Fruit Flavored Yoghurt: Chemical, Functional and Rheological Properties

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Abstract— *Yoghurt is a coagulated milk product that results from the fermentation of lactose in milk by Lactobacillus bulgaricus and Streptococcus thermphillus. The health benefits can be increased by adding native fruit pulps. Yoghurt with different fruit pulp includes papaya and cactus pear was prepared and stored up to 10 days. The fruit were added at the rate of 5%, 10% and 15%w/w. Physicochemical properties of yoghurt samples include moisture, protein, fat, carbohydrate and ash were determined at first days of storage. Acidity, pH, syneresis, water holding capacity (WHC), total count, coliform group, yeast &mould and organoleptic properties were evaluated yoghurts at zero time, after 5 and 10 days of storage at refrigerator.There were significantly differences between plain yoghurt and fruit yogurt in the pH, moisture, ash, protein, carbohydrate content and titratable acidity amounts 5 day of storage. The results showed that acidity increased over the storage period. Highest values for WHC and lowest values for syneresis were belonged to yogurt with 15 % cactus pear and 10 days storage with 71.21% and 16.01%, respectively. Sensory evaluation results showed that there were significant differences among the yoghurt samples. The yoghurt containing papaya pulp had the highest overall acceptability scores as compare to other fruit yogurt samples and also plain yogurt. The results of current study demonstrated that the addition of fruits to the yogurt significantly improved the quality of yogurt.*

Keywords*— *Fruit yoghurt, Phytochemicals, Sensory quality, Syneresis, Water holding capacity (WHC).

I. INTRODUCTION

Yoghurt is a coagulated milk product that results from the fermentation of lactose in milk by *lactobacillus bulgaricus* and *streptococcusthermphillus* (Bourlioux and Pochart, 1988). Other lactic acid bacteria (LAB) are also frequently used to produce yoghurt with unique characteristics (Adolfsson *et al.*, 2004)

Yogurt consumption has increased around the world because of its nutritional value, therapeutic effects, and functional properties (McKinley, 2005). The use of different fruits and additives in fruit yogurt production has improved its nutritional and sensory properties (Cakmakcı *et al.*, 2012). Peaches, cherries, apricots, papaya, cactus pear and blueberries are frequently used in yogurt production (Arslan and Ozel, 2012).

Yoghurt is an increasingly popular cultured dairy product in most countries. This is partly because of an increased awareness of the consumers regarding possible health benefits of yoghurt. Yoghurt is easily digested, has high nutritional value, and is a rich source of carbohydrates, protein, fat, vitamins, calcium, and phosphorus. Because milk protein, fat, and lactose components undergo partial hydrolysis during fermentation, yoghurt is an easily digested product of milk (Sanchez *et al.*, 2000).

The flavors are key factors for food stuff acceptability by consumers. Organoleptic evaluations have shown a marked preference for the fruity yoghurt (Barnes *et al*., 1991). Addition of different fruit in yogurt manufacture has been attempted increasingly. Use of fruit in yogurt makes its more delicious. This product contains both the refreshing flavor of fruit and beneficial effect of yogurt. Fruit yogurt has more taste and pleasing flavor (Mahmood *et al*., 2008)

The pectin and sugars from the fruit are mixed with the yoghurt, causing an increase in its consistency and viscosity and therefore mouth fell is improved (Nongonierma *et al*., 2007). Pectins are added to acidified dairy products to avoid syneresis (Tromp *et al*., 2004)They adsorb on casein reversibly, inducing an increase in the steric repulsion and thus decreased their aggregation (Nongonierma *et al*., 2007).

Introduction of various fruit-flavoured yoghurts has significantly contributed to the consumption of yoghurt from all ages. Fruits may be added to yoghurt formulae as single or blends in the form of refrigerated, frozen, canned fruit, juice or syrup. Most common fruits used in yoghurt formulae are peach, cherry, orange, lemons, purple plum, boysen berry, spiced apple, apricot, pineapple, strawberry, raspberry and blueberry (Chandan *et al*., 1993). Incorporation of fruits endorses the healthy image of yoghurts. In contrast to the study dealing with the health influences of the addition of fruit, there is a very limited research about the technological, physicochemical, organoleptic, and microbiological properties of fruit-added yoghurts (Bardale *et al*., 1986).

