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QUALITY OF YOGHURT MADE FROM COW'S MILK SUPPLEMENTED WITH WHEY PROTEINS

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ABSTRACT: *Effect of supplementing cow's milk that used in making yoghurt with either whey protein isolate or whey protein hydrolysate were studied. control yoghurt treatment was made from 3.0%fat cow's milk that was fortified with 3.0% skim milk powder. Another 8 yoghurt treatments were made by supplementing fortified cow's milk with 0.75 , 1.5 , 2.25 and 3% with either whey protein isolate or whey protein hydrolysate and stored at 6°C for 12 days. Supplementing with whey protein isolate or hydrolysate did not affect significantly (p>0.05) fat contents of yoghurt treatments. Protein , total solids and ash content increased significantly ($p \leq 0.05$)by adding whey protein isolate and hydrolysate and this increase was proportional to the rate of supplementation, while there were no significant differences ($p > 0.05$) between corresponding yoghurt treatments made with either whey protein isolate or hydrolysate. Adding whey protein isolate and hydrolysate did not affect significantly ($p > 0.05$) titratable acidity. Increasing the rate of adding whey protein isolate and hydrolysate caused a significant ($p \leq 0.05$) increase in total volatile fatty acids and diacetyl and acetyl methyl carbinol. Supplementation with whey protein isolate and hydrolysate caused a significant reduction in whey syneresis. On the other hand , curd tension of yoghurt increased by adding 3.0% of whey protein isolate and hydrolysate. Yoghurt treatments those made by adding 3.0% whey protein isolate and whey protein hydrolysate were the most acceptable yoghurt treatments, and were not significantly different from yoghurt treatments those made by adding 0.75 and 1.5% whey protein isolate and hydrolysate.*

Key words: *Whey protein isolate – whey protein hydrolysate – yoghurt – cow's milk yoghurt – supplementation.*

INTRODUCTION

In recent years the consumption of yoghurt has been increased rapidly owing to the fact that it fulfils many current dietary needs. Consumption of yoghurt has been reported to exert a number of health benefits like increased bone mineralization, gut associated immune responses and laxation. Furthermore, yoghurt has proved to be an excellent vehicle for the production of functional foods, especially those containing probiotic bacteria. One major characteristic of yoghurt, which distinguishes it from many other foods, is the presence of beneficial lactic acid bacteria. The fermentation of the milk by lactic acid bacteria releases a large number of peptides and amino acids with varying biological actions such as angiotensin- converting enzyme (ACE) inhibitory, immune modulatory and antioxidant activities. (Meance *et al.*, 2003and Nielsen *et al.*, 2009).Yoghurt has also been shown to be a good matrix for enrichment with omega-3 fatty acids (Nielsen *et al.*, 2007). In contrast to omega-3 enriched milk, yoghurt enriched with omega-3 fatty acids had a very good oxidative stability (Let, *et al.*, 2007). As there is no difference in gross composition between yoghurt and milk, which could explain the high oxidative stability of yoghurt, it is assumed that compounds liberated during fermentation, namely peptides and free amino acids play a significant role. It has been reported that free amino acids are formed during fermentation of yoghurt and it is well known that some free amino acids possess antioxidative properties. (Farvin *et al.*, 2010)

