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QUALITY OF YOGHURT MADE FROM COW'S MILK FORTIFIED WITH WHEY PROTEIN ISOLATE
BY

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SUMMARY

Five yoghurt treatments were made to study the effect of fortifying cow's milk with whey protein isolate on the quality of yoghurt, control yoghurt was made by adding 3% non-fat dry milk to cow's milk while the other four treatments were made by fortifying cow's milk with 0.5, 1.0, 1.5 and 2.0% whey protein isolate respectively and 3.0% nonfat dry milk to each treatment. All yoghurt treatment was stored in refrigerator for 12 days and was sampled when fresh and at 3, 6, 9 and 12 days for chemical, rheological, microbiological analysis and sensory evaluation. The obtained results indicated that adding whey protein isolate to cow's milk caused a significant increase of total solids, total protein, ash contents and titratable acidity, while decreased pH values and whey syneresis of yoghurt treatments and these effects were proportional to the rate of adding whey protein isolate. Also, the values of Hardness, adhesiveness, cohesiveness, springiness and gumminess of the resulting yoghurt had increased and this increase was proportional to the rate of fortification. Adding whey protein isolate up to 1.5% increased the scores of organoleptic properties and treatment that made with adding 1.5% whey protein isolate was the most acceptable yoghurt treatments. Total solids, total protein, ash and fat contents of all yoghurt treatments did not change significantly, ($P > 0.05$) during storage period, while titratable acidity increased. Whey separation decreased during storage period up to the sixth day of storage period then increased up to the end of storage period, while the scores of organoleptic properties were almost stable up to the ninth day of storage period.

Key words: Cow's milk, non-fat dry milk, whey protein isolate, yoghurt, syneresis, organoleptic properties.

INTRODUCTION

Yoghurt is the most popular fermented milk produced all over the world. Supplementing yoghurt with probiotic bacteria and prebiotics increased the health and nutritional benefits of yoghurt. Recently the production and consumption of yoghurt has been increased tremendously in Egypt. The nutritional importance of yoghurt is based not only on the nutritive value of the milk from which it is made and the chemical changes of milk components occurring during fermentation but also some beneficial effects such as prophylactic and healing (Birollo *et al*., 2000; Ayar *et al*., 2006; Chandan, 2006 and Shah, 2007). There is large quantity of whey are produced during cheese making, whey was considered the most important pollutant of the dairy industry. Most of whey produced in Egypt was discharged directly into the sewage system, but according to the Egyptian environmental low that was issued recently, dairy effluents should be treated before its drainage into the sewage system. Therefore, recovery of whey proteins which represent 20 % of milk proteins can be very important. Whey protein products have been used in the manufacture of many dairy and nondairy products because of their valuable health and technological benefits. Whey proteins can be used as an emulsifying, thickening, gelation, foaming, and water binding agent resulting in manufactured products with similar and desired characteristics compared to those produced with classical ingredients.

In view of a for mentioned the objective of this study were to investigate the possibility of making a good quality yoghurt that made from cow's milk using whey protein isolate and monitor the changes of chemical, microbiological and organoleptic properties during cold storage.

MATERIALS AND METHODS

Materials:

Bacterial strains

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

Manufacture of yoghurt

Fresh cow's milk was obtained from the herd of agricultural secondary school, Shibin El-kom, Egypt. Fresh cow's milk was standardized to 3% fat. The preliminary experiment showed that the best yoghurt quality was made by supplementing cow's milk with 3.0% nonfat dry milk. Standardized (3.0 % fat) cow's milk was fortified with 3.0 % non-fat dry milk. This milk was divided into 5 treatments. These treatments were fortified with 0.0, 0.5, 1.0, 1.5, and 2.0 % whey protein isolate (C, T1, T2, T3 and T4, respectively). Non-fat dry milk (Dairy America, California, USA) and whey protein isolate (Arla Food Ingredients, Skander, Denmark) were added to milk and stirred thoroughly, then filtered through cheesecloth. All milk batches 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 until complete coagulation. All yoghurt treatments were stored in a refrigerator (6°C±1) for 12 days and were sampled when fresh and at 3, 6, 9 and 12 days for chemical, microbiological, rheological analysis and sensory evaluation. The whole experiment was triplicated.

Microbiological analysis:

The total bacterial counts were determined using standard plate count agar (Marth, 1978). Streptococci were enumerated on yeast lactose agar medium (Skinner and Quensel, 1978). Lactobacilli were determined using MRS agar medium (De man *et al*., 1960). Moulds and yeasts were enumerated on Potato Dextrose agar (acidified) medium (Difco, 1953).