Carica papaya belongs to the small family Caricaceae and is one of the non-seasonal and evergreen fruits in Malaysia. There is always a soft main trunk and tufted leaves at the top. Papaya varies in sizes, shape, color and taste. In Malaysia, the preference is for the red-fleshed varieties namely Eksotika. The skin color of papaya is usual green when immature, changing to fully reddish-orange when fully ripened. The changed in outer color of the skin of fruit is an indicator of ripeness, and this change is considered mainly due to an increase in the carotene content and a decrease in chlorophyll. The color of papaya fruit flesh is determined largely by the presence of carotenoid pigments. Red-fleshed papaya fruit contain lycopene, whilst this pigment is absent from yellow-fleshed fruit (Devitt *et al*., 2010) . The red-fleshed papaya has 63.5% of total carotenoids as lycopene which is absent in yellow-fleshed fruit [

(Yamamotohy, 1964). Papaya contains a broad spectrum of phytochemicals including enzymes (in the latex), carotenoids (in fruits and seeds), alkaloids (in leaves), phenolics (in fruits, leaves, and shoots), and glucosinolates (in seeds and fruits).

Cactus pear (*Opuntia spp*.) is a tropical fruit tree, native to America, which grows in arid and semiaridregions (Pimienta-Barrios & del Castillo, 2002). There are green fruits and also coloured fruits (red, yellow or purple) due to the presence of various pigments such as betalains and carotenes (Tesoriere *et al.*, 2005). This fruit is abundantly found in Mexico and United States, but also grown in North Africa, Madagascar, Australia, Srilanka and India (Piga, 2004). Prickly pear fruit (PPF) can be considered a food of nutraceutical and functional importance due to its high content of chemical constituents characterized bynutritional and health improving properties.

Generally, Prickly pear fruit (PPF) is rich in pectin, mucilage and minerals, whereas the fruits are good sources of vitamins, and amino acids. The pulp of prickly pear could be processed into many different products such as marmalades, jellies, natural sweeteners, wines and other alcoholic beverages, candies, canned, frozen fruit, etc. (Sawaya et al., 1983; Ewaidah and Hassan, 1992; Barbera, 1995; Saenz Hernandez, 1995; Gurrieri et al., 2000; Saenz, 2000; Sepulveda et al., 2000; Abdel-Nabey, 2001; Moßhammer et al., 2006).

II. MATERIALS AND METHODS

2.1 Materials

Cow's milk was obtained from Suez Canal university farm. The yoghurt culture including *Streptococcus thermophilus* & *Lactobacillus bulgaricus* and skim milk powder was obtained from Agricultural Research Center (Giza).Papaya (*Carica Papaya*) and Cactus Pear (*Opuntiaficusindica*).) fruits were obtained from local market from Ismailia governorate. Experimental yoghurts were made in the laboratory of Food Science Department, Faculty of Home Economic, El- Azhar University, Egypt.

2.2 Preparation of fruit pulp

Fresh ripe fruits (papaya & cactus pear) were gentle wash under tap water, peeled with the help of a knife aseptically and then were subjected to pulp extraction. The prepared fruit homogenates were filled into jars and pasteurized at 95°C for 15 min.

2.3 Production of Yoghurt

Standardized milk cow`s (milk fat 3%, protein 3.5%, TS 12% and acidity 0.17%) was used (5 kg) for yoghurt production and to increase solids of milk 2% NFDM (skim milk powder) was added. The mix was heated to 60^{o}C and homogenized. The mix was pasteurized at 85 ^{o}C for 30 min. and then rapidly cooled to 45^{o}C. Pasteurized milk cow`s was divided to three parts. The first part with no additives served as a control. To other treatments divided to 3 equal portion, then 5%, 10% and 15% of each fruit pulp were added, then inoculated with yogurt culture as a starter culture at 2.5 % inoculation level. The inoculated yogurt mixes were filled into 0.5 kg plastic cups and incubated at 43^{o}C until pH reaches 4.7. After complete coagulation, all treatments were stored in the refrigerator at 5°C for 10 days and examined when fresh and after 5 and 10 days of storage. All experiments were carried out in duplicate.

