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IMPACT OF USING DIFFERENT STABILIZERS ON THE PHYSIOCHEMICAL AND SENSORY PROPERTIES OF FUNCTIONAL POMEGRANATE YOGHURT DRINK

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SUMMARY

The use of different stabilizers to improve the rheological properties of functional pomegranate low fat yoghurt drinks was investigated. Standardized milk (1.5% fat) was supplemented with 2.2% skim milk powder to make yoghurt drink. Modified starch (MS), xanthan gum (XA), sodium carboxy methyl cellulose (CMC) and their mixtures were used as stabilizers. The different formulations for yoghurt drink was prepared from 55% yoghurt, 15% pomegranate juice and 30% cooled sweetened solutions of different stabilizers to give 8% sugar in the final product. The different formulations were heat treated to 75±1° C for 5 min. followed by cooling to 5±1° C. Changes in serum separation, phenolic compounds content (PC), antioxidant activity (AA) as well as chemical, rheological and organoleptic characteristics of the different products were followed during cold storage for 12 days. Generally the different stabilizers had no significant effect ($p \leq 0.05$) on the protein, fat contents, PC, AA and pH values of the obtained products. Low fat pomegranate yoghurt drinks with optimum rheological characteristics and minimum serum separation and acceptable sensory properties were obtained by using 1.5% MS or mixture of 0.75% MS and 0.15% CMC.

Key word: Stabilizers, Pomegranate juice, Yoghurt drink, Antioxidant activity, Rheological properties, Organoleptic properties

INTRODUCTION

Yoghurt drinks are popular dairy product, prepared by mixing yoghurt with milk or water with sugar, stabilizer and fruit juice. Optimum consistency and minimum serum separation are desirable characteristics for yoghurt drinks. Addition of stabilizers in yoghurt drinks effectively reduces serum separation during storage. Bayarri *et al.* (2011) reported that the sensory and functional characteristics of drinking yoghurt were food choice motives for its acceptability.

High dietary fat is known to be associated with increased risk of obesity, atherosclerosis, coronary heart disease, elevated blood pressure and tissue injury diseases associated with lipid oxidation (Steijns, 2008). Increasing consumer interest in healthy products promoted the development and availability of low-fat and fat free yoghurts in the market. Production of these products requires careful control of textural attributes (Haque and Ji, 2003) since fat removal causes changes in the texture due to modifications of the gel structure (Houzé *et al*., 2005).

Pomegranate (*Punica granatum L.*) is an important tree of the tropical and subtropical regions of the world. Pomegranate arils are rich source of polyphenols gallic acid, protocatechinuie acid, chlorogenic acid, caffeic acid, ferulic acid, coumaric acids and catechin (Poyrazoglu *et al*., 2002). Also, arils and husk of pomegranate fruit were reported to have antioxidant, anti-inflammatory and antiatherosclerotic activities against some degeneration and metabolic diseases (Faria and Calhau, 2011; Al-Muammar and Khan, 2012). Pomegranate contains phytochemicals compounds which identified to be flavonoids, condensed tannins and hydrolysable tannins (Gil *et al*., 2000; Seeram *et al*., 2006). Because of its potential health benefits, pomegranate fruit juice has been used to increase the functionality and antioxidant activity of foodstuffs.

Different concentrations of pomegranate juice (PJ) were added in yoghurt drinks and with the use of 0.15% CMC as a stabilizer (Khalil, 2013). As PJ ratio was increased, the pH values was significantly decreased, while the total phenolic compounds and antioxidant scavenging activity of yoghurt drink were increased. However, the addition of PJ had an adverse effect on the rheological characteristics and serum separation and overall acceptability of yoghurt drink.

The adverse effect of adding PJ in yoghurt drink were reported with others (Arjmand, 2011) who found that addition of concentrated pomegranate juice to yoghurt decreased the fracture stress and firmness of the product as compared with control one, but still considered acceptable.

Water- soluble polysaccharide stabilizer such as pectin, gelatin, modified starch, xanthan gum and sodium carboxy methyl cellulose (CMC) are used in yoghurt and yoghurt drinks to ensure appropriate body and texture (El-Sayed *et. al*, 2002). The hydrocolloid can interact with casein network and contributes to the gel formation through partial absorbance of the free water and improving the water holding capacity of proteins (Goff and Guo, 2019). The main objective of this research was to evaluate the effect of using different stabilizers on the chemical, rheological, physical and organoleptic characteristics of pomegranate low fat yoghurt drink.