Chemical analysis:

pH value, titratable acidity and fat content were determined according to A.O.A.C(2012), while total solids, ash and total protein were determined according to A. O. A. C (2012).

Rheological properties:

Synerasis was determined according to the method of Danneberg and Kessler (1988) with slight modification. One hundred grams of yoghurt in plastic cup were cut into four sections and transferred into funnel fitted with 120 mesh metal screen. The amount of whey drained into a graduated cylinder was measured after 120 min. at room temperature (20 ± 1°C) for all yoghurt treatments stored for 1, 3, 6, 9 and 12 days.

Textural parameters are determined using Texture Analyzer TMS-Pro (Food Technology Corporation, sterling, Virginia, USA). equipped with (250lbf) load cell and connected to a computer programmed with Pro™ texture analysis software (program, DEV TPA withhold). The texture of yoghurt samples was evaluated in triplicate of each batch of a set yoghurt sample prepared in a 100-ml cup at a temperature of 4°C. A flat rod probe was subjected to two subsequent cycles (bites) of compression-decompression. The probe used in "Texture Profile Analysis" (TPA) was 49.95 mm. diameter, double compression test to penetrate 50% depth, at speed of 1 mm/s and of penetration using cycle or hold programs. Data were collected on computer and the texture profile parameters were calculated from LFRA texture analyzer and computer interface. Calculation described by Bourne (2003) was used to obtain the texture profile parameters. The parameters stimulating included hardness (measure of force required to achieve a given deformation), adhesiveness (the work necessary to overcome the attractive forces between the surface of a food and surface of other materials with which it comes in contact, e.g., the teeth, palate and tongue, cohesiveness (a measure of strength of internal bonds making up the body of the product), springiness (a measure of the rate at which a deformed material returns to its original

dimensions after the deforming force is removed), chewiness (the energy required to masticate a solid food material to a state ready for swallowing) and guminess (the energy required to disintegrate a semisolid food to a state ready for swallowing) (Fox *et al.*, 2017).

Sensory evaluation:

Yoghurt was judged by ten panelists from the staff members of Dairy Science and Technology Department, and Food Science and Technology Department, Faculty of Agriculture, Menoufia University. Results were recorded on a score sheet described by (Kebary and Hussein, 1999).

Statistical analysis:

Data were analyzed using completely randomized block design and 2×3 factorial design. Newman-Keuls test was used to make the multiple comparisons (Steel and Torrie, 1980) using Costat program. Significant differences were determined at $p \leq 0.05$.

RESULTS AND DISCUSSION

Titratable acidity of all yoghurt treatments increased by fortifying cow's milk with whey protein isolate ($p \leq 0.05$). There was positive correlation between the rate of fortification with whey protein isolate and the titratable acidity of yoghurt (Tables 1, 5). Yoghurt treatment (T4) that was made by adding the highest amount of whey protein isolate (2.0%) had the highest titratable acidity (Tables 1, 5). These results might be due to the stimulating effect of whey protein on the growth of lactic acid bacteria and consequently increasing the development of acidity (Gaudreau *et al*., 2013; Zhao and Shah, 2014; Muniandy *et al*., 2016 and Akgul, 2018). Titratable acidity of all yoghurt treatments increased gradually ($p \leq 0.05$) as storage period progressed (Tables 1, 5). These results are in agreement with those reported by Ali *et al*. (2014); Chatterjee *et al*. (2016); Elkot (2017); Al-aswad *et al*.(2018); Blassy and Abdeldaiem (2018); Abdalla and Ahmed (2019); El-Garhi *et al*. (2019) and Saleh *et al*. (2019).

pH values of yoghurt treatments as affected by adding whey protein isolate and storage period followed an opposite trends to those of titratable acidity (Tables 1, 5)

Total solids and total protein contents increased significantly ($P \leq 0.5$) by increasing the amount added of whey protein isolate (Tables 1, 5). These results are in agreement with those reported Ali *et al*. (2014); Wang *et al*. (2015) and Bierzuńska and Sokolińska (2018). Total solids and total protein contents didn't change significantly ($P > 0.5$) during storage period. These results are in accordance with those of Al-aswad *et al*. (2018); Blassy and Abdeldaiem (2018) and Abdalla & Ahmed (2019).

