Journal of Food Technology 4 (1) : 44-49, 2006

Physical, Chemical, Nutritional and Organoleptic Characteristics of Fruit Added Yogurts

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Abstract: The effect of adding some fruits on the nutritional and sensory properties of yogurt was examined. Trabzon's date (*Diospyros kaki*), black date (*Diospyros lotus*), Rosehip (*Rosa rugosa Thunb.*) and Cornelian cherry (*Cornus mas* L.) were used in the production of aromatized yogurts. Fruit addition caused an important increase in the emulsion viscosity of the yogurts compared with control yogurts. Increasing fruit amount resulted in a significant decrease in the syneresis of samples. Dry matter, carbonhydrate and ash contents were increased and fat, protein and acidity were decreased by the addition of fruit. Fruit addition significantly increased some inadequate minerals such as Fe and K in traditional yogurt. The organoleptic characteristics of fruit added yogurts were higher than control yogurt. Fruit-supplemented yogurts constituted a good source of Ca, Mg, Zn, P and K. The nutritional, variousness, organoleptic characteristic and fiber content of yogurt were increased by addition of fruits.

Key words: Fruit, yogurt, nutritional, chemical characteristic

INTRODUCTION

The increase in consumer demand for dairy products with functional properties was a key factor driving value sales growth in developed markets in 2003[1]. Yogurt ranks as a popular food in many parts of the world. People in Turkey and some other countries of the Middle East have eaten yogurt for thousands of years. Yogurt is part of the diet in southeastern Europe and the Middle East for millennia and is now part of the dairy counters even in the smallest grocery stores in many countries[2]. Yogurt is used abundantly in Middle Eastern and Northern African meals. It is served plain, mixed with fruits, or is drunk as a beverage and is used as a cooking medium and thickener. Yogurts are also sauced over fried eggplant, mixed into a cucumber soup or served alongside a pilaf. Cucumber and yogurt salad served as a mezze is a popular item in eastern Mediterranean cooking and has many variations with garlic, mint or dill[3].

The energy intake form different foods is low in Turkey. Total protein consumption is adequate but most of the intake is of vegetable origin. The production of milk and milk products has increased between 1990 and 1998, but this increase was lesser than population growth, thus actually reducing consumption per capita from 171 to 157 kg. On the other hand, per capita milk consumption is around 200-240 kg in the EU and other developed countries. Yogurt and cheese varieties have a significant share in dairy product consumption. The per capita consumption of yogurt in Turkey is approximately 110 kg[4, 5].

Yogurt is a valuable health food for both infants and elderly people. The nutritional constituents of yogurt are derived from the milk used in making it, those that are synthesized by the lactic acid bacteria and those that are added by the manufacturers. The nutritional value of the milk proteins is well-preserved during the fermentation process. Like most dairy products, it is a good source of protein, or roughly 16-20g 100g of the daily amount recommended. The milk proteins in yogurt are partially hydrolysed and therefore become more digestible. In comparison with cheeses, the serum proteins in Yogurt (lacto albumin and lacto globulin) remain within the product. Some lactic acid bacteria synthesize folic acid and others lactase, an enzyme that reduces the lactose content of the yogurt. Most lactose intolerant people can consume yogurt without any problem. Yogurt has a high content of conjugated linolenic acid, which has been reported to have immuno-stimulatory and anti-carcinogenic properties. And finally, yogurt is an excellent source of calcium (yielding up to 33g 100g of daily needs) and phosphorus; the acidic nature of yogurt 'ionizes' calcium thereby improving calcium uptake into the body[6]. It is also high in minerals and essential vitamins, like potassium and vitamin B12. Best of all, it comes in a full spectrum of fat levels, including non-fat,

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low-fat and whole-milk varieties and is also available in light and reduced-calorie forms[7].

There is currently considerable growth in the economical importance of yogurts in industrialized countries. In the last few years, this tendency has driven the manufacturers to develop a wide variety of these products with different characteristics. Consumers especially children demand novel yoghurt formulations more than traditional products such as plain yoghurt. Introduction of various fruit flavored yoghurts has significantly contributed to the consumption of yoghurt from all ages. Fruit -added yoghurts can be prepared as Sundae style where the fruit is on the bottom of the cup and Swiss style where the fruit is uniformly distributed through the product. Yoghurt can be a good source of essential nutrients as minerals in the human diet. It could contribute significantly to the recommended daily requirements for calcium and magnesium to maintain the physiological processes. Yoghurt is also a good dietary source of phosphorus and its contribution to total phosphorus intake has been reported as 30–45g/100g in western countries. Other key nutrients supplied would include zinc. Analysis of total content of minerals in yoghurts have been carried out and studies of mineral composition of milk fruit-added yoghurts) can also be found in the literature[8, 9].