III. ANALYTICAL METHODS

3.1 Physicochemical analysis

The samples were mixed and analyzed in duplicate for moisture, total soluble solids (TSS), fat, protein, ascorbic acid, ash, total acidity(as citric acid), pH and crude fiber (AOAC, 2010).The micro-Kjeldahl method was used to determine total nitrogen content, protein content was obtained by multiplying the percentage of TN by 6.38 for milk ingredients and 6.25 for plant ingredients, fat content was measured by the Gerber method (Kurt et al., 1996) and ash by heating a 5g sample in a muffle furnace at100^{o}C for 1hour, 200^{o}C for 2 hours and 550^{o}C overnight (Marth,1978). TS were determined using a drying oven (AOAC, 2010). Titratable acidity was expressed in terms of % lactic acid (Anonymous, 1989). Total carbohydrate was calculated by difference [100 – (moisture + protein + fat + ash+ fiber) %].

3.2 DPPH radical scavenging activity

The determination of antioxidant activity through DPPH scavenging system was carried out according to the method of Musa *et al*. (2011). Stock solution was prepared by dissolving 40 mg DPPH in 100 mL methanol and kept at -20°C until used. About 350 mL stock solutions was mixed with 350 mL methanol to obtain the absorbance of 0.70±0.01 unit at 516 nm wave length by using spectrophotometer (Epoch, Biotek, USA). About 100 µL papaya extracts with 1 mL methanolic. DPPH solutions prepared were kept overnight for scavenging reaction in the dark. Percentage of DPPH scavenging activity was determined as follow: DPPH scavenging activity (%) = $A_{blank} – A_{sample} / A_{blank} \times 100$. where, A is the absorbance.

3.3 Determination of total phenolics content

Total phenolics content were determined by the Folin-Ciocalteau method following a published procedure (Roy *et al.*, 2014). The samples (0.5 ml) were mixed with Folin-Ciocalteau reagent (5 ml, of 1:10 diluted sample with distilled water) for 5 min and aqueous sodium carbonate (4 ml, 1 M) was then added. The absorbance of the reaction mixture was then measured at 765 nm with a UV-Vis spectrophotometer (model – Systronics 2202). Gallic acid was used as standard. The results were expressed as gallic acid equivalents (mg/100gsample).

3.4 Syneresis

Syneresis was determined by measuring the volume of separated whey (ml whey/50ml yoghurt) collected after 30 min at room temperature (Abd El-Salam *et al.*, 1991)

3.5 Water holding capacity (WHC)

Water holding capacity was determined according to Arslan and Ozel (2012).

20 g sample of native yogurt (NY) was centrifuged for 10 min at 669g and supernatant was removed and weighted (whey expelled (WE). The samples were analyzed at 0, 5, and 10 days

The WHC % was defined as:

$$\text{WHC \%} = \frac{\text{NY-WE} \times 100}{\text{NY}}$$

3.6 Microbial analyses

Plate count agar (PCA) medium (Difco) was used to the Total viable bacteria. Testing for Coliform, Mold and Yeast was according to Standard Methods for the Examination of Dairy Products(Marth, 1978), using the Violet Red Bile Agar (VRB) and acidified Potato Dextrose Agar (PDA) respectively.

3.7 Sensory Evaluation

The appearance, body -texture and flavor of all yoghurt samples were evaluated sensorily by a trained panel of ten members using a ten-point scoring system (10 excellent, 1unacceptable) (Anonymous, 1989). The sensory profiles were conducted on coded samples at 0, 5, and 10 day of storage, inviting comments on rate of flavor addition also (Larmond, 1987)

3.8 Statistical Analysis

Data were assessed using SPSS (1997) for Microsoft Windows. Statistical results were analyzed by Duncan's (1955) multiple-range test at the P < 0.05 level of significance.