There were no significant differences among yoghurt treatments in fat content which means adding whey protein isolate did not affect significantly ($P > 0.05$) the fat contents of the resulting yoghurt treatments (Tables 1, 5) (Shamsia, 2010 and Ali *et al*., 2014). These results are in agreement with those reported by Blassy and Abdeldaiem (2018) Abdalla and Ahmed (2019) and El-Garhi *et al*. (2019).

There were slight differences in ash content among yoghurt treatments which mean that adding of whey protein isolate affected significantly ($p \leq 0.05$) the ash content of all yoghurt treatments (Tables 1, 5). Ash content of all yoghurt treatments did not change significantly during storage period ($P>0.5$) These results in agreement with those reported by Kebary *et al*. (2012); Ali *et al*. (2014) and Abdalla & Ahmed (2019).

Whey syneresis of all yoghurt treatments decreased significantly ($p \leq 0.05$) by adding whey protein isolate (Tables 3, 5). There was negative correlation between whey syneresis and the rate of adding whey protein isolate (Tables 3, 5) (Lee and Lucey, 2010; Henriques *et al*., 2013 and Akgul, 2018). These results might be due to increasing the total solids content (Khalil and Blassy, 2017; Abdalla and Ahmed, 2019 and Saleh *et al*., 2019), increasing the water holding capacity

(Henriques *et al*., 2013; Delikanli and Ozcan, 2014; Jeewanthi *et al*., 2015; Ghanimah, 2018; Akgul, 2018 and Nastaj *et al*., 2019) and increasing the gel strength of yoghurt as a result of decreasing the casein to whey protein ratio, which enables to the shift form compact structure to larger aggregates by interaction with casein micelles created a more rigid gel structure in yoghurt (Delikanli and Ozcan, 2014). Whey syneresis of all yoghurt treatments decreased as storage period proceeded and reached their minimum values at the sixth day of storage period, then increased up to the end of storage period (Tables 3, 5). This increase of whey syneresis might be due to the contraction of curd as a result of developed acidity during storage, that help to expel the whey from the curd. These results in agreement with those reported by Blassy and Abdeldaiem (2018); Abdalla and Ahmed (2019) and Saleh *et al*. (2019).

Table (1): Chemical composition of yoghurt fortified with WIP during storage.

Yoghurt treatments	Titratable acidity (%)					pH values				
	Storage period (days)					Storage period (days)				
	1	3	6	9	12	1	3	6	9	12
C*	4.85	4.73	4.56	4.43	4.28	4.85	4.73	4.56	4.43	4.28
T1	4.76	4.62	4.50	4.43	4.30	4.76	4.62	4.50	4.43	4.30
T2	4.70	4.85	4.53	4.42	4.38	4.70	4.85	4.53	4.42	4.38
T3	4.66	4.58	4.46	4.38	4.34	4.66	4.58	4.46	4.38	4.34
T4	4.61	4.50	4.46	4.33	4.26	4.61	4.50	4.46	4.33	4.26
	Total solids content (%)					Total protein content (%)				
	Storage period (days)					Storage period (days)				
C*	13.32	13.31	13.36	13.37	13.35	3.56	3.58	3.58	3.57	3.56
T1	13.78	13.77	13.78	13.79	13.78	4.02	4.03	4.05	4.02	4.01
T2	14.22	14.23	14.24	14.22	14.23	4.45	4.43	4.45	4.44	4.42
T3	14.65	14.68	14.64	14.66	14.66	4.91	4.90	4.92	4.91	4.90
T4	15.11	15.12	15.13	15.11	15.13	5.35	4.35	5.33	5.34	5.33
	Fat content (%)					Ash content (%)				
	Storage period (days)					Storage period (days)				
C*	3.1	3.0	3.0	3.1	3.1	0.82	0.83	0.84	0.84	0.83
T1	3.0	3.0	3.0	3.0	3.1	0.84	0.84	0.86	0.85	0.84
T2	3.0	3.1	3.1	3.0	3.0	0.88	0.87	0.89	0.88	0.87
T3	3.0	3.0	3.0	3.0	3.0	0.91	0.92	0.94	0.94	0.95
T4	3.1	3.0	3.0	3.0	3.0	0.98	0.97	0.98	0.99	0.99

◊Each value in the table was the mean of three replicates.

*C: yoghurt made from cow's milk fortified with 3% non-fat dry milk.

T1, T2, T3, T4 and T5 yoghurt treatments made from cow's milk fortified with 3% nonfat dry milk and 0.5, 1.0, 1.5, and 2.0 % whey protein isolate, respectively.