MATERIALS AND METHODS

Materials:

Raw buffalo's milk was obtained from herds of faculty of Agriculture, Suez Canal University, Ismailia, Egypt and partially skimmed milk (1.5 % fat, SNF 9.62, pH 6.63) was standardized. Direct vat starter containing *Streptococcus thermophilus* and *Lactobacillus delbreuckii* sub sp. *bulgaricus* (YCX11) was obtained from Chr. Hansen's laboratories, Denmark. Cow's skim milk powder (97% TS, product of Dairy America^{TM}) was obtained from the local market. Sodium carboxy methyl cellulose (CMC) was obtained from Misr Food Additives – MIFAD. Xanthan gum was obtained from Nimingyu Fufeng Biotechnology Company (China). Modified corn starch produced by Capgill, Netherlands was obtained from Alnour for Dairy Industries (Egypt). Grindsted Carrageenan CH 525 was obtained from Alpha Trade Company, Egypt. Commercial grade sugar and pomegranate fruit were obtained from the local market.

Manufacture of yoghurt:-

The standardized buffaloe`s milk was supplemented with 2.2% skim milk powder, heated up to 85±1°C, cooled to 42±1°C, inoculated with DVS starter culture (0.004%) and incubated at 42±1°C until gel formation at pH 4.6-4.8. The resultant yoghurt was kept under cooling for 14 hrs. and then mixed vigorously at 6000 rpm/min for 5 min (using Ultra-Turrax Homogenizer).

Preparation of pomegranate juice:-

The pomegranate fruits were washed, arils were separated. Large sized, dark red coloured arils were selected and blended (using Braun PowerMax MX 2000 Blender, Germany), the strained pomegranate juice (PJ) was homogenized at 6000 rpm/min for 5 min. and the insoluble material was removed by filtration. The composition of pomegranate juice (PJ) is given in Table (1).

Preparation of different yoghurt drink formulations:-

Sugar and different ratios of stabilizers were dissolved in water to give 8% sweetened solution and heat treated to 85°C for 5 min., the different formulations for yoghurt drink supplemented with PJ are illustrated in Table (2).

Six treatments were done by mixing 55% yoghurt with 15% PJ and 30% sweetened solution to give 8% sugar in the final product and different stabilizers were added as follows: T_1 was made with 0.3% CMC; T_2 with 0.2% xanthan gum; T_3 with1.5% modified starch; T_4 with 0.15% CMC+ 0.1% xanthan gum; T_5 with 0.15% CMC+ 0.75%

modified starch and T_6 with 0.1% xanthan gum+ 0.75% modified starch.

Methods:-

Analysis of pomegranate juice

The moisture, fat, protein, ash, total pectin, fiber contents, and pH values of PJ were determined according to the AOAC methods (AOAC, 1990). The total soluble solids (TSS) content (as Brix) was measured using a refract meter (Abbe Hergestellt in der DDR, Germany) at 20 ˚C. The colour of PJ and different yoghurt drink samples was measured with a light reflectance spectrophotometer (Minolta, CR 300, Osaka, Japan) Measurements were recorded in L (lightness), +a (redness) and +b (yellowness) CIE (Commission Internationale de I'Eclairage) colour coordinates.

Table (1): The gross chemical composition, pH, phytochemical, antioxidant activity and colour reading of pomegranate juice after homogenization*.

Chemical / physical characteristics		Content
Total solids %		18.20 ±0.3
Acidity%		1.20 ±0.04
Total soluble solids %		16.50±0.31
Total sugars %		15.77±0.24
Dietary Fiber %		0.15±0.01
Total Pectin %		1.42±0.40
Ash %		3.00± 0.05
pH		4.12 ±0.02
Total Phenolic compounds (mg GAE /100gm)		173.0±2.10
Antioxidant activity %		47.50 ±0.45
Colour reading	*L*	20.20 ±2.10
	b	2.30 ±1.20
	a	14.60 ±1.0

* Average of three replicates

Table (2): Composition of different pomegranate yoghurt drink mixes (%) with different stabilizers*.