IV. RESULTS AND DISCUSSION

4.1 Physicochemical Composition of fruits pulp:

Physicochemical composition of papaya and cactus pear pulps used for fruit yogurt making are shown in Table 1.Data showed that, papaya pulp had higher acidity, moisture content, crude fiber and ash content compared with cactus pear pulp and lower protein, TSS, fat and total carbohydrates.

TABLE 1
PHYSICOCHEMICAL COMPOSITION OF PAPAYA AND CACTUS PEAR PULP

Fruit	pH	Acidity (%)	Moisture (%)	TSS (%)	Protein (%)	Fat (%)	Crude fiber (%)	Ash (%)	CHO (%)
Papaya	4.90	0.35	87.64	11.48	0.58	0.36	0.82	0.64	9.96
Cactus pear	6.1	0.20	84.79	12.60	0.68	0.42	0.64	0.40	13.07

Ascorbic acid (mg/100g), phenolic compounds (mg EGA /100g) and antioxidant activity (%) of papaya and cactus pear pulp were (44.5&14.50), (268.80 &45.00) and (84.90&62.20) respectively, Table 2. These results agreement with, El-Samahy *et al*. (2006b) and Bari *et al* (2006)

TABLE 2
ASCORBIC ACID, TOTAL PHENOLIC COMPOUNDS, TPC AND ANTIOXIDANT ACTIVITY, AA OF PAPAYA AND CACTUS PEAR PULP

Fruit	Ascorbic acid (mg/ 100g)	TPC (mg EGA /100g)	AA(%)
Papaya pulp (PP)	44.50	268.80	84.90
Cactus pear pulp(CPP)	14.50	45.00	62.20

4.2 Physicochemical Composition of different types of fruit flavored yoghurt

Physicochemical compositions of freshly fruit yoghurt samples are shown in Table 3. The addition of fruit pulps decreased the acidity of fruit yogurt and acidity was decreased with the increase in the amount of fruit pulp added. The acidity of different types of yoghurts limited from 0.886- 1.085 percent. Lowest acidity for the sample was 0.886% that related to CPY (15%) and the maximum was 1.085% that belongs to the plain yogurt. The decrease in acidity of fruit yoghurt might be due to the low acidity of papaya and cactus pear pulp acidity The moisture content of different types of yogurt varied from 84.21-89.00 %. Moisture content of plain yogurts was recorded as the highest (89.00 %). Moisture content and the total solids affected on the texture, low moisture content and high total solid increased the firmness and consistency of yogurt and therefore affected on mouth feel. The addition of fruit caused an increase in carbohydrate and protein content of yogurt. According to the results of this research there were significant differences in the protein and ash content(P<0.05) of different experimental yoghurts. Yoghurt containing CPP (15%) had significantly higher protein content (3.80%) and ash content (0.7%) than others. Fat content of yoghurts ranged from 2.50% to 2.92%. There were slight decreases in the fat content of the yoghurt contained fruit, as shown Table 2. This result is due to low fat content of fruit.

TABLE 3
PHYSICOCHEMICAL COMPOSITION OF PLAIN YOGHURT AND DIFFERENT TYPES OF FRUIT FLAVORED YOGHURT.

sample	pH	Acidity (%)	Moisture (%)	Protein (%)	Fat (%)	Crude fiber (%)	Ash (%)	CHO (%)
Plain yogurt	4.61^{e}	1.085^{a}	89.00^{a}	3.44^{d}	2.92^{a}	ND	0.68^{a}	3.96^{d}
PY (5%)	4.63^{d}	1.080^{a}	87.88^{ab}	3.62^{c}	2.72^{a}	0.09^{b}	0.70^{a}	4.99^{c}
PY (10%)	4.68^{d}	1.076^{b}	86.20^{c}	3.60^{c}	2.54^{c}	0.11^{a}	0.74^{a}	6.81^{b}
PY (15%)	4.74^{c}	1.042^{bc}	85.12^{d}	3.72^{ab}	2.50^{c}	0.16^{a}	0.78^{a}	7.72^{a}
CPY (5%)	5.13^{b}	0.945^{c}	87.00^{b}	3.68^{b}	2.88^{a}	0.06^{b}	0.62^{b}	5.76^{c}
CPY (10%)	5.20^{ab}	0.912^{d}	85.42^{d}	3.78^{a}	2.72^{a}	0.08^{b}	0.68^{a}	7.32^{a}
CPY (15%)	5.42^{a}	0.886^{e}	84.21^{e}	3.80^{a}	2.68^{b}	0.11^{a}	0.70^{a}	8.50^{a}