The effect of adding whey protein isolate on textural parameters is shown in Table (2). Hardness of yoghurt treatments increased significantly (P≤ 0.05) by fortifying the milk with whey protein isolate. This increase was proportional to the rate of fortification with whey protein isolate (Chatterjee *et al*., 2016 and Nastaj *et al*., 2019). These results could be attributed to the formation of protein-casein complexes that improve their firmness by protein network formation (Mahomud *et al*., 2017) and / or the high concentration of thiol groups and consequently creating the disulphide bonds during yoghurt production that increase the final gel strength (Matumoto-Pintro *et al*., 2011 and Tsevdou *et al*., 2013).

Adhesiveness has a positive effect on the thickness and is an important factor governing the stability of yoghurt. Fortification of milk with whey protein isolate caused a significant increase of the adhesiveness of the resulting yoghurt treatments (Table 2) there was a positive correlation between the value of adhesiveness and the rate of fortification with whey protein isolate. Similar results were reported by Delikanli and Ozcan (2014) and Nastaj *et al*. (2019) who reported that yoghurt fortified with whey protein isolate had higher hardness values showed more compact structure with more adhesiveness and this resulted in the good mouthfeel and improved the stability of yoghurt during storage. On the other hand fortification of milk with whey protein isolate increased significantly (P≤0.05) the values of cohesiveness, springiness and gumminess of the resulting yoghurt and these increase were proportional to the rate of fortification. These results might be due to the formation of fine network that contains very small pores. These results are in agreement with those reported by Sandoval-Castilla *et al*. (2004) and Delikanli and Ozcan (2014). Also it has been reported that fortification of milk with whey proteins that was used in the manufacture of yoghurt improved the physiccal, textural and rheological properties of the resultant yoghurt (Singh, 2007; Guggisberg *et al*., 2007 and Landge, 2009).

Table (2): Textural parameters of yoghurt fortified with whey protein isolate.

Yoghurt treatments◊	Fracture (N)	Hardness (N)	Adhesiveness (mj)	Cohesiveness (Ratio)	Springiness (mm)	Gumminess (N)	Chewiness (mj)
C*	4.5^{e}	4.5^{c}	1.227^{e}	0.40^{b}	10.60^{c}	1.8^{c}	33.25^{e}
T1	7.1^{d}	7.1^{b}	2.064^{d}	0.44a^{b}	11.70^{c}	2.8^{c}	51.79^{d}
T2	7.9^{c}	8.0^{b}	4.540^{c}	0.49a^{b}	13.50^{b}	3.2^{b}	58.69^{c}
T3	8.3^{b}	8.3^{b}	4.828^{b}	0 52a^{b}	15.60^{a}	3.8^{a}	69.99^{b}
T4	8.8^{a}	10.1^{a}	5.146^{a}	0.56^{a}	16.59^{a}	4.7^{a}	86.83^{a}

◊ See table (1).
a, b different letters in the same column means the treatment are significantly different.
Significant at 0.05 level (0.05).

Table: (5) Statically analysis of yoghurt fortified with whey protein isolate.

Properties of yoghurt	Effect of treatments						Effect of storage period(days)					
	Mean squares	Multiple comparisons●					Mean squares	Multiple comparisons●				
		C◊	T1	T2	T3	T4		1	3	6	9	12
Titratabe acidity (%)	0.0627*	D	C	B	A	A	0.1865*	E	D	C	B	A
PH value	0.055*	A	AB	A	B	C	0.432*	A	B	C	D	E
Total solids (%)	9.274*	E	D	C	B	A	0.229	A	A	A	A	A
Total protein (%)	4.319*	E	D	C	B	A	0.056	A	A	A	A	A
Fat (%)	0.0779	A	A	A	A	A	0.0180	A	A	A	A	A
Ash (%)	0.3105*	A	A	ABC	BC	C	0.1299	A	A	A	A	A
Seneraseis (%)	488.52*	A	B	C	D	E	74.22*	A	B	C	B	A
Organoleptic properties												
Flavor	20.879*	C	B	B	A	B	4.079*	A	A	A	AB	B
Body&texture	6.179*	C	BC	AB	A	BC	1.679*	A	A	A	AB	AB
Appearance	0.420*	B	B	B	A	AB	0.419*	A	A	A	B	B
Acidity	2.579*	B	B	AB	A	B	4.379*	A	A	A	A	B
Total	85.49*	D	C	B	A	B	29.699*	A	A	A	AB	B

◊See table (1)

● For each effect the different letters in the same row means the multiple comparisons are different from each other , letter (A) is the highest mean followed by (B),(C),……. Etc.
*Significant at 0.05 level (0.05).

