. Chaudhari *et al.* (2007), reported the average curd tension in *dahi*prepared from buffalo milk was higher (43.44) than *dahi* prepared from cow milk (34.94). Increase in curd tension, helps to overcome wheying off with improvement in viscosity and consistency.

Syneresis is collection of whey from yoghurt and is the key quality parameter for yoghurt. Higher level of syneresis shows that yoghurt is of low quality. No syneresis was observed till 5th day of storage for both plain and fruit pulp-based yoghurts. Syneresis of 1.0% and 1.02% were observed on the 10th day and 15th day of storage in plain yoghurts. In sapota and guava yoghurts, a syneresis level of 0.5 and 0.6% were detected on the 10th and 15th day of storage. Syneresis level of 1.10% was noticed by Sarabhai (2012) in plain yoghurt. Joon *et al*. (2017) found that yoghurts from goat milk revealed the higher syneresis (9.92±0.02), whereas, yoghurt from cow milk was found to be the lowest (9.65±0.03). The major visible defect occur during yoghurt storage and can affect the final product acceptance. Syneresis occurs due to the loss of yoghurt gel capacity to entrap serum phase through the weakening of the gel network resulting on whey separation.

Changes in the nutritional content of yoghurts with the days of storage are presented in Table 3. The control yoghurt had a TSS content of 14° Bx (initial) to 13.24° Bx (15th day). The TSS content was found to be higher than plain yoghurt and the gradual decrease was noticed throughout the storage period. The TSS content of sapota and guava yoghurts reduced to 15.10 and 13.99, respectively at the end of storage. Compared to control, fruit yoghurts had higher reducing and total sugar content. Kale *et al*.(2008) prepared pomegranate yoghurt with reducing sugar content of 5.67%.

Lactose content of yoghurt is comparatively low than that of milk. Fruit yoghurts showed significant decrease in lactose content. In control (plain yoghurt) the lactose content ranged between 2.94% to 2.82%. Hassan and Amjad (2010) reported that average lactose value of *L. bulgaricus* yoghurt was 5.21% while that of *L. acidophilus* yoghurt was 4.61%.

Protein content decreased significantly in all samples during storage. As per FSSAI (2011) regulations milk yoghurt should contain 3.2% milk proteins and for fruit yoghurts it is 2.6%. The fat content in all freshly prepared yoghurts was above 1.02 g, and decreasing trend of fat was observed in every five days interval. A decrease in fat content during storage which is due to lipolytic activity of enzymes lipase and lipoxidase produced by microorganisms.

Vitamin C content of fruit yoghurts were found to be higher than that of plain yoghurt. Addition of fruit pulp increased the vitamin C content. The addition of water melon juice into yoghurt resulted in an increase in vitamin C content (Warakaulle *et al*., 2014). Calcium content of FPBY were low when compared to control yoghurt. Fruit yoghurts had a slightly higher value for iron and potassium content compared to control yoghurt.

CONCLUSION

Fruits such as sapota and guava can be used for fruit yoghurt preparations. Incorporation of 10% fruit pulp attained the maximum organoleptic scores for both sapota pulp-based yoghurt and guava pulp-based yoghurt. It was also found that incorporation of 20% fruit pulps will give acceptable products. Moisture, pH and acidity of fruit pulp-based yoghurts was on par with plain yoghurt. An increase in water holding capacity and curd tension with storage were observed in all yoghurts. Syneresis was not observed till 5th day of storage, and on 15th day,

Table 1. Mean score for organoleptic qualities of sapota and guava yoghurt

Treatments	Milk: Fruit pulp	Appe-arance	Color	Flavour	Taste	Text-ure	Overall accep-tability	Total score
T_0	100:0	8.84	8.75	8.64	8.86	8.80	8.68	52.57
SP		8.37	8.93	8.88	8.71	8.77	8.57	52.23
T_1	90:10	8.66	8.57	8.46	8.66	8.35	8.53	51.23
SP: GP		8.97	8.06	8.08	8.91	8.26	8.06	50.34
T_2	85:15	8.46	7.93	8.26	7.91	7.71	7.86	48.13
SP: GP		7.73	7.73	7.48	7.42	7.37	7.46	45.19
T_3	80:20	7.62	7.24	8.02	7.46	7.42	7.46	45.22
SP: GP		7.31	7.31	7.00	6.84	7.24	7.02	42.72
T_4	75:25	6.91	6.86	7.53	6.64	6.73	6.42	41.09
SP: GP		6.95	6.91	6.26	6.48	6.57	6.91	40.08
T_5	70:30	6.40	5.60	6.77	6.35	6.02	6.28	37.42
SP: GP		6.35	5.73	6.33	5.77	6.42	5.93	36.53
Kendall's (W)		**0.928**	**0.895**	**0.810**	**0.919**	**0.939**	**0.940**	**5.431**
		0.989	**0.986**	**0.985**	**0.968**	**0.959**	**0.972**	**5.859**

Table 2. Changes in the physico-chemical properties of yoghurts with the days of storage

Treatments	Day of storage			
	0	**5**	**10**	**15**
Moisture (%)				
T_0 (Control)	78.05	75.01	72.11	70.00
T_1 (SPBY)	79.58	76.03	74.56	72.07
Treatments	**Day of storage**			
	0	**5**	**10**	**15**
T_2 (GPBY)	79.40	76.00	74.22	73.04
pH				
T_0 (Control)	4.52	4.41	4.36	4.27
T_1 (SPBY)	4.68	4.53	4.43	4.37
T_2 (GPBY)	4.57	4.42	4.35	4.15

Table 2 Contd.