Whey protein concentrates are commonly used as ingredients in numerous foods because of their excellent technological functionality and high nutritional value. They are applied in liquid food preparations as textural ingredients to increase firmness or cause gel formation after heating. In addition, several sources have suggested specific physiological properties of whey protein. (Patocka, *et al.*,2004) Undenatured whey protein is now being investigated as a dietary aid for enhancement of immune status through intracellular glutathione synthesis. (Middleton *et al.*, 2003). Adding nutraceutical (nutritional and pharmaceutical) ingredients such as native whey proteins to the yoghurt has been reported. Whey protein products offer several benefits to yoghurt formulations. Addition of 2% whey protein concentrate (WPC) instead of 2% skim milk powder (SMP) has been shown to lead to improve consistency of set-style yoghurt (Guggisberg, *et al.*, 2004), while strengthening of the three-dimensional gel network is achieved by heat treatment of the whey protein (Lucey, *et al.*, 1998; Remeuf, *et al.*, 2003). Lucey *et al.* (1998) have suggested that denatured whey proteins aggregate with casein micelles during the acidification of heated milk. Without adequate heat treatment whey proteins are not able to assist in strengthening the network. Patocka, *et al.* (2004) and Patocka, *et al.* (2006) reported that textural effects of soluble whey protein isolate (WPI) added to stirred yoghurt after fermentation. The native WPI was added to a commercial stirred yoghurt at different concentrations (2–10%) as a nutraceutical rather than as a technological ingredient. Although the apparent viscosity of the fortified yoghurt decreased at WPI concentrations of 2–8%, at an addition level of 10% WPI in the stirred yoghurt the apparent viscosity increased. Three factors seem to have a major contribution on the yoghurt structure: the heat treatment/homogenization of the milk base (casein/whey protein ratio), the starter culture, and technological influences such as temperature, pressure, valves and the shear history (Sodini, *et al.*, 2004). Solak and Akin (2012) reported that the potential benefits of whey proteins have been a subject of growing commercial interest in the context of health-promoting functional foods. Whey proteins can be incorporated in the form of ingredients in functional and novel foods, dietary supplements and even pharmaceuticals with the purpose of delivering specific health benefits. As a result, it can be used as a basic compound of functional foods, nutraceuticals and dietary supplements. The intake of some whey protein and food with whey constituents due to health promoting and nutrition value. As the findings of some studies showed, they display regulatory functions besides their nutritional roles. Also, they can widely used in food as an ingredient because of their functionality including gelation, emulsification, chelating agent, antioxidant activity, foaming, thermal stability, solubility, flavor binding and water-binding capacity.

The objectives of this study were to evaluate the possibility of making a good quality yoghurt that made from cow's milk by supplementation with whey protein isolate and whey protein hydrolysate, study the chemical, rheological and sensory quality of yoghurt and to monitor the changes during storage of yoghurt.

MATERIALS AND METHODS

Bacterial strains and culture:

Active *Streptococcus thermophilus* (EMCC 1043) and *Lactobacillus delbrueckii subsp. bulgaricus* (EMCC 1102) were obtained from Cairo Mircen, Ain Shams University, Egypt. *Lactobacillus bulgaricus* and *Streptococcus thermophilus* were activated individually by three successive transfers in sterile 10% reconstituted skim milk powder.

Yoghurt manufacture

Fresh cow's milk was obtained from the herd of Faculty of Agriculture, Minoufia University, Shibin El-kom, Egypt. Milk was standardized to 3% fat. Preliminary experiment showed that the best yoghurt quality was made by supplementing cow's milk with 3.0% skim milk powder. 3.0% fat

cow's milk was supplemented with 3.0% skim milk powder (Dairy America, California, USA). That milk was divided into 9 batches. One batch was served as control yoghurt. Another four batches were supplemented with 0.75, 1.5 , 2.25 and 3.0% whey protein isolate (LACPRODAN DI-9224) (T_2, T_3, T_4 and T_5 respectively). The other four batches were supplemented with 0.75, 1.5 , 2.25 and 3.0% whey protein hydrolysate (LACPRODAN DI-3065) (T_6, T_7, T_8 and T_9 respectively). Whey protein isolate (LACPRODAN DI-9224) and whey protein hydrolysate (LACPRODAN DI-3065) were gratefully obtained from Arla ingredients group, Denmark. Non –fat dry milk , whey protein isolate and whey protein hydrolysate were added to milk and stirred thoroughly, then filtered through cheese cloth. All treatments were heated to 85°C for 20 min, then cooled to 42 °C and inoculated with 1.5% *Streptococcus thermophilus* and 1.5% *Lactobacillus delbrueckii subsp. bulgaricus*. The inoculated batches were packed in plastic cups and incubated at 42 °C for 3.0 - 3.5 hrs. until complete coagulation. All yoghurt treatments were stored in refrigerator (6 ±1 °C) in refrigerator for 12 days and were sampled when fresh and at 3,6,9 and 12 days for chemical , rheological analysis and sensory evaluation. The whole experiment was triplicated.