Counts total bacteria, Lactobacilli and Streptococci of yoghurt treatments increased significantly by adding whey protein isolate (Tables 3, 5). There was positive correlation between the total bacterial counts and the rate of adding whey protein isolate. Treatment T4 that was made by adding the highest amount of whey protein isolate exhibited the highest counts of total bacterial counts. This increase of total bacterial, Lactobacilli and Streptococci counts could be attributed to the stimulating effect of whey protein isolate on the growth of bacteria and consequently increasing the total bacterial counts (Kailasapathy and Supriadi, 1996; Gaudreau *et al*., 2013; Muniandy *et al*., 2016 and Akgul, 2018). On the other hand the obtained results indicated that total bacterial, Lactobacilli and Streptococci counts of all yoghurt treatments increased during the first three days of storage period and reached their maximum counts at the third day of storage period, then decreased gradually up to the end of storage period. This decrease might be due to the development of acidity during storage period and /or the cold storage. Similar trends were obtained by Kebary *et al*. (2010).ElKot (2017) and Saad & Elkhtab (2019).

All yoghurt treatment samples were free from moulds and yeasts during first nine days of storage period, then they apeard towards the end of storage period (Table 3). These results are in agreement with those reported by Mehriz *et al*. (1993) who detected moulds and yeast only at the end of storage period. Similar trends were optained by Ali *et al*. (2014); Priyadarshani and Muthumuniarachchi (2018) and Saad & Elkhtab (2019).

Scores of organoleptic properties (flavor, body & texture, acidity and appearance) of yoghurt treatments fortified by whey protein isolate are presented in Table (4). The obtained results revealed that the score of flavor, body and texture, appearance and total scores of organoleptic properties followed

similar trends. Fortification of yoghurt treatments up to 1.5 % WPI increased the scores of organoleptic properties while increasing the rate of fortification above that decreased the scores of organoleptic properties. Treatment T3 that was made by fortification cow's milk with 1.5 %whey protein isolate was the most acceptable yoghurt treatment although other yoghurt treatments were accepted by the panelists (Tables 4, 5). These results are confirmed with the results of texture parameters, where adding whey protein isolate improved the texture parameters of yoghurt treatments. It has been reported that adding whey proteins to yoghurt improved the texture of the resulting yoghurt and improved the mouth feel of this yoghurt (Megenis *et al*., 2006; Sodini *et al*., 2005; Guggisberg *et al*., 2007; Aziznia *et al*., 2008 and Landge, 2009). On the other hand scores of all yoghurt treatments did not change significantly during the first nine days of cold storage, while they decreased slightly after that up to the end of storage period (Tables 4, 5). These results are in agreement with reported by ElKot (2017); Khalil and Blassy (2017); Al-Aswad *et al*. (2018) and Blassy & Abdeldaiem (2018).

It could be concluded that fortification of cow's milk with whey protein isolate increased titratable acidity, total solids content, protein content, total bacterial counts, Lactobacilli counts, Streptococci counts and improved the texture parameters, while decreased pH and whey syneresis, but did not affect the fat and ash content. Adding whey protein isolate up to 1.5 % increased the scores of organoleptic properties. Therefore it is possible to make good quality yoghurt from cow's milk by adding up to 1.5 % whey protein isolate.

REFERNCES

Abdalla, A.K. and Ahmed, Z.F.R. (2019). Physicochemical and sensory properties of yoghurt supplemented with green banana flour. EgyptianJ. Dairy Sci., 47: 1.

A.O.A.C. (2012). Official Method of Analysis of Association of Chemists. 19thEd. Published by Assiociation of Official Agriculture Chemists, Washington. D. C. (USA).

Al-Aswad, S.; Helal, A.; Shamsia, S. M. and Awad, S. (2018). Quality and rheolo-gical properties of sweetened yoghurt and bio-yoghurt enriched with pomegranate juice. Egyptian J. Dairy Sci., 46: 41.

Akgul, F.Y. (2018). Enhancement of strained (Torba) yoghurt with Whey Protein Isolates. Int. J. Dairy Technol., 71: 898.

Ali, M.M.E., Kebary, K.M.K. ; Shaheen K.A. and Abo Bakr, B.M. Maally, (2014). Quality of yoghurt made from cow's milk supplemented with whey proteins. Menoufia J. Agric. Res., 39: 1815.