Treatment	Components (%)		
	Yoghurt	Pomegranate juice	Water with sugar 8% and stabilizer
T_1	55	15	30 (with 0.30 % CMC*)
T_2	55	15	30 (with 0.20 % XA)
T_3	55	15	30 (1.5% MS)
T_4	55	15	30 (0.15% CMC+ 0.1% XA)
T_5	55	15	30 (0.15% CMC+ 0.75%MS)
T_6	55	15	30 (0.1% XA+ 0.75% MS)

*CMC: carboxy methyl cellulose- XA: Xanthan- MS: Modified Starch

Determination of total phenolic compounds, and antioxidant activity

Five grams of PJ were mixed with 50 ml of 50% ethanol and stirred at room temperature for 1 h and filtered through Whatman No. 1 filter paper. The total phenolic compounds were determined in the ethanolic extract as described by Singleton and Rossi 1965). Results were expressed as mg of gallic acid equivalents (GAE) per 100g of the sample.

The antioxidant activity of PJ was evaluated by using 2, 2-diphenyl-1-picrylhydrazyl (DPPH) assay (Cuendet and Potterat, 1997;

Burits and Bucar, 2000). Absorbance was measured at 517 nm against a blank (ethanol). The DPPH radical-scavenging activity was calculated using the following formula:

DPPH radical – scavenging activity (%) = $[(1 - A_1 / A_0) \times 100]$

Where A_0 is the absorbance of the control and A_1 is the absorbance of the sample

For the yoghurt drink samples, extraction of phenolic compounds and antioxidant activity were carried out according to Li *et al.* (2009) with some modifications as follows: twenty ml of acidified ethanol (15 ml 1N HCl and 85 ml ethanol 95%) were added to 10 g of yoghurt drink in 50-mL brown bottles and shaked up for 90 min at 30°C using a rotary shaker (Julabo D-7633 Labortechmik, GMBIT, Jeelback / wast Germany) set at 200 rpm. Then, the mixture was centrifuged at 2500 g (ICE PR-7000 centrifuge, International Equipment Company) for 45 min at 5°C. The supernatant fluids were analysed for total phenolic compounds and DPPH scavenging activity as described above.

Chemical analysis of milk and yoghurt drink

Total solids, fat and protein contents of milk and yoghurt drink were determined according to AOAC (1990). All pH values of yoghurt drink samples were done according to AOAC (1990) when fresh and during 12 days of cold storage at 4ºC.

Rheological characteristics of yoghurt drink

The rheological properties of different yoghurt drinks were measured using a Brookfield viscometer (Brookfield Engineering Laboratories, USA), equipped with a SC4-21spindle running at 25 rpm. Measurements were made at 10ºC and shear rates ranging from 20 to 200 s^{-1}. All rheological properties were performed in quadruplicates. Flow curves were drawn from measured values of shear stresses and apparent dynamics viscosity.

Serum separation of yoghurt drink

Yoghurt drink samples were filled into 250 ml bottles and stored at 5 ºC during the storage period, the height of supernatant was measured and divided by the total sample height in bottle and multiplied by 100 and expressed as the percent serum separation (Foroughinia *et al*., 2007).

Organoleptic properties of yoghurt drink

All samples were evaluated for appearance/colour, flavour, consistency and mouthfeel and overall acceptability by 8 panelists from the dairy department as described by Meilgaard *et al*. (1999) with scores ranging from liked extremely (10) to disliked extremely (1).

Statistical analysis

All measurements were done in trireplicates, and analysis of variance with two factorial (treatments and storage period) were conducted by the procedure of General Linear Model (GLM) according to Snedcor and Cochran (1967) using Costat under windows software version 6.311 and least significant difference (LSD) test were employed to determine significant difference at $p<0.05$.

RESULTS AND DISCUSSION

Chemical composition and antioxidant activity of pomegranate juice (PJ)

The analysis of PJ (Table 1) indicated that it contained small percentage of crude fiber (0.15%) and pectin (1.42%). The total soluble solids of PJ was 16.5%, most of it were sugars. The pH of the PJ was found to be 4.12 due to the presence of organic acids, which is favorable for long shelf life of the final product. The total phenolic compound of PJ was 173 mg/100gm which results in a strong DPPH scavenging activity (47.5%). The antioxidant activity of plant extracts is mainly ascribed to its phenolic compounds contents and degree of their hydroxylation (Silva *et al*., 2006). Polyphenols are the major class of pomegranate fruit phytochemicals, including flavonoids (anthocyanins), condensed tannins (proanthocyanidins) and hydrolysable tannins; ellagitannins and gallotannins (Gil *et al*., 2000).