Analytical Methods:

1- Chemical analysis:

pH values and titratable acidity was determined according to Ling (1963), while total solids, ash and total protein were determined according to the methods described by (A.O.A.C, 2012). Diacetyl and acetyl methyl carbinol (DA+AMC) were determined according to the mothod of Brandel (1960). The method of Kosokowski (1982) was used to determine the total volatile fatty acids (TVFA).

2- Rheological properties:

Synerasis was determined according to the method of Dannenberg and Kessler (1988) with slight modification. One hundred grams of yoghurt in plastic cups was cut into four sections and transferred into funnel fitted with 120 mesh metal screen. The whey was drained into a graduated cylinder. The amount of whey drained off was measured after 15, 30, 45,60, and120 min at room temperature (20 + 1°C) for one day yoghurt and after 120 min for yoghurt stored for 3, 6, 9 and 12 days.

Curd tension of yoghurt was assessed using non destructive Effagi firmness measurements (Effagi , Albonsine, Italy). The penetration depth was 50 mm using a stainless steel plunger flat ended with diameter of 5 mm. five readings were taken for each yoghurt treatment.

Sensory evaluation:

Yoghurt was assessed according to Kebary and Hussein (1999) by ten panelists from the Staff of Dairy Science and Technology Department, and Food Science and Technology Department, Faculty of Agriculture, Minoufia University. Using the following score points: flavor (45 points), acidity(10 points), body and texture (35 points) and appearance (10 points).

Statistical analysis:

Factorial design 2×3 and completely randomizes design were used to analyze all data and student. Newman-Keuls' Test was followed to make the multiple comparisons (Steel and Torrie, 1980) using Costat Program. Significant differences were determined at $P \leq 0.05$.

RESULTS AND DISCUSSION

Change in titratable acidity of yoghurt are shown in Table (1). Titratable acidity of all yoghurt treatments increased gradually ($p \leq 0.05$) as storage period progressed (Tables 1,6). These results are in agreement with those of Herby and El-Sabie (2001), Badawi *et al.* (2004), Kebary *et al.*(2009), Farag *et al.*(2010), Hamed *et al.*(2010) and Kebary *et al.*(2010). Adding whey protein isolate or whey protein hydrolysate to yoghurt treatments caused no significant ($p > 0.05$) changes in acidity, which means that neither the type of whey protein nor the amount added from whey protein had significant ($p > 0.05$) effect on the titratable acidity of yoghurt treatments at any time of storage

Table (1): Effect of adding whey protein on titratable acidity and pH value of resultant yoghurt during storage period.

Treatments*	Titratable Acidity %					pH value				
	Storage period (days)					Storage period (days)				
	1	3	6	9	12	1	3	6	9	12
T_1*	0.87	0.97	1.08	1.17	1.25	4.69	4.61	4.50	4.48	4.33
T_2	0.87	0.98	1.11	1.19	1.26	4.64	4.58	4.50	4.40	4.31
T_3	0.88	0.98	1.14	1.22	1.28	4.65	4.60	4.51	4.39	4.32
T_4	0.89	0.97	1.12	1.26	1.27	4.66	4.61	4.55	4.40	4.30
T_5	0.90	0.98	1.10	1.23	1.26	4.66	4.60	4.56	4.41	4.30
T_6	0.88	0.99	1.11	1.19	1.30	4.65	4.61	4.47	4.42	4.28
T_7	0.91	1.02	1.12	1.25	1.31	4.68	4.59	4.46	4.41	4.25
T_8	0.92	1.03	1.13	1.27	1.29	4.68	4.57	4.45	4.42	4.26
T_9	0.92	1.03	1.14	1.25	1.27	4.69	4.59	4.48	4.40	4.26