Ayar, A.; Sert, D.; Kalyonku, H. and Yazici, F. (2006). Physical,chemical, nutritional and organoleptic characteristics of fruit added yogurts. J. Food Technol., 4: 44.

Aziznia, S.; Khosrowshahi, A.; Madadlou, A. and Rahimi, J. (2008). Whey protein concentrate and gum tragacanth as fat replacers in nonfat yogurt: chemical, physical, and microstructural properties. J. Dairy Sci., 91: 2545.

Bierzuńska, P. and Sokolińska D. (2018). Determination of antioxidant activity of yoghurt enriched with polymerized whey protein. Mljekarstvo, 68: 272.

Birollo, G.A.; Reinheimer J.A. and Vinderola C.G. (2000). Viability of lactic acid microflora in different types of yoghurt. Food Res. Int., 33: 799.

Blassy, I. Kholoud, and Abdeldaiem A. M. (2018). Preparation and properties of buffalo milk yoghurt fortified with some healthy additives. Egyptian J. Dairy Sci., 46: 51.

Bourne, M. C. and Szczesniak A. S. (2003). Sensory evaluation-texture. In: Caballero B, Trugo L, Finglas P (Eds.): Encyclopedia of Food Sciences and Nutrition, Academic Press, Amsterdam, the Netherlands, pp. 5167 – 5174.

Chandan, R. C. (2006). Manufacturing of yogurt and fermented milks. Edited by Chandan, R. C.; White, C. H.; Kilara, A.; Hui, Y. H., 1st edition, Blackwell Publishing Professional, Ames, Iowa, pages 151-265.

Chatterjee, A.; Kanawjia, S. K. and Khetra, Y. (2016). Properties of sweetened Indian yogurt (mishti dohi) as affected by added tryptic whey protein hydrolysate. J. Food Sci. and Technol., 53: 824.

Danneberg, F. and Kessler H. G. (1988). Effect of denaturation of B- lactoglubulin on texture properties of set-style nonfat yoghurt. 1.syneresis. Michwissenschaft, 43: 632.

De Man, J.C.; Rogosa, M. and Sharpe, M.E. (1960). Amedium for the cultivation of lactobacilli. J. Appl. Bacteriol, 23: 130.

Delikanli, B. and Ozcan, T. (2014). Effects of various whey proteins on the physico-chemical and textural properties of set type nonfat yoghurt. Int. J. Dairy Technol., 67: 495.

Difco manual (1953). Dehydated Culture Media and Reagents 9th ed. Difcolabortories, Detriot, Michigan.

ElGarhi, H. M.; Hamdy, M. Shaima and Nasr, M. Nesreen (2019). Anew healthy yoghurt flavoured with menthol. Egyptian J. Dairy Sci., 47: 11.

ElKot, W.F. (2017). Preparation and properties of yoghurt using Jerusalem artichoke tubers powder and different probiotic strains. Egyptian J. Dairy Sci., 45: 55.

Fox, P. F.; Guinee, P. T.; Cogan, M. T. and McSweeney, P.L.H. (2017). Fundamentals of Cheese Science, 2th Ed. Published by Springer Nature, New York, pp. 523 – 524.

Gaudreau, H.; Champagne, C.P.; Remondetto, G.; Bazinet, L. and Subirade, M. (2013). Effect of catechins on the growth of oxygen-sensitive probiotic bacteria. Food Res. Int., 53: 751.

Ghanimah, M.A. (2018). Functional and technological aspects of whey powder and whey protein products. Int. J. Dairy Technol., 71: 454.

Guggisberg, D.; Eberhard P. and Albrecht B. (2007). Rheological characterization of set yogurt produced with additives of native whey proteins. Int. Dairy J., 17: 1353.

Hamed, A.I.; Kebary, K.M.K.; Badawi, R. M. and Omar, S. Nevein (2010). Manufacture of low fat prebiotic yoghurt. Menoufia J. Agric. Res., 35: 157.

Henriques, H. F.Marta; Gomes, D.M.G.S.; Pereira, C.J.D. and Gil, H. M. Maria (2013). Effects of Liquid Whey Protein Concentrate on Functional and Sensorial Properties of Set Yogurts and Fresh Cheese. Food Bioprocess Technol., l: 952.

Jeewanthi, R.K.C.; Lee, N. and Paik, H. (2015). Improved functional characteristics of whey protein hydrolysates in food industry. Korean J. Food Sci. Animal Resources, 35: 350.