Trabzon's date (*Diospyros kaki*), black date (*Diospyros lotus*), Rosehip (*Rosa rugosa Thunb.*) and Cornelian cherry (*Cornus mas* L.) are very popular and cheap national fruits in Turkey. Those fruits are a good source of dietary fiber (Black date), some minerals, protein (Rosehip) and ash. Utilization of traditional fruits in yogurt production is going to increase their market share and reduce the losses during the peak production times. The objective of this study was to investigate the chemical, nutritional and organoleptic properties of the fruit added yogurts.

MATERIALS AND METHODS

Materials: Fresh cows' milk was daily purchased from [a]eker Company in Konya in Turkey. Milk powder was obtained from ENKA Company in Konya. *Streptococcus salivarius* ssp. *thermophilus* and *Lactobacillus delbrueckii* ssp. *bulgaricus* were obtained from WISBY (Germany). Cornelian cherry (*Cornus mas* L.) and Trabzon's date (*Diospyros kaki*), black date (*Diospyros lotus*) and ku°burnu (*Rosa rugosa Thunb.*) from was obtained from Agricultural Faculty Research Centre and Trabzon province, respectively. Fruits (Table 1) were naturally grinded by a mixer and than added in yogurt milk (Table 1).

The raw milk was preheated at 50°C. Milk powder, gelatin and sugar (Table 2) were added into the milk and stirred with mixer. Then, the milk was heated at 90°C for 10 minute and cooled to 45°C, followed by addition of 3 mL 100 mL yogurt culture (*Streptococcus salivarius* ssp. *thermophilus* and *Lactobacillus delbrueckii* ssp. *bulgaricus*). The milk was partitioned to 9 different 600 mL groups. Fruits were added into the milks as shown in Table 2. The cultured milks were fiiled in a series of plastic cups. The milk mixtures in the closed cups were incubated at 42°C for 3 h. The yogurts were then stored in a refrigerator at 5°C for 12 h. Three replicates of each yogurt were made (Table 2).

Table 1: Some properties of the ingredients used for yogurt production

	Milk	Rosehip	Black date	Trabzon's date	Cornelian cherry
Water (g/100g)	87.20	49.93	35.43	69.45	81.40
Dry matter (g/100g)	12.80	50.07	64.57	30.55	18.60
Protein (g/100g)	2.94	9.60	2.05	1.83	2.16
Tot. Lipid (g/100g)	4.02	1.72	0.48	0.41	------
CHO (g/100g)	4.85	32.35	51.51	22.81	9.30
Fiber (g/100g)	------	3.45	7.33	2.05	------
Ash (g/100g)	0.69	2.18	1.69	1.74	0.73
Ca (mg/100g)	85.36	99.16	98.42	66.43	15.30
P (mg/100g)	156.03	25.04	6.65	42.36	157
Mg (mg/100g)	20.00	18.92	10.81	13.06	5.12
Na (mg/100g)	40.02	5.20	16.74	54.02	15.21
Fe (mg/100g)	0.04	51.85	1.22	0.61	0.13
Zn (mg/100g)	0.50	1.92	0.40	0.86	0.13
K (mg/100g)	130.00	388.41	473.60	272.36	80.00

Table 2: Ingredients used for yoghurt production (g/100mL milk)

Components	Control	Rosehip		Black date		Trabzon's date		Cornelian cherry	
Milk power	5	3	3	3	3	3	3	3	3
Starter culture	3	3	3	3	3	3	3	3	3
Sugar	-	5	3	5	3	5	3	5	3
Gelatin	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5
Fruit	-	5	10	5	10	10	20	10	20

Dry matter, crude protein, fat, acidity and ash contents of yogurt samples were determined according to the standard methods of AOAC[10]. Protein was calculated using the factor Nx 6.38. pH was determined according to Bradley *et al.*[11]. Viscosity and syneresis was determined according to Ogaro *et al.*[12] and Konar[13], respectively. The organoleptic evaluation was carried out by 10 semi trained panelists according to the method modified from Bodyfelt *et al.*[14] with maximum scores of 5 for flavour, consistency with spoon, consistency with mouth, colour, appearance and smell. General acceptability was calculated as the sum of all attributes for each sample. Carbohydrates in yogurts were calculated by using the equation: Carbohydrates = Dry matter-(protein+fat+ash).