*T_1 :yoghurt treatment made with adding 3.0% non-fat dry milk.
T_2 T_3 T_4 T_5: yoghurt treatments made by adding 3.0% non-fat dry milk and 0.75,1.5,2.25 and 3.0% whey protein isolate, respectively.
T_6 T_7 T_8 T_9: : yoghurt treatments made by adding 3.0% non-fat dry milk 0.75,1.5,2.25 and 3.0% whey protein hydrolysate, respectively.

period (Tables 1, 6). Similar trends were reported by Kebary *et al.* (2008) and Kebary *et al.* (2009).

pH values of all yoghurt treatments as affected by supplementing with whey protein isolate and hydrolysate to and storage period followed contradictory trends to that of the acidity.

Total solids content of yoghurt treatments increased significantly ($p \leq 0.05$) by adding either whey protein isolate or whey protein hydrolysate (Tables 2, 6). This increase was proportional with the rate of supplementation with whey proteins. Similar results were obtained by Abd El-Baky *et al.*(1981) and El-Neshawy and El-Safhie (1988). Total solids content of all yoghurt treatments did not change significantly ($p > 0.05$) during storage period (Table 2). These results are in agreement with those reported by Farag *et al.* (2010), Hamed *et al.* (2010) and Kebary *et al.* (2010).

There were no significant ($p > 0.05$) differences among yoghurt treatments in fat content (Tables 2, 6) these results suggested that the supplementation with either whey protein isolate or whey protein hydrolysate did not exhibit significant effect ($p > 0.05$) on fat content of the resultant yoghurt treatments, these results are in accordance reported by Badawi *et al.*(2008) and Kebary *et al.*(2008).on the other hand fat content of all yoghurt treatments did not change significantly ($p > 0.05$) as storage period progressed (Tables 2, 6). These results are in agreement with those reported by Farag *et al.* (2010), Hamed *et al.* (2010) and Kebary *et al.* (2010).

Supplementing cow's milk with whey protein isolate and hydrolysate caused a significant ($p \leq 0.05$) increase in total protein content of the resultant yoghurt. This increase was proportional to the rate of supplementation (Tables 2, 6). Yoghurt treatments T_5 and T_9 contained the highest total protein content. These results could be attributed to the higher protein content of whey protein isolate and whey protein hydrolysate. There were no significant differences among corresponding yoghurt treatments made with either whey protein isolate nor whey protein hydrolysate, which means that total protein content was not significantly affected ($p > 0.05$) with the type of whey protein. Total protein content of all yoghurt treatments did not change significantly ($p > 0.05$) as storage period advanced (Table 2). Similar results were reported by Khader (1994) and Kebary *et al.* (2009).

Supplementation of yoghurt treatments made with cow's milk with whey protein isolate and hydrolysate caused an obvious ($p \leq 0.05$) increase in ash content compared with control yoghurt treatment. This increase was proportional to the rate of supplementation (Tables 3, 6). Ash content of yoghurt treatments made with adding whey protein isolate were not significantly different ($p > 0.05$) from those made with whey protein hydrolysate . Ash content of all yoghurt treatments did not change significantly ($p > 0.05$) as storage period advanced (Table 3). These results are in agreement with those of Kebary and Hussein (1999) and Ibrahim *et al.* (2001).