Gross composition of yoghurt drinks

Table (3) illustrates the gross composition of different yoghurt drinks samples as affected by using different stabilizers. The average of total solids % of fresh yoghurt drink samples are 18.02, 17.92, 19.05, 18.27, 18.62 and 18.47% for treatments T_1, T_2, T_3, T_4, T_5 and T_6 respectively. Earlier study showed that total solids for pomegranate free fat yoghurt drinks ranged between 17.67-17.97 % (Khalil, 2013).

Treatments made with 1.5% modified starch (T_3) and its mixture with CMC mixture (T_5) or xanthan gum (T_6) had significantly higher total solids than other treatments because of its higher used ratio. Similar results were noticed by Ibrahim and Khalifa (2015) who used different stabilizers in camel yoghurt drinks. All yoghurt drink made with the use of 0.5% CMC, pectin or gelatin are conformed to the Egyptian standards specifications of fermented milks (ES, 2016).

No significance differences were found in the fat and protein contents of yoghurt drink from different treatments. The Egyptian standards (ES, 2016) of yoghurt drink, specify that the protein content shouldn`t be less than 2.7% (w/w). Therefore the different low fat formulations were fortified with 2.2% skim milk powder to get the protein content to meet these specifications.

Table (3) shows significant differences ($p \leq 0.05$) in the rheological parameters of yoghurt drink from different treatments as affected by using different stabilizers. Using CMC separately (T_1) or in combinations with XA and MS (T_4 and T_5) respectively led to significant increases in the viscosity compared to other stabilizers and that CMC and XA or MS mixtures were more efficient than using CMC only to improve the rheological characteristics of the resultant yoghurt drinks. This may be due to the synergistic effect of mixed stabilizers. CMC can be used as stabilizer in dairy product to minimize aggregation and sedimentation of casein and to control the texture, viscosity, and mouth feel of the product (Ntazinda *et al.*, 2014). But its concentration used should be carefully controlled in acidified milk systems (Yu *et al.* 2004). Imeson (1997) reported that CMC/ casein mixtures were stable to heat treatment, but with slight decreases in viscosity. Also, this system was affected by agitation causing a decrease in the viscosity. So, this mixture is recommended for use in yoghurt-based drinks at level of 0.5% and pH 4.3-4.4 (Tamime and Robinson, 2007). Stabilizer should be added after fermentation since its addition prior to fermentation will cause protein agglomeration, whey separation, and other defects (Imeson, 1997).

Using XA separately (T_2) gave yoghurt drink which the lowest rheological characteristics values among treatments. While its combinations with CMC (T_4) or with modified starch (T_6) gave products significantly ($p \leq 0.05$) higher rheological properties than T_2. This may be due to the higher rheological characteristics of resultant yoghurt drink made of MS (T_3) or CMC (T_1) than that made of XA (T_2).

Yoghurt with MS separately (T_3) had higher rheological characteristics values than T_1 and T_2. The modified starch is completely soluble in milk, thus giving smooth, viscous yoghurt. Also, its combinations with CMC (T_5) increased significantly the viscosity value of yoghurt drink as compared to T_3, but its combination with xanthan gum (T_6) decreased the viscosity of yoghurt drink as compared with T_4 and T_5. Using different stabilizer mixtures improved the rheological characteristics of the resultant yoghurt drink samples and the most promising stabilizer was found for those made with CMC and MS or its mixtures.

The pH values

Table 4 shows that pH values of different yoghurt drink treatments decreased significantly ($p \leq 0.05$) with increasing the storage period up to 8 days as a result of further fermentation of lactose into lactic acid, but changes in pH after 12 days of cold storage were not significant. The use of different stabilizers had no significant effect on the pH value yoghurt drink. This indicates that the added stabilizers did not interfere with the growth and activity of starter microorganisms.

Similar findings were reported by Schonbrun (2002) for strawberry drinkable yoghurt.