Mineral contents of yogurt samples were determined as the following; 500 mg sample was weighed into crucibles and ashed in the microwave furnace (MARS 5, CEM Corporation) at 200°C, 170 psi for 30 min. The ashes were dissolved with a few drops of nitric acid (65 g/100g) (Sigma, USA) and diluted to 50 mL with deionised water. Concentrations of major and trace minerals were quantified by Inductively Coupled Plasma Atomic Emission Spectroscopy (Model VARIAN-CCD Simultaneous ICP-AES, Australia) with an auto-sampling system. The sample flow rate was 1.5 L/min. Wavelengths used for the tested minerals were: S, 191.4; P, 213.6; K, 766.4; Mg, 285.2; Ca, 317.9; Na, 588.9; Fe, 259.9; Cu, 324.7; Zn, 213.8 nm, respectively[15].

Data obtained from the chemical and organoleptic analysis of the samples were statistically evaluated by variance analysis and comparisons were done with Duncan's Multiple Range Test[16].

RESULTS AND DISCUSSION

Some physical and chemical properties of yogurt samples are presented in Table 3. Viscosity is an important factor to influence the final product quality and therefore, it has to be monitored and controlled. The viscosities of all fruit added- yogurt samples were higher than that of control yogurts. The highest viscosity was determined in the black date added yogurt at 50 rpm. It is concluded that selection of specific fruits having higher pulp viscosities can improve the physical properties of yoghurts. The viscosity of yogurt is affected from milk composition, heat process and starter culture used, method of processing and ingredients added in yogurt[17]. The effect of various fruits on viscosity can be different. The findings of Nila *et al.*[18] are different from our results. This may be related to the contents of the dry matter and pectin of the fruits. Pectin is a gum found naturally in fruits that causes jelly to gel. Pectin is used only to give more body to yogurts. The texture of yogurt may be improved by small amounts of pectin which is added before the yogurt milk is heated[19].

Syneresis is a body defect in yoghurt and described as the whey collected on the surface of the yogurt[20]. Syneresis values of all fruit added yogurts are generally lower than that of control yogurts, but this value was decreased when fruit levels increased. The lowest syneresis was determined in the 10 g/100g black date added yogurts. Total solids content has a great effect on the ability of yogurt to hold water. Syneresis of yogurts fortified with calcium and dietetic fiber ranged from 42 to 72 g/100g as a function of the yogurt composition; particularly, syneresis showed an increasing when calcium salt was augmented and a decreasing trend with increasing fiber content[21]. The apparent viscosity and whey syneresis measurements were in between 3624-5904 cp and 40-52 g/100g, respectively, depending on sugar and coffee concentrations[22]. Sodini *et al.*[23] have found that water holding capacity was the same for the five WPC enriched yogurts (63±2 g $100g^{-1}$). It was higher than for the SMP enriched yogurt (53±1g $100g^{-1}$). These values are similar to those found in our study.

The total solids, ash and CHO contents of fruit added yogurts were higher than in control sample. The fruit added yogurts had higher total solids contents than that reported for plain yogurts[24-27] and similar with the aromatized yogurts in the literature[26-28]. The ash content of fruit added yogurts was similar with found in plain yogurts by Park[25], Yaygun[29] and in fruit-yogurts by