Total volatile fatty acids increased significantly ($p \leq 0.05$) in yoghurt treatments as cold storage proceeded (Tables 3, 6). Similar results were reported by Kebary *et al.* (2007), Badawi *et al.* (2008) and El-Sonbaty *et al.* (2008). TVFA of all yoghurt treatments increased slightly during the first nine days of storage period, while they increased significantly ($p \leq 0.05$) during the last three days of storage period. This could be attributed to the lipase activity of lactic acid bacteria. These results are in accordance with those reported by Rastic and Karman (1978). Supplementation with whey protein isolate and hydrolysate at 3.0% increased ($p \leq 0.05$) the TVFA content in resultant yoghurt treatments (Table 3). These results might be due to the stimulation effect of whey protein on the growth of lactic acid bacteria and subsequently increasing the lipase activity. (Bury *et al.* 1998 and Bu *et al.* 2010).

Supplementation of yoghurt made from cow's milk with whey protein isolate and whey protein hydrolysate caused a significant ($p \leq 0.05$) increase in diacetyl and

Table (2): Effect of adding whey protein on fat content, total solids content and total protein of yoghurt during storage period.

Treatments*	Total solids content %					Fat content %					Total protein content %				
	Storage period (days)					Storage period (days)					Storage period (days)				
	1	3	6	9	12	1	3	6	9	12	1	3	6	9	12
T_1*	14.50	14.35	14.56	14.60	14.55	3.0	3.1	3.0	3.1	3.0	3.18	3.20	3.23	3.25	3.25
T_2	16.30	16.30	16.20	16.20	16.30	3.1	3.0	3.1	3.0	3.1	5.23	5.23	5.24	5.24	5.27
T_3	16. 69	16.79	16.81	16.78	16.82	3.0	3.0	3.0	3.0	3.0	5.75	5.80	5.80	5.79	5.85
T_4	18.59	18.70	18.50	18.80	18.85	3.0	3.1	3.0	3.1	3.0	6.23	6.20	6.25	6.23	6.24
T_5	19.96	19.97	19.92	19.90	20.10	3.0	3.0	3.0	3.0	3.0	6.79	6.81	6.83	6.78	6.84
T_6	16.25	16.27	16.26	16.55	16.56	3.0	3.1	3.0	3.1	3.0	5.25	5.29	5.29	5.29	5.30
T_7	16.96	16.90	16.87	16.95	16.79	3.1	3.0	3.1	3.0	3.1	5.59	5.58	5.59	5.61	5.68
T_8	17.77	17.69	17.90	18.10	18.12	3.1	3.0	3.1	3.0	3.1	6.20	6.21	6.27	6.25	6.20
T_9	18.86	18.83	18.85	18.89	18.83	3.0	3.1	3.0	3.1	3.0	6.76	6.78	6.75	6.77	6.81

* See Table (1)

Table (3): Effect of adding whey protein on ash content, total volatile fatty acids (TVFA) and diacetyl and acetyl methyl carbinol (DA+AMC) of yoghurt during storage period.

Treatments*	Ash content %					TVFA content (ml NaOH 0.1 N / 100gm)					Diacetyl and acetyl methyl carbinol				
	Storage period (days)					Storage period (days)					Storage period (days)				
	1	3	6	9	12	1	3	6	9	12	1	3	6	9	12
T_1*	0.96	0.97	9.98	0.98	0.99	14.10	14.50	16.10	18.10	19.01	21.79	26.44	29.98	27.23	23.52
T_2	0.99	1.01	1.00	0.98	0.99	14.20	15.10	17.30	18.20	19.30	28.45	32.16	32.67	31.49	26.72
T_3	1.01	1.02	1.02	1.07	1.08	15.10	15.50	17.10	18.00	19.30	32.32	36.01	36.96	35.61	30.99
T_4	1.05	1.01	0.99	1.02	1.02	15.20	16.00	16.50	18.00	19.00	32.51	36.58	39.93	38.67	31.79
T_5	1.11	1.09	1.10	1.12	1.09	15.95	16.20	17.10	18.90	19.95	35.29	39.16	40.19	40.25	32.72
T_6	0.99	1.00	0.99	0.98	1.00	14.50	15.20	16.90	17.80	18.50	30.91	34.27	37.71	35.55	28.11
T_7	1.02	1.01	1.02	1.01	1.02	14.90	15.50	16.90	18.10	19.10	33.63	36.81	37.77	35.11	31.61
T_8	1.05	1.04	1.03	1.05	1.04	15.10	16.10	16.70	17.90	19.20	34.50	39.11	40.33	38.55	32.11
T_9	1.11	1.12	1.08	1.09	1.10	16.11	16.20	17.20	18.10	19.90	39.19	41.79	45.75	44.51	33.95