Serum separation

Table 5 shows that the serum separation values for all treatments tended to increase with prolonged cold storage probably due to the developed acidity which decreases electrostatic repulsions causing aggregation of the protein matrix and release of serum from the gel network (Khalil, 2013). Using stabilizers was found to be necessary to minimize serum separation in fermented milk (Lucey *et al.*, 1999). The highest reduction of serum separation can be obtained by using 1.5% MS in yoghurt drink. Ibrahim and Khalifa (2015) reported that using of 1.5% modified starch reduced syneresis in yogurt drink. Using CMC separately (T_1) has no positive effect on serum separation during cold storage period, while its combinations with xanthan gum (T_4) or with modified starch (T_5) decreased significantly serum separation. Using XA separately (T_2) gained the highest serum separation value ($p \leq 0.05$) compared to other treatments, in agreement with that reported by Macit and Bakrici (2017). Mixtures of xanthan gum with CMC (T_4) or with modified starch (T_6) had significant lower serum separation values as compared to T_2. Using MS separately (T_3) resulted in the lowest serum separation value among treatments, probably due to an increase in the water holding capacity and improved thickening property (Okoth *et al.*, 2012). However, no significant difference in serum separation between yoghurt drinks containing MS or its combination with CMC (T_5). While its combination with xanthan gum (T_6) led to significantly higher serum separation. The most promising stabilizers to minimize serum separation in low fat pomegranate yoghurt drink were using 1.5% MS or mixture of 0.75% MS and 0.15% CMC.

Table (3): The gross composition and rheological characteristics of pomegranate yoghurt drinks as affected by using different stabilizers ratios (average of three replicates)

Treatments	T_1	T_2	T_3	T_4	T_5	T_6
Total solids %	18.02^c	17.92^c	19.05^a	18.07^c	18.62^b	18.47^b
Fat %	0.83^a	0.83^a	0.83^a	0.83^a	0.83^a	0.83^a
Protein %	3.10^a	3.10^a	3.10^a	3.10^a	3.10^a	3.10^a
Apparent viscosity (cp)	75^d	57^f	95^c	160^a	141^b	60^e
Plastic viscosity (cp)	66^d	49^f	82^c	147^a	126^b	51^e
Consistency coefficient (cp)	63^d	44^f	74^c	90^a	83^b	54^e

Means with the same row with different superscript (a, b, c…) are significantly different ($p \leq 0.05$).

Table (4): Changes in pH values during cold storage of pomegranate yoghurt drinks as affected by using different stabilizers ratios (average of three replicates)

Storage periods	Treatments						
	T_1	T_2	T_3	T_4	T_5	T_6	Mean
1 day	4.04	4.01	3.99	4.03	4.01	4.00	4.01^a
4 days	3.95	3.93	3.91	3.95	3.93	3.92	3.93^b
8 days	3.86	3.85	3.82	3.85	3.84	3.83	3.84^c
12 days	3.82	3.81	3.79	3.81	3.81	3.80	3.81^c
Mean	3.92^a	3.90^a	3.88^a	3.91^a	3.90^a	3.89^a	

Means with the same column or row with different superscript (a, b, c…) are significantly different ($p \leq 0.05$).

Table (5): Changes in serum separation % during cold storage of pomegranate yoghurt drinks as affected by using different stabilizers ratios (average of three replicates)

Storage period	Treatments						
	T_1	T_2	T_3	T_4	T_5	T_6	Mean
1 day	0.0	0.0	0.0	0.0	0.0	0.0	0.0^{d}
4 days	15.0	15.0	0.0	5.0	2.5	5.0	7.41^{c}
8 days	20.0	25.0	10.0	5.0	5.0	10.0	12.0^{b}
12 days	25.0	30.0	10.0	10.0	10.0	15.0	18.05^{a}
Mean	15.05^{b}	16.61^{a}	4.25^{d}	5.16^{d}	4.29^{d}	7.75^{c}	

Means with the same column or row with different superscript (a, b, c…) are significantly different ($p \leq 0.05$).