Table 3: The chemical properties of different fruits added yogurts

		Rosehip		Black date		Trabzon's date		Cornelian cherry	
	Control	l10g/100g	20g/100g	5g/100g	10g/100g	5g/100g	10g/100g	10g/100g	20g/100g
Viscosity (cP)									
50rpm	925	1200	1300	1425	1400	1250	1400	1050	1300
100rpm	600	800	800	800	1000	925	900	700	825
Syneresis (g/100g)	56.36	59.25	55.86	50.67	55.34	54.01	54.16	57.23	53.35
Dry matter (g/100g)	18.82	23.49	23.39	23.40	23.52	25.10	25.77	20.38	20.69
Ash (g/100g)	0.66	0.80	0.99	0.95	0.83	0.78	0.91	0.86	0.85
Fat (g/100g)	3.70	3.40	3.50b	3.60	3.40	3.40	3.40	3.50	3.60
Protein (g/100g)	7.27	7.91	6.98	7.21	8.38	7.10	7.07	7.18	7.10
Carbohydrate (g/100g)	6.05	10.42	10.97	10.67	9.79	12.74	12.64	11.21	11.68
pH	4.06	4.27	4.43	4.44	4.16	4.28	4.44	4.10	4.14
Acidity (g/100 glactic acid)	1.14	0.99	0.95	0.98	1.09	1.05	1.08	1.02	1.10

Table 4: The mineral content of fruit added yogurts (mg/100 g of yogurt)

		Rosehip		Black date		Trabzon's date		Cornelian cherry	
Minerals	Control	l10g/100g	20g/100g	5g/100g	10g/100g	5g/100g	10g/100g	10g/100g	20g/100g
Ca	111.69	109.84	107.32	107.14	119.47	108.27	106.10	108.50	101.98
P	114.08	140.53	144.50	109.59	104.03	108.54	94.26	120.72	123.08
Mg	23.52	16.22	15.21	11.24	11.85	13.78	13.07	12.77	11.12
Na	41.02	30.56	30.07	32.99	29.84	46.78	41.60	29.94	28.61
Fe	0.16	0.21	0.25	0.19	0.22	0.16	0.11	0.15	0.14
Zn	0.64	0.76	1.16	0.46	0.20	0.64	0.86	0.57	0.40
K	109.55	170.64	199.73	208.34	231.24	136.31	154.94	117.22	126.55

Table 5: Mean daily intake (µg/day), percentage of contribution to the Recommended Daily Allowance (RDA) and nutrient density (DN) for the minerals investigated*

	Ca	Mg	Na	Zn	Fe	K	P	
Recommended daily allowance	900	350	2000	15	15	200	1000	
Main daily intake**	271.42		32.87	84.47	1.57	0.42	420.30	295.37
Average of fruit added yogurts	108.57		13.15	33.79	0.63	0.17	168.12	118.15
% RDA	30.15		9.39	4.22	10.46	2.80	210.15	29.53
% D.N.	329	102	46	114	30	2295	322	

* The daily contribution to dietary intake was calculated from the mean concentration of each of the element investigated
**Calculated on the basis of the ingestion of one yogurt (≈250g)

Table 6: Organoleptic quality of the yogurts produced with fruit addition

		Rosehip		Black date		Trabzon's date		Cornelian cherry	
Attributes	Control	l10g/100g	20g/100g	5g/100g	10g/100g	5g/100g	10g/100g	10g/100g	20g/100g
Flavour	3.75	4.25	4.10	4.20	4.10	3.95	3.90	4.55	4.45
Consistency with spoon	3.75	4.15	4.30	3.65	3.90	4.10	3.96	4.55	4.20
Consistency with mouth	3.75	4.05	4.05	3.95	3.95	3.90	3.97	4.30	4.10
Colour	3.80	4.10	4.00	3.85	4.00	3.78	3.95	4.00	4.03
Appearance	3.50	4.20	3.70	4.10	3.60	3.85	3.65	4.00	4.43
Smell	3.60	4.18	4.18	3.70	3.75	4.10	4.00	3.90	4.05
General acceptability	22.15	24.93	24.33	23.45	23.30	23.68	23.43	25.30	25.26

Musaigera *et al.*[27], Ayar *et al.*[30]. The fat content of fruit added yogurts decreased compared with control yogurts. The protein contents of fruit added yogurts were lower than control yogurts, but Rosehip added yogurts was higher because Rosehip fruit have higher protein content than that of milk. The carbohydrates contents of fruit added yogurts was higher than that of plain yogurt The acidity in fruit added yogurts was found lower than those of control. Parallel to the acidity of the yogurts, the pH were higher in fruit added yogurts, but not significantly so. The differences between chemical results may dependent on raw milk, ingredients added and processing conditions[24, 28, 31] (Table 3).