PY: papaya yoghurt
CPY: cactus pear yoghurt
$^{(a-d)}$ Different lowercase superscripts represent significant differences in the same column (P < 0.05)

4.3 Antioxidant activity of plain yogurt and different types of fruit flavored yogurt

Regular intake of fruit and vegetables is related to the reduced risk of diseases such as cancer and cardio vascular diseases, because they include natural antioxidants (Jang *et al.*, 2010). The ascorbic acid, phenolic contents and antioxidant activity values of yogurt samples are presented in Table 4 There were significant differences in the ascorbic acid, phenolic contents and antioxidant activity of the samples (P <0.05).

The ascorbic acid content of different types of yogurt varied from (0.73- 7.21 mg/ 100g). Yoghurt contains15%papaya pulp had the highest value (7.21mg/ 100 g), it may be due to the highest ascorbic acid in papaya pulp. Phenolic contents and antioxidant activity varied between (0.62 to 18.2 mg EGA /100g) and (0.17 to 2.02%) respectively. The highest value of % AA was (2.02%) for PY (15%), it may be due to the high concentrations of vitamin C and other antioxidant compounds of papaya pulps (Leong and Shui, 2002) have observed the highest activity using DPPH

TABLE 4
ASCORBIC ACID, TOTAL PHENOLIC COMPOUNDS, TPC AND ANTIOXIDANT ACTIVITY, AA OF PLAIN YOGURT AND DIFFERENT TYPES OF FRUIT YOGURT.

sample	Ascorbic acid (mg/ 100g)	TPC (mg EGA /100g)	AA (%)
PlainYoghurt	0.73^{f}	0.62^{f}	0.17^{e}
PY (5%)	2.82^{d}	12.40^{c}	1.70^{c}
PY (10%)	3.48^{c}	14.64^{b}	1.93^{b}
PY (15%)	7.21^{a}	18.20^{a}	2.02^{a}
CPY (5%)	1.40^{e}	3.20^{e}	1.58^{d}
CPY (10%)	2.98^{d}	4.98^{e}	1.72^{c}
CPY (15%)	4.72^{b}	5.20^{d}	1.98^{b}

PY: papaya yoghurt
CPY: cactus pear yoghurt
$^{(a-d)}$ Different lowercase superscripts represent significant differences in the same column (P < 0.05)

4.4 pH and acidity of plain and fruit flavored yogurt during storage period

Table 5 illustrates changes in pH and acidity of control and different type of yogurt during storage period. Generally, the pH of all yogurt samples decreased during storage period. It means that in both of control and fruit yogurt the highest of pH related to the first day of production with limit (4.61- 5.42) coupled with acidity of (1.085- 0.886%), respectively. And the lowest of pH related to the tenth day with limit (3.92-5.08) coupled with acidity of (1.72- 1.10%). After 5 days of storage a significant ($P \leq 0.05$) increase in acidity by 1.01% in plain yogurt was observed. However, the trend of increment in acidity continued to the 10th day of storage. This phenomena was due to the growth of lactic acid bacteria and produced the lactic acid, which was due to the especial synergism between *Lac. Spp*. and *Strep. spp*. The values of pH and acidity recorded in this study were consistent with the results obtained by Mahmood, (2008) and, Tarakci, (2010).