Total phenolic compounds (TPC) and Antioxidant scavenging activity (AA)

Figs. (1 A and B) shows no significant differences in the TPC and AA values of yoghurt drink as affected by using different stabilizers. This may be attributed to its higher protein and other non-protein antioxidants contents such as vitamins A, C and E (Lindmark-Mansson and Akesson, 2000). The pomegranate contains phenolic compounds and polyphenols including flavonoids (anthocyanins), condensed tannins (proanthocyanidins) and hydrolysable tannins; ellagitannins and gallotannins (Santagati *et al*, 1984; Gil *et al*., 2000).

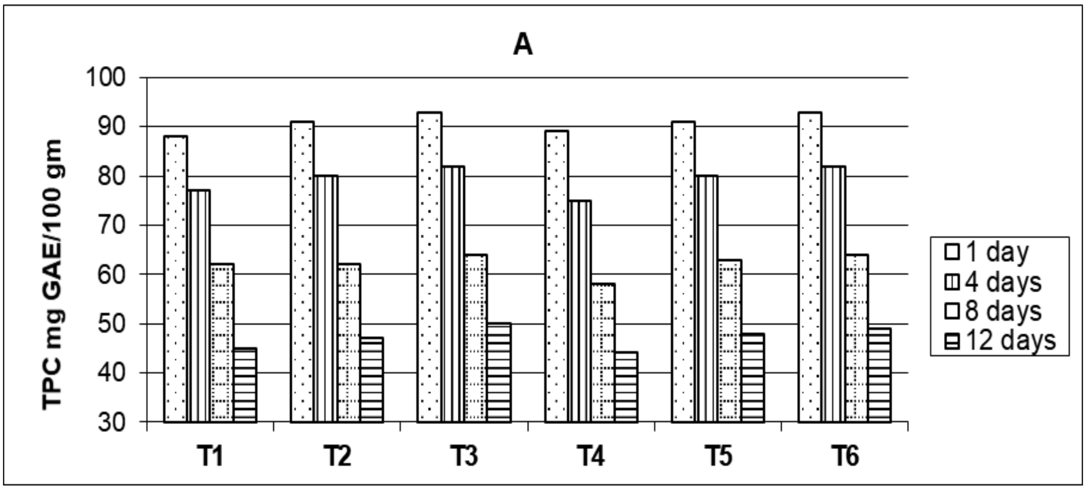
Generally all TPC and AA values of yoghurt drink tended to decrease along the cold storage for all treatments as a result of possible oxidation of TPCs during and/or its interactions with caseins or whey proteins (Han *et al*., 2019). Similar findings were reported by Khalil (2013) and El-Samahy *et al*. (2014) for yoghurt drink made with pomegranate juice and Cactus pear fruit respec-tively.