* See Table (1)

acetyl methyl carbinol content (DA + AMC) and this increase was proportional to the amount of added whey protein isolate and hydrolysate (Table 3). It was found that yoghurt treatments made with adding whey protein hydrolysate contained higher diacetyl and acetyl methyl carbinol content than those,made with whey protein isolate. These results might be due to the presence of some constituents (short-chained peptides) in whey protein hydrolysate which stimulate the production of DA and AMC).The diacetyl and acetyl methyl carbinol content of all yoghurt treatments increased gradually ($p \leq 0.05$) and reached their maximum values at 6th day of storage, then decreased up to the end of storage period (12 days) (Table 3). Similar trends were obtained by Salama (2001), Zedan *et al.*(2001), Talwalkar and Kailasapathy (2004), Badawi *et al.*(2008) and El-Sonbaty *et al.*(2008). The decrease of diacetyl and acetyl methyl carbine during storage period may be due to the reduction of these compounds to aceton (Cogan, 1974).

Syneresis from all yoghurt treatments decreased gradually ($p \leq 0.05$) as storage period advanced and reached their minimum values at the 6th day of storage period, then increased up to the end of storage period (Tables 4, 6). These results were in agreement with those reported by Farooq and Haque (1992), Kebary and Hussein (1999) and Kebary *et al.* (2009). Supplementation with whey protein isolate and whey protein hydrolysate to yoghurt made with cow's milk caused a pronounced ($p \leq 0.05$) reduction of whey syneresis (Tables 4, 6). There was negative correlation between the rate of supplementation and whey syneresis. These results were reported by Kebary and Hussein (1999), Guggisberg *et al.*(2009) and Hamed *et al.* (2010). These results might be due to addition of whey protein which lead to form complex with casein micelles and prevent them from excessive fusion and form a fine meshed gel network which is less susceptible to whey separation and/ or increasing in the water hold capacity (Danneberg and Kessler, 1988). There were no significant ($p > 0.05$) between treatments of yoghurt supplemented with whey protein isolate and whey protein hydrolysate. These results might be due to the highest water holding capacity of either whey protein isolate nor hydrolysate.

Supplementation of yoghurt made with cow's milk with either whey protein isolate or whey protein hydrolysate increased the curd tension of the resultant yoghurt treatments. Curd tension increased by increasing the rate of adding whey protein (Table 4). Yoghurt treatments made with whey protein isolate were not significantly different from those of corresponding yoghurt treatments made with whey protein hydrolysate. These results might be due to the higher protein content of whey protein isolate and hydrolysate that might trend the form of strong curd. These results were reported Patocka *et al.*, 2006 and Ko and Kwak,2009.

Scores of organoleptic properties (flavor, body &texture, appearance and acidity) of yoghurt treatments are presented in (Tables 5, 6). There were significant ($p \leq 0.05$) differences among yoghurt treatments in acidity, appearance and body &texture scores in the resultant yoghurt treatments (T_5 and T_9) compared with control yoghurt treatment (Table 5). While scores of flavor and total scores were not significantly ($p > 0.05$) different from control yoghurt treatments . Supplementation with either whey protein isolate or whey protein hydrolysate at the rate of 3.0% were the most acceptable treatments of the resultant yoghurt. On the other hand organoleptic scores of all yoghurt treatments did not change significantly ($p > 0.05$) up to the sixth day of storage period, then decreased as storage period progressed (Zedan *et al.*,2001; Kebary *et al.*,2004; Kailasapathy, 2006; Kebary *et al.*,2008 and ; Kebary *et al.*,2010).