Kailasapathy, K. and Supriadi, D. (1996). Effect of whey protein concentrate on the survival of Lactobacillus acidophilus in lactose hydrolyzed yogurt during refrigerated storage. Milchwissenschaft, 51: 566.

Kebary, K.M.K. and Hussein, S.A. (1999). Improving viability of bifidobacteria by microentrapment and their effect on some pathogenic bacteria in stirred yoghurt. J. Dairy Sci. and Technol., 28:113.

Kebary, K. M. K.; Badawy, R. M.; Hamed, A. I. and Omar, S. Nevein (2010). preparation and properties of novel functional yoghurt from bufflo milk. Proc11th Egyptian Conf. Dairy Sci., Technol., pp. 463.

Kebary, K.M.K.; El-Sonbaty, A. H. ; Kamaly, K.M. and Badawi, R.M. Khadega (2012). Effect of using normal and roby strains of yoghurt starter in the manufacture of yoghurt from cow's milk fortified with different levels of inulin and non-fat dried milk. Egyptian J. Dairy Sci., 40: 99.

Khalil, R.A.M. and Blassy, I. Kholoud (2017). Preparation and properties of free fat yoghurt supplemented with oat and flavoured with pomegranate juice and soursop pulp. Egyptian J. Dairy Sci., 45:143.

Landge, V.L. (2009). Quality of yogurt supplemented with whey protein concentrate and effects of whey protein denaturation. Master's Thesis. Faculty of Food Sciences, Kansas State University, Manhattan, Kansas.

Lee, W. J. and Lucey, J. A. (2010). Formation and physical properties of yogurt. Asian-Aust. J. Animal Sci., 23: 1127.

Mahomud, M. S.; Katsuno, N. and Nishizu, T. (2017). Formation of soluble protein complexes and yoghurt properties influenced by the addition of whey protein concentrate. Innovative Food Sci. and Emerging Technol., 44:173.

Marth, E. H. (1978). Standard methods for the examination of dairy products, 14th ed. Am. Buble. Health Assoc. Washington, DC.

Matumoto-Pintro P. T.; Rabiey L.; Robitaille G. and Britten M. (2011). Use of modified whey protein in yoghurt formulations. Int. Dairy J., 21: 21.

Megenis, B. R.; Prudencio, E. S.; Amboni, R.D.M.C.; Cerquiera Junior, N.G.; Olivierra, R.V.B. ; Soldi, V. and Benedet, H. D. (2006). Compositional and physical properties of yogurt manufactured from whey and cheese concentrated by ultrafiltration. Int. J. Food Sci. Technol., 41: 560.

Mehriz, A. M.; Hassan, M. N. A; Hefny, A. A. and Aziz, A. H. (1993). Manufacture and some properties of ABT cultured and sweet acidophilus milks. Egyptian J. Dairy Sci., 21:259.

Muniandy, P.; Shori, A. B. and Baba, A. S. (2016). Influence of green, white and black tea addition on the antioxidant activity of probiotic yogurt during refrigerated storage. Food Packaging and Shelf Life, 8: 1.

Nastaj, M; Sołowiej, B. G.; Gustaw, W.; Huertas, S. P.; Mleko, S. and Trojanowska, M. W. (2019). Physicochemical properties of high- protein-set yoghurts obtained with the addition of whey protein preparations. Int. J. Dairy Technol., 72: 395.

Priyadarshani, W.M.D. and Muthumuniar-achchi, M.A.M.R. (2018). Physico-chemical and sensory quality of mung bean (Vigna radiata) enriched stirred yoghurt. Int. Food Res. J., 25: 2051.

Saad, A. Marwa and Elkhtab, E. S. (2019). Antimicrobial activity of moringa oleifera leaves extract and its effect on the shelf life and quality of yoghurt. Egyptian J. Dairy Sci., 47: 91.

Saleh, A.E.; Moussa, M.A.M. and Elgaml, N.B. (2019). The use of desert truffle (terfezia claveryi) to improve the functional and antioxidant properties of yoghurt. Egyptian J. Dairy Sci., 47: 27.

Sandoval-Castilla, O.; Lobato-Callerosa, C.; Aguirre-Mandujanoa, E. and Vernon Carterb, E. J. (2004). Microstructure and texture of yoghurt as influenced by fat replacers. Int. Dairy J., 14: 151.

Shah, N. P. (2007). Functional cultures and health benefits. Int. Dairy J., 17: 1262.

Shamsia, S.M. (2010). Forification of standar-dized buffalo milk yoghurt with calcium citrate and whey protein concentrate. J. Agric. and Env. Sci. Damanhour. Univ., Egypt .9:25.