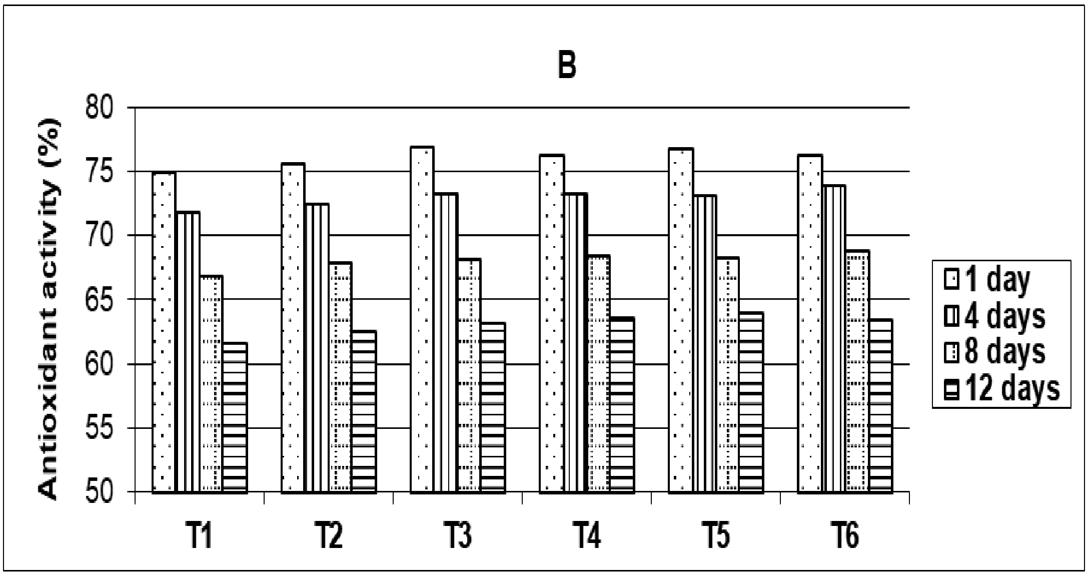
Acetaldehyde and Diacetyl contents

The changes in the acetaldehyde and diacetyl contents of yoghurt drink from different treatments are presented in Figs. (2 A and B). The use of different stabilizers had no significant effect on acetaldehyde and diacetyl contents of low fat yoghurt drink. During cold storage, acetaldehyde and diacetyl contents tended to decrease significantly in all treatments with advanced storage period, which may be associated with the metabolic activity of starter culture. Similar results were found by El.-Zahar and Abdel-Galeel (2008).

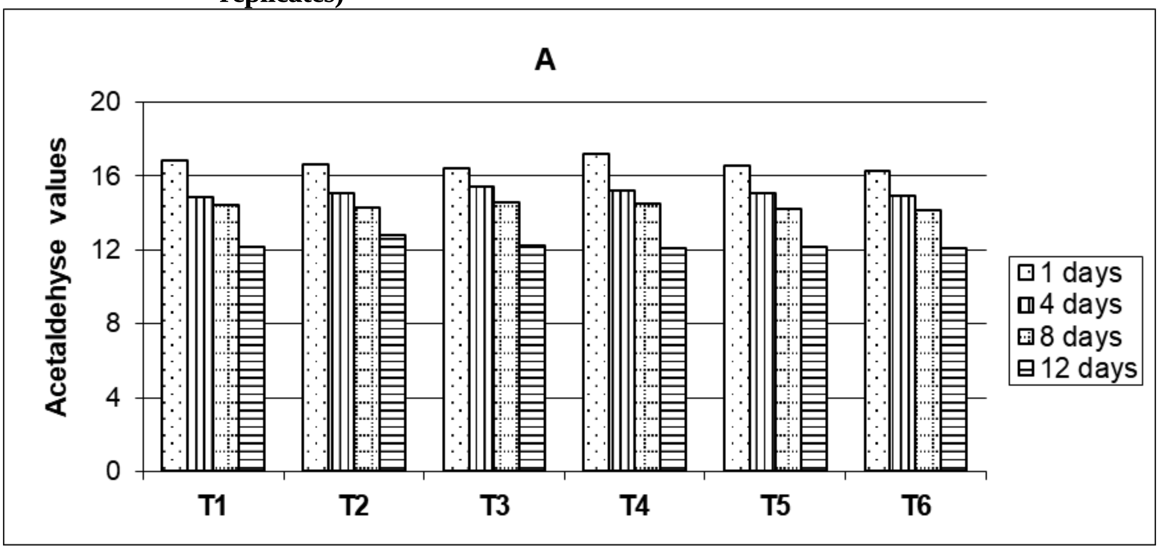
Sensory properties

The sensory properties of different yoghurt treatments were examined after 1 and 12 days of cold storage and presented in Table (6). Optimum consistency and homogeneous texture for good mouthfeel and no serum separation are desired characteristics for fermented milk beverages. Serum separation occurs in fermented milk beverages without the use of stabilizers (Lucey *et al*., 1999). The sensory properties depend largely on the relative balance of flavour compounds derived from milk constituents such as protein, fat or carbohydrate. The flavour components of yoghurt include the volatile and non-volatile compounds already present in the milk and specific compounds produced from milk fermentation (Cheng, 2010). It has been suggested that more than 90 different volatile compounds have been identified in yoghurt, including carbohydrates, alcohols, aldehydes, ketones, acids, esters, lactones, sulphur-containing compounds, pyrazines, and furan derivative (Imhof and Bosset, 1994). Storage time had obvious significant effect on reducing the sensory properties of yoghurt drinks samples. Stabilizers had a clear effect on appearance, consistency and general acceptability scores. Using CMC and modified starch and mixture of both gave yoghurt drink that ranked the highest scores for consistency, mouthfeel, flavour perception and total overall acceptability scores among treatments along the storage period. Addition of CMC to yoghurt drink improved its sensory characteristics. CMC stabilizer enhanced the dispersions of protein, particularly close to their isoelectric point of pH value and gives better stability for yoghurt drink