It could be concluded that the supplementation of yoghurt made from cow's milk with whey protein isolate and hydrolysate did not affect significantly fat content and acidity. Yoghurt treatments made by adding 3% of whey protein isolate and hydrolysate were the most acceptable yoghurt treatments and were not significantly different from each other.

Table (4):Effect of adding whey protein on some rheological properties of yoghurt treatments during refrigerated storage period

Treatments*	Whey Syneresis %					Curd Tension(mm/100 gm)
	Storage period (days)					
	1	3	6	9	12	
T_1*	49	40	38	39	41	21
T_2	39	32	30	32	35	23
T_3	28	22	19	20	21	27
T_4	25	20	14	16	19	29
T_5	20	15	12	15	18	33
T_6	38	31	28	29	30	22
T_7	30	26	23	24	25	25
T_8	28	23	19	20	22	28
T_9	19	15	10	14	16	30

* See Table (1)

Table (5): Effect of adding whey protein on total organoleptic properties score of resultant yoghurt during storage period.

Treatments*	Organoleptic Properties																								
	Flavour (out of 45)					Body and Texture (out of 35)					Acidity (out of 10)					Appearance (out of 10)					Total (100 Score)				
	1	3	6	9	12	1	3	6	9	12	1	3	6	9	12	1	3	6	9	12	1	3	6	9	12
T_1	44	44	43	43	44	34	34	33	33	34	9	8	9	8	8	8	8	9	9	9	95	94	94	93	95
T_2	44	44	43	43	43	34	32	34	33	33	8	9	8	8	8	9	9	9	9	9	95	94	94	93	93
T_3	43	43	43	43	42	34	34	33	33	33	9	7	8	8	8	9	8	9	9	9	95	92	93	93	92
T_4	43	44	44	42	41	33	33	34	33	34	9	8	9	7	7	9	8	9	9	9	94	93	96	91	91
T_5	43	42	43	43	44	33	33	33	34	33	8	8	9	8	7	9	9	9	9	9	93	92	94	94	93
T_6	40	44	42	44	44	30	32	33	34	31	9	8	8	7	7	8	8	8	9	9	87	92	91	94	91
T_7	40	44	43	42	40	32	33	31	33	31	8	7	7	7	7	8	9	7	8	7	88	93	88	90	85
T_8	40	42	41	41	39	30	30	33	31	33	8	8	7	6	6	8	6	9	7	7	86	86	90	85	85
T_9	43	40	42	43	42	34	33	34	33	34	7	7	7	6	6	9	8	9	8	8	93	88	92	90	90

* See Table (1)

Table (6). Statically analysis of resultant yoghurt properties.