Singh, G. (2007). Calcium lactate fortification of reduced fat yoghurt and fortification of "simulated yoghurt gel "with partially hydrolyzed whey protein. THESIS M. s. c. Master of Science Major in Biological Sciences Food and Biomaterials Processing Specialization South Dakota State University.

Skinner, F.A. and Quesnel, L.B. (1978). Streptococci. Academic press, New York, P 390.

Sodini, I.; Montella, J. and Tong, P. S. (2005). Physical properties of yogurt fortified with various commercial whey protein concen-trates. J. Sci. Food Agri., 85: 853.

Steel, R.G.D. and Torrie, J. H. (1980). Principles and Procedures of Statistics.

A biometrical approach. 2thEd. McGraw-Hill Book Co., New York.

Tsevdou, M.S.; Eleftheriou, E.G. and Taoukis, P.S. (2013). Transglutaminase treatment of thermally and high pressure processed milk: effects on the properties of storage stability of set yoghurt. Innovative Food Science and Emerging Technologies, 17:144.

Wang, C.; Gao, F.; Zhang, T.; Wang, Y. and Guo M. (2015). Physiochemical, textural, sensory properties and probiotic survivability of Chinese Laosuan Nai (protein-fortified set yoghurt) using polymerised whey protein as a co- thickening agent. Int. J. Dairy Technol., 68: 261.

Zhao, D. and Shah, N. P. (2014). Influence of tea extract supplementation on bifidobacteria during soymilk fermentation. Int. J. Food Microbiol., 188: 36.

تأثير تدعيم اللبن البرى ببروتينات الشرش المعزولة على صفات اليوجورت

يحتوى الشرش الناتج من صناعة الجبن على حوالى 20% من البروتينات، ولقد بذلت جهود كبيرة لفصل هذا البروتين للإستفادة منه إقتصاديا وكذلك تقليل مخاطر التلوث الناتج من تصريف الشرش المحتوى على بركتينات الشرش، واليوم توجد منتجات عديدة من الشرش وبروتينات الشرش تستخدك فى كثير من الصناعات منها تدعيم منتجات الألبان وذلك للإستفادة من الفوائد الغذائية والصحية والتكنولوجية العديدة لبروتينات الشرش ولذلك يهدف هذا البحث إلى تدعيم اليوجورت المصنع من اللبن البقرى ببروتينات الشرش للإستفادة منها فى تحسين خواص اليوجورت المصنع من اللبن البقرى ولقد تم تصنيع 5 معاملات من اليوجورت العينة الكنترول صنعت من اللبن البقرى المضاف له 3% من اللبن الفرز المجفف أما المعاملات الأربع الأخرى فقد صنعت مثل الكنترول بالإضافة إلى إضافة 0.5، 1.0، 1.5، 2.0% من بروتينات الشرش المعزولة. ولقد تم تخزين كل المعاملات فى الثلاجة لمدة 12 يوم حيث حللت عينات وهى طازجه وبعد 3، 6،

9، 12 يوم كيميائيا وميكروبيولوجيا وريولوجيا وكذلك التقييم الحسى، ولقد أوضحت النتائج المتحصل عليها بعد تحليلها إحصائيا مايلى:-

1- أدى إضافة بروتينات الشرش المعزولة إلى زيادة نسب كل من الحموضة والجوامد الصلبة الكلية والبروتين الكلى والرماد، فى حين لم تؤثر على نسبة الدهن.
2- أدى إضافة بروتينات الشرش المعزولة إلى خفض قيم الـ pH وكذلك انفصال الشرش.
3- إزدادت درجات التحكيم الحسى لمعاملات اليوجورت بإضافة بروتينات الشرش المعزولة وكانت أكثر المعاملات قبولا هى المعاملة المصنعة بإضافة 1.5% من بروتينات الشرش المعزولة.
4- لم تتغير نسب كل من الجوامد الصلبة الكمية والبروتين الكلى والدهن والرماد لكل معاملات اليوجورت أثناء فترة التخزين، فى حين إزدادت نسبة الحموضة وانخفضت قيم الـ pH.
5- إنخفضت نسب إنفصال الشرش أثناء الأيام الست الأولى من التخزين ثم إزدادت تدريجيا بعد ذلك حتى نهاية فترة التخزين.
6- لم تتغير درجات التحكيم لكل معاملات اليوجورت معنويا أثناء التخزين لمدة 9 أيام ثم إنخفضت قليلا بعد ذلك.