TABLE 5
pH AND ACIDITY OF PLAIN AND FRUIT FLAVORED YOGURT DURING STORAGE PERIOD

Sample	pH			Acidity		
	Storage period / days			Storage period / days		
	0	5	10	0	5	10
Plain yogurt	4.61^{Ad}	4.43^{Bd}	3.92^{Cd}	1.085^{Ba}	1.096^{Ba}	1.72^{Aa}
PY (5%)	4.63^{Ad}	4.46^{Bd}	4.31^{Cd}	1.080^{Ba}	1.091^{Ba}	1.48^{Aa}
PY (10%)	4.68^{Ad}	4.49^{Bd}	4.28^{Cd}	1.076^{Ab}	1.090^{Ba}	1.48^{Aa}
PY (15%)	4.74^{Ac}	4.52^{Bc}	4.36^{Cc}	1.042^{Cab}	1.073^{Bab}	1.34^{Aab}
CPY (5%)	5.13^{Ab}	4.92^{Bb}	4.60^{Cb}	0.945^{Cb}	1.053^{Bb}	1.21^{Ab}
CPY (10%)	5.20^{Aab}	5.00^{Aab}	4.70^{Bab}	0.912^{Cb}	1.026^{Bb}	1.16^{Ab}
CPY (15%)	5.42^{Aa}	5.23^{Ba}	5.08^{Ca}	0.886^{Bc}	0.96^{Bc}	1.10^{Ac}

PY: papaya yoghurt
CPY: cactus pear yoghurt
$^{(A-B)}$ Different uppercase superscripts represent significant differences in the same rows ($P < 0.05$)
$^{(a-d)}$ Different lowercase superscripts represent significant differences in the same column ($P < 0.05$)

4.5 Reological attributes of fruit flavored yoghurt

Syneresis is the losing out of liquid from yogurt. Syneresis is one of the key quality parameters for yogurt. Higher level of syneresis shows that yogurt is of low quality. The syneresis of yogurts were affected significantly ($P<0.05$) by both fruit concentration and storage time and the changes were shown in Table 6. Syneresis values of different types of yogurt varied from 16.01 to 26.80 percent this result was matched with (Tarakci, 2003). In the first day the highest mean value (26.80%) of syneresis was related to control and the lowest mean value (16.01 %) in sample containing 10% **(**CPP). The addition of fruit pulp caused a decrease of syneresis in all samples of yogurts and the differences between the control and these samples were statistically significant ($P<0.05$). It could be related to the capacity to absorb water by solid that present in fruit which leads to a decrease of syneresis (Mahmood *et al*., 2008).

As shown in Table 6, there were significant differences between the water holding capacity (WHC) of fruit yogurt and control. The higher WHC was obtained for yogurt samples made using CPP (10%). On 1st day, the WHC of 10% CP yogurt was 61.88 % which was 21.46 % higher than that of control yogurt (48.60 %). The average of WHC of fruit yogurt on first day (58.28 %), 5th day (61.56%) and 10th day (63.03%) was found to be statistically higher than that of control yogurt at 48.6%, 51.3% and 52.20 % respectively. Lower WHC or whey separation is referring to a weakness of gel network (Singh and Muthukun 2008). The WHC of cactus pear yogurt was found to be higher than that of papaya yogurt. Nevertheless WHC for all samples increased in whole of storage time; it's due to high total solid of cactus pear in compare to another fruit.

TABLE 6
SYNERSIS AND WATER HOLDING CAPACITY, WHC OF PLAIN AND FRUIT YOGURT DURING STORAGE PERIOD

Sample	Synersis (%)			WHC (%)		
	Storage period / days			Storage period / days		
	0	5	10	0	5	10
Plain yogurt	26.80^{Aa}	26.32^{Aa}	26.02^{Aa}	48.60^{Ce}	51.3^{Be}	52.2^{Ae}
PY (5%)	24.35^{Aab}	22.75^{Ab}	22.15^{Ab}	51.47^{Cd}	55.82^{Bd}	57.00^{Ad}
PY (10%)	22.12^{Ab}	22.00^{Ab}	19.89^{Bc}	54.88^{Bcd}	57.64^{Ac}	58.02^{Ad}
PY (15%)	18.45^{Ac}	18.65^{Ac}	16.02^{Bd}	57.22^{Bc}	60.22^{Abc}	61.42^{Acd}
CPY (5%)	22.28^{Ab}	23.00^{Ab}	22.82^{Ab}	60.02^{Bb}	63.50^{Ab}	63.25^{Ac}
CPY (10%)	20.05^{Ab}	19.88^{Ac}	20.00^{Ab}	61.88^{Cb}	65.21^{Bb}	68.31^{Ab}
CPY (15%)	16.32^{Bd}	17.00^{Ad}	16.01^{Bd}	64.22^{Ca}	67.01^{Ba}	70.21^{Aa}