Figs. (1 A, B): Effect of using different stabilizers on A) total phenolic compounds expressed as mg Gallic acid/100gm, B) the antioxidant activity (%) during cold storage of pomegranate yoghurt drink (average of three replicates)



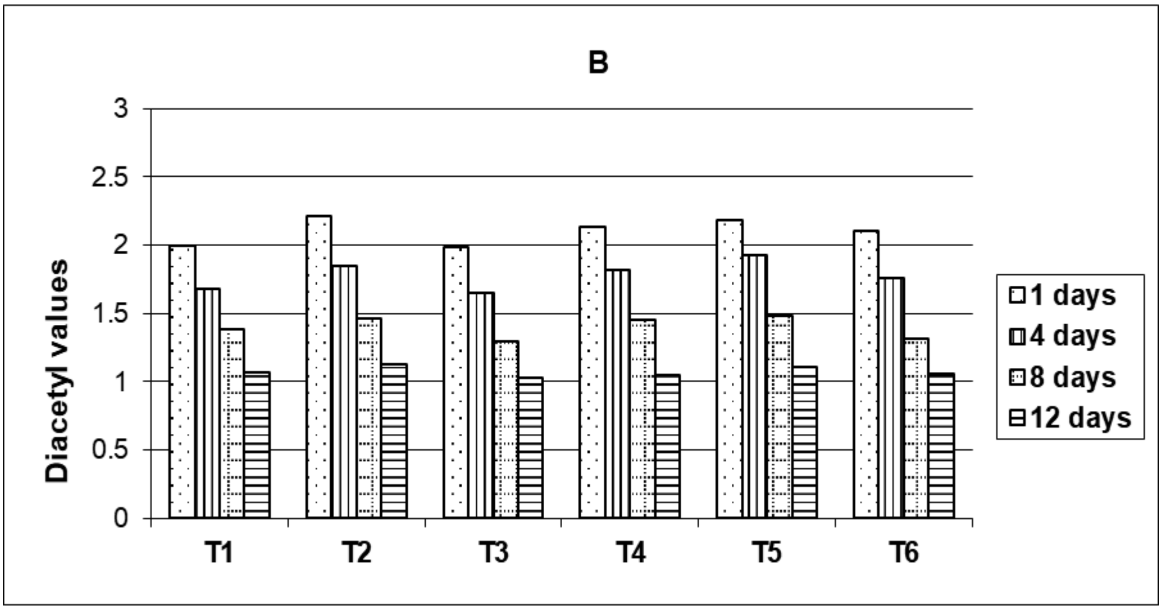


Fig. (2 A, B): Effect of using different stabilizers on A) Acetaldehyde values (mg/kg), B) diacetyl values (mg/kg) during cold storage of pomegranate yoghurt drink (average of three replicates)

Table (6): Sensory characteristics of pomegranate yoghurt drinks as affected by using different stabilizers ratios during 12 days of cold storage (average of three replicates).

Treatments	Appearance /Colour (10)	Flavour (10)	Consistency and mouthfeel (10)	Overall acceptability
After 1 day of cold storage				
T_1	9.0	9.0	9.0	27.0^{a}
T_2	9.0	7.5	7.5	24.0^{c}
T_3	9.0	9.0	9.0	27.0^{a}
T_4	9.0	8.5	8.0	25.5^{b}
T_5	9.0	9.0	9.0	27.0^{a}
T_6	9.0	8.0	9.0	26.0^{b}
After 12 days of cold storage				
T_1	7.5	7.5	7.5	22.5^{a}
T_2	7.5	6.0	6.0	19.5^{c}
T_3	7.5	7.5	7.5	22.5^{a}
T_4	7.5	7.0	6.5	21.0^{b}
T_5	7.5	7.5	8.0	23.0^{a}
T_6	7.5	6.5	7.5	21.5^{b}

* Statistical analysis was carried out only for total acceptability scores of different yoghurt drink treatments.
**Means with the same column with different superscript (a, b, c…) are significantly different ($p \leq 0.05$)

CONCLUSION

Pomegranate juice can be added in yoghurt drink as a functional ingredient. The type of stabilizer used in had a great impact on its quality characteristics of yoghurt drink. Yoghurt drink made