Mineral contents of fruit added-yoghurts are presented in Table 4. The phosphorus content of yogurts significantly increased by adding Rosehip and Cornelian cherry. The sodium, zinc and potassium contents of Trabzon's date added yoghurts were higher than that of control yogurt. In black date and Rosehip added samples, a positive influence was proven on the final iron content of the yogurts in the presence of fruits (Table 1). The addition of Trabzon's date and Rosehip to yogurt samples increases the zinc content. The potassium content in all fruit added yogurts was higher than that of control yogurt.

In the literature, Ca concentrations are between 97.30 and 174.00 mg/100 g in plain yogurts[31-34] and between 77.20 and 128.70 mg/100 g in flavoured yogurts[19, 26]. These results are in agreement with our findings. The average Mg content in the fruit added yogurts was lower than that of found in plain yogurts[26, 31, 35] and flavoured yogurts[25, 33]. The total Na concentrations in plain yogurts have been reported to be between 31.10 and 75.00 mg/100 g[8, 25, 26] and in flavoured yogurts between 26.5 and 73.2 mg/100 g[26, 33]. Our results are similar to these values. Plain yogurts had 0.27-0.70 mg/100 g Zn levels[26, 35] and flavoured yogurts 0.28-0.59 mg/100 g[26, 34]. These results are also similar to our results. The Fe content In the plain and flavoured yogurts was between 0.04 and 0.40 mg/100 g[31, 32] and 0.05 and 0.35 mg 100 g[25, 26], respectively. Our results are higher than these values due to the addition of fruits. The P concentrations of the plain yogurts are reported as 98.00-141.00 mg/100 g[9, 25]. The total P concentration in the fruit added yogurts in our study is higher than the plain and flavoured yogurts. It can be concluded that the addition of fruit confers a dilution phenomenon of Mg and Ca elements in the yogurt (Table 4).

Nutritional assessment: Both the percentage of the Recommended Daily Amount (RDA) that the consumption of one yogurt covered (˜250 g) for each of the mineral elements[36] and the nutrient density were calculated in order to determine the nutritional

value of fruit added yogurts in terms of their mineral composition[9]. Table 5 shows that the fruit added yogurts constituted a very good source of calcium, phosphorus, potassium and, to a lesser extent, of magnesium and zinc, both by the RDA percentage and their nutrient density values (Table 5).

Organoleptic properties: The organoleptic properties of the yogurts are presented in Table 6. The flavour scores of fruit added yogurts were higher than that of the control yogurt. The general acceptability of fruit added yogurts was higher than that of the control yogurt. There was no significant difference between fruit added yogurts with control yogurt. Yogurts with 10 and 20 g/100g cornelian had the highest general acceptability (25.30 and 25.26/30, respectively). Similar results were observed in bananas, kokum and papaya-added yogurts by Desai *et al.*[24], in strawberry-added yogurts by Ward *et al.*[37], in soursop-added yogurts by Lutcmedial *et al.* (2004) and in germ-added aromatise yogurts by Ayar *et al.*[30] (Table 6).

CONCLUSIONS

It was expected that adding fruit to the yogurt samples would increase their total solids, CHO and ash contents compared with control yogurts because of the higher total solids, CHO and ash contents in some fruits. Rosehip addition increased the protein contents of the yogurts, this increase was statistically significant. The significant ash increase in the yogurts was due to the fruits having between 0.73-2.18 g/100 g ash. Whole yogurt with fruits can be considered "a very good source of calcium, potassium, phosphorus" and a food "containing zinc and magnesium" based on the modifications proposed for nutritional labeling regulation (Porter *et al.*, 1991). The concentrations of these minerals considerably increased with the addition of fruits. This way of rating means a food is "a very good source of... when the nutrient is more than 20% of the corresponding RDA, a good source of... is when it is 11% to 20% of the RDA and contains... refers to a nutrient between 2% and 10% of the RDA.

Addition of different flavourings to mask the acidic flavour of the natural yogurt is a successful way of increasing the palatability of yogurts. In this study, plain yogurt was fortified with fruits to increase the fiber and mineral content and to improve the organoleptic properties. Thus, yogurt was produced with higher plant fiber, plant protein content, mineral composition and organoleptic acceptance as a new variety of yogurt with high palatability.

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