PY: papaya yoghurt
CPY: cactus pear yoghurt
(a- d) Different uppercase superscripts represent significant differences in the same column ($P < 0.05$)
(A- B) Different lowercase superscripts represent significant differences in the same rows ($P < 0.05$)

4.6 Sensory evaluations of plain and fruit yogurt

Duncan‟s test reveals that there was significant different between control and the different type of yoghurt for appearance and color attribute, the highest values were 8.0, 7.4 and 7.2 for PY (15%), PY (10%) and PY (5%) respectively. Regarding Body and texture attribute there was significant differences between all samples. Regarding flavor attribute that there was significant difference exists for variations control and all treatments, the highest score was (8.0) for PY (15%). Regarding Over all acceptability attribute, the values ranged from 6.8 to 8.1, the highest mean value (8.1) was related to sample containing 15% (PP) and the lowest mean value (6.8) was related to sample containing 5% (CPP). Storage period had slightly effect on all attributes. According to this result papaya yogurt has the most acceptability in point view of consumer.

TABLE 7
SENSORY PROPERTIES OF PLAIN AND FRUIT FLAVORED YOGHURT DURING STORAGE PERIOD

Samples	Appearance and color*			Body and texture*			Flavor*			Over all acceptability*		
	0	5	10	0	5	10	0	5	10	0	5	10
Plain yogurt	6.9^{Ac}	6.8^{Ac}	6.5^{Bb}	7.6^{Aa}	7.0^{Ba}	6.2^{Cb}	7.0^{Ac}	7.2^{Ab}	7.2^{Ab}	7.0^{Abc}	6.5^{Bb}	5.3^{Be}
PY (5%)	7.2^{Ab}	7.2^{Ab}	6.5^{Bb}	7.0^{Ab}	7.0^{Aa}	6.5^{Ba}	7.2^{Ac}	7.1^{Ab}	7.1^{Ab}	7.1^{Abc}	7.0^{Aa}	7.0^{Ab}
PY (10%)	7.4^{Ab}	7.2^{Ab}	6.9^{Ba}	6.9^{Ab}	6.8^{Aa}	6.6^{Ba}	7.5^{Ab}	7.6^{Aa}	7.5^{Aa}	7.6^{Ab}	7.2^{Ba}	7.0^{Bb}
PY (15%)	8.0^{Aa}	7.6^{Aa}	7.0^{Ba}	6.4^{Ac}	6.4^{Ab}	6.0^{Bc}	8.0^{Aa}	7.9^{Aa}	7.6^{Ba}	8.1^{Aa}	7.5^{Ba}	7.5^{Ba}
CPY (5%)	6.8^{Ac}	6.1^{Be}	5.9^{Bc}	6.5^{Ac}	6.4^{Ab}	6.0^{Bc}	6.1^{Ae}	6.0^{Ad}	5.8^{Bd}	6.8^{Ac}	6.2^{Bc}	6.0^{Bd}
CPY (10%)	6.8^{Ac}	6.2^{Be}	6.0^{Bc}	6.5^{Ac}	6.4^{Ab}	6.0^{Bc}	6.5^{Ad}	6.7^{Ac}	6.4^{Ac}	6.8^{Ac}	6.2^{Bc}	6.0^{Bd}
CPY (15%)	6.5^{Ad}	6.4^{Ad}	5.9^{Bc}	6.8^{Ab}	6.8^{Aa}	6.2^{Bb}	6.8^{Acd}	6.6^{Ac}	6.6^{Ac}	7.0^{Abc}	7.0^{Aa}	6.5^{Bc}