Treatments	Day of storage			
	0	5	10	15
Acidity (%)				
T_0 (Control)	0.68	0.70	0.72	0.76
T_1 (SPBY)	0.61	0.63	0.64	0.65
T_2 (GPBY)	0.60	0.65	0.77	0.89
Water holding capacity (%)				
T_0 (Control)	47.30	50.25	52.20	53.66
T_1 (SPBY)	50.46	51.72	52.60	53.00
T_2 (GPBY)	50.34	51.11	52.10	52.80
Curd tension (%)				
T_0 (Control)	54.00	54.11	56.70	60.00
T_1 (SPBY)	38.60	41.00	43.00	45.60
T_2 (GPBY)	38.66	40.11	42.11	45.66
Syneresis (%)				
T_0 (Control)	ND	ND	1.00	1.02
T_1 (SPBY)	ND	ND	0.5	0.6
T_2 (GPBY)	ND	ND	0.5	0.6

SPBY: Sapota pulp-based yoghurt; GPBY: Guava pulp-based yoghurt

0.6 and 1.0% were observed in fruit pulp-based and plain yoghurt, respectively. The TSS, total sugar, reducing sugar, carbohydrate and lactose content were similar in all the yoghurts till the 15th day of storage.Yoghurt with cow milk had higher energy and fat content than sapota and guava yoghurts. Fruit yoghurts were found to have higher amounts of â carotene, vitamin C, iron and potassium compared to the plain yoghurt. Thus, the enrichment with sapota and guava pulp made the yoghurts enriched with micronutrients making it healthier and product diversification using fruits.

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Table 3. Changes in thenutritional content of yoghurts with the days of storage

Treatments	Day of storage			
	0	5	10	15
Total Soluble Solids				
T_0 (Control)	14.00^{NS}	13.87^{NS}	13.53^{NS}	13.24^{NS}
T_1 (SPBY)	16.00^{NS}	15.76^{NS}	15.43^{NS}	15.10^{NS}
T_2 (GPBY)	15.00^{NS}	14.56^{NS}	14.21^{NS}	13.99^{NS}
Total sugar (%)				
T_0 (Control)	11.88^{NS}	11.82^{NS}	11.77^{NS}	11.71^{NS}
T_1 (SPBY)	15.14^{NS}	15.11^{NS}	15.01^{NS}	14.94^{NS}
T_2 (GPBY)	14.14^{NS}	14.10^{NS}	14.07^{NS}	14.02^{NS}
Energy (Kcal))				
T_0 (Control)	82.68^{a}	72.68^{b}	63.32^{c}	55.20^{d}
T_1 (SPBY)	73.54^{a}	68.52^{b}	61.95^{c}	50.35^{d}
T_2 (GPBY)	55.72^{a}	50.24^{b}	44.13^{c}	37.65^{d}
Carbohydrate (%)				
T_0 (Control)	11.5^{NS}	11.00^{NS}	10.58^{NS}	10.00^{NS}
T_1 (SPBY)	10.6^{NS}	10.10^{NS}	9.80^{NS}	9.40^{NS}
T_2 (GPBY)	8.0^{NS}	7.50^{NS}	7.20^{NS}	6.00^{NS}
Lactose (%)				
T_0 (Control)	2.94^{NS}	2.90^{NS}	2.86^{NS}	2.86^{NS}
T_1 (SPBY)	2.72^{NS}	2.68^{NS}	2.65^{NS}	2.62^{NS}
T_2 (GPBY)	1.44^{NS}	1.40^{NS}	1.37^{NS}	1.33^{NS}
Protein (%)				
T_0 (Control)	4.59^{NS}	3.88^{NS}	3.67^{NS}	3.35^{NS}
Treatments	**Day of storage**			
	0	**5**	**10**	**15**
T_1 (SPBY)	3.77^{NS}	3.57^{NS}	3.33^{NS}	2.71^{NS}
T_2 (GPBY)	3.23^{NS}	3.11^{NS}	3.00^{NS}	2.61^{NS}

Table 3 Contd.

Treatments	Day of storage			
	0	5	10	15
Fat (%)				
T_0 (Control)	2.8[a]	2.00[ab]	1.2 [b]	1.00[c]
T_1 (SPBY)	1.02 [NS]	1.00 [NS]	0.55 [NS]	0.20[NS]
T_2 (GPBY)	1.2 [NS]	1.00 [NS]	0.71 [NS]	0.51[NS]
â Carotene (IU)				
T_0 (Control)	ND	ND	ND	ND
T_1 (SPBY)	1.29[NS]	1.28[NS]	1.27[NS]	1.26[NS]
T_2 (GPBY)	2.1[NS]	2.00[NS]	1.98[NS]	1.96[NS]
Vitamin C(mg/100g)				
T_0 (Control)	0.53[NS]	0.53[NS]	0.52[NS]	0.51[NS]
T_1 (SPBY)	0.76[a]	0.74[b]	0.73[bc]	0.72[c]
T_2 (GPBY)	0.85[a]	0.82[b]	0.80[c]	0.75[c]
Calcium (mg/100g)				
T_0 (Control)	78.00[NS]			77.12[NS]
T_1 (SPBY)	59.19[NS]			59.00[NS]
T_2 (GPBY)	61.24[NS]			60.15[NS]
Iron (mg/100g)				
T_0 (Control)	0.10[NS]			0.10[NS]
T_1 (SPBY)	1.24[NS]			1.21 [NS]
T_2 (GPBY)	0.49[NS]			0.47 [NS]
Treatments	**Day of storage**			
	0	**5**	**10**	**15**
Potassium (mg/100g)				
T_0 (Control)	60.01[NS]			59.50[NS]
T_1 (SPBY)	72.06 [NS]			72.01[NS]
T_2 (GPBY)	74.03[NS]			73.09[NS]

5% significant level; Values having different superscripts differ significantly in DMRT, Minerals were estimated only in the initial and 15[th] day

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