Properties of yoghurt•	Effect of treatments										Effect of storage period (days)					
	Mean squares	Multiple comparisons♦									Means squares	Multiple comparisons♦				
		T_1	T_2	T_3	T_4	T_5	T_6	T_7	T_8	T_9		1	3	6	9	12
Titratable acidity (%)	0.028	A	A	A	A	A	A	A	A	A	2.459*	E	D	C	B	A
pH value	0.033	A	A	A	A	A	A	A	A	A	0.213*	A	C	B	D	E
Total solids (%)	31.279*	E	D	C	B	A	D	C	B	A	2.381	A	A	A	A	A
Fat (%)	0.012	A	A	A	A	A	A	A	A	A	0.011	A	A	A	A	A
Total protein (%)	1.089*	E	D	C	B	A	D	C	B	A	0.059	A	A	A	A	A
Ash (%)	0.048*	B	B	B	B	A	B	B	B	A	0.039	A	A	A	A	A
TVFA	0.791*	C	B	B	B	A	C	B	B	A	52.701*	E	D	C	B	A
DA + AMC (µg/100 ml)	173.858*	I	H	F	D	B	G	E	C	A	180.632*	C	B	A	B	D
Syneresis (%)	573.5*	A	BC	CD	CD	D	B	BC	BC	D	369.7*	A	B	E	D	C
Curd tension	33.75*	E	D	CD	BC	A	D	BC	AB	A						
Organoleptic properties																
Flavour	9.949*	D	C	C	A	A	C	B	BC	AB	33.252*	A	A	B	C	CD
Body & Texture	8.275*	A	C	BC	AB	AB	C	B	C	A	15.693*	A	AB	B	BC	C
Appearance	108.03*	C	CB	B	A	A	C	B	B	A	56.961*	A	A	B	C	CD
Acidity	3.103*	D	C	B	A	A	B	CB	B	A	25.648*	A	A	AB	C	C
Total	134.099*	D	C	B	AB	A	C	CB	B	A	26.733*	AB	A	AB	B	C

• See Table (1).

♦ Each different letter (in the same row) means that multiple comparison are different from each other letter. A is the highest mean followed by B, C, ... Etc.

* Significant at 0.05

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تأثير تدعيم اللبن البقري بواسطة بروتينات الشرش على جودة اليوجورت

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الملخص العربي

يهدف هذا البحث لدراسة تأثير تدعيم اللبن البقري المستخدم في صناعة اليوجورت بواسطة بروتين الشرش المعزول(WPI) ,وبروتين الشرش المحلل (WPH) على صفات اليوجورت الناتج. لذلك فقد تم تصنيع ٩ معاملات من اليوجورت حيث تم تصنيع العينة الكنترول من اللبن بقري المحتوى على ٣% دهن وتم تدعيمه بإضافة ٣% لبن فرز مجفف.

وقد تم تصنيع ٨ معاملات من نفس نوع اللبن السابق مع اضافة إما باضافة بروتينات الشرش المعزول أو بروتينات الشرش المحلل بنسب ٠,٧٥ و ١,٥ و ٢,٢٥ و ٣% على التوالي. وقد تم تخزين كل المعاملات على درجة حرارة الثلاجة لمدة ١٢ يوم. ولقد أوضحت النتائج المتحصل عليها بعد تحليلها إحصائيا:

- أدى تدعيم اللبن البقري بواسطة كل من WPI، WPH إلى زيادة قيم كل من الداي اسيتيل والاسيتايل ميثيل كربينول والاحماض الدهنية الكلية الطيارة TVFA ونسبة البروتين الكلي ونسبة الرماد ونسبة الجوامد الصلبة الكلية وقوة الخثرة، بينما انخفضت نسبة انفصال الشرش، في حين لم يؤثر التدعيم على نسب كل من الحموضة والـ pH والمحتوى من الدهن.
- ازدادت نسبة الحموضة و TVFA باستمرار التخزين، بينما انخفضت نسبة الـ pH ، في حين لم يؤثر التخزين على نسب كل من الجوامد الصلبة الكلية والبروتين الكلي والدهن والرماد.
- ازدادت نسبة الداي اسيتيل والاسيتايل ميثيل كربينول بتقدم فترة التخزين حتى اليوم السادس حيث انخفضت بعد ذلك ، وعلى العكس من ذلك انخفض انفصال الشرش بتقدم فترة التخزين حتى اليوم السادس ثم ازداد بعد ذلك.
- ازدادت درجات التحكيم لصفات اليوجورت المختلفة بإضافة كل من بروتين الشرش المعزول وبروتين الشرش المحلل ، وكانت أحسن المعاملات وأكثرها قبولا تلك العينات التي صُنّعت بإضافة ٣٪ من كل من بروتين الشرش المعزول وبروتين الشرش المحلل.