PY: papaya yoghurt
CPY: cactus pear yoghurt
(a- d)Different uppercase superscripts represent significant differences in the same column ($P < 0.05$)
(A- B) Different lowercase superscripts represent significant differences in the same rows ($P < 0.05$)
***Judged by a ten member experienced panel using a 10 point scale; 10 is excellent.**

Microbial analysis of plain and fruit flavored yogurt during storage period:

Table 8 revealed that data regarding viable count of colonies of bacterial count in plain and flavored yoghurt treatments. The viable colonies of each treatment were enumerated on 0, 5^{th} and 10^{th} day of storage. It was obvious that the total bacterial count in all fruit yoghurt decreased in proportion to increase percentage of fruit addition. microbial load in control sample was 6.18×10^6CFU/ ml. Total bacterial count of different types of yogurt varied from4.12×10^4 to 3.43×10^6. The decrease in total counts of bacteria maybe attributed to the high content of phytochemicals in papaya and cactus pear pulps (Leong and Shui, 2002).Also, it could be observed that the yoghurt contains15%papaya pulp had the lowest microbial load (4.12×10^4CFU/ ml) compared with the same percentage addition of cactus pear (1.71×10^6CFU/ ml), it may be due to papaya pulp contains more phenolic compound (268.80 mg EGA /100g) than cactus pear pulp (45.0 mg EGA /100g),Table (2).It was observed that there was an increase in number of bacteria during storage conditions in each treatment. Data represented in Table 8 showed that, all treatments and control yoghurt were free from Coliform group, mould and yeast either in fresh or stored product

TABLE 8
EFFECT OF FRUIT PULPS ON TOTAL VIABLE COUNT, COLIFORM BACTERIA AND YEAST & MOULD (CFU/ML) OF YOGHURT DURING STORAGE PERIODS.

Properties	Storage period (day)			
	Treatments	0	5	10
TBC	Plain yogurt	6.18×10^{6Aa}	6.85×10^{6Aa}	7.82×10^{6Aa}
	PY (5%)	7.21×10^{5Bc}	7.90×10^{5Ac}	8.01×10^{5Ac}
	PY (10%)	1.24×10^{5Bd}	1.40×10^{5Ad}	1.60×10^{5Ad}
	PY (15%)	4.12×10^{4Ae}	4.32×10^{4Ae}	4.68×10^{4Ae}
	CPY (5%)	3.43×10^{6Ba}	3.64×10^{6Aa}	4.01×10^{6Aa}
	CPY (10%)	3.12×10^{6Ba}	3.24×10^{6Aa}	3.74×10^{6Aa}
	CPY (15%)	1.71×10^{6Cb}	2.01×10^{6Bb}	2.85×10^{6Ab}
Coliform	Plain yogurt	Nil	Nil	Nil
	PY (5%)	Nil	Nil	Nil
	PY (10%)	Nil	Nil	Nil
	PY (15%)	Nil	Nil	Nil
	CPY (5%)	Nil	Nil	Nil
	CPY (10%)	Nil	Nil	Nil
	CPY (15%)	Nil	Nil	Nil
Mould&Yeast	Plain yogurt	Nil	Nil	Nil
	PY (5%)	Nil	Nil	Nil
	PY (10%)	Nil	Nil	Nil
	PY (15%)	Nil	Nil	Nil
	CPY (5%)	Nil	Nil	Nil
	CPY (10%)	Nil	Nil	Nil
	CPY (15%)	Nil	Nil	Nil

PY: papaya yoghurt
CPY: cactus pear yoghurt
[(a- d)] Different uppercase superscripts represent significant differences in the same column ($P < 0.05$)
[(A- B)] Different lowercase superscripts represent significant differences in the same rows ($P < 0.05$)

V. CONCLUSION

There were differences in physical, chemical and sensory properties of fruit-additives yoghurt compare to control. 15% w/w fruit additives increased acceptability of yoghurt. Panelist preferred papaya added yoghurt compare to other samples. Fruit additions have an increasing effect on yoghurt consumption. Also, using different fruit additives give more yoghurt choices to the consumers in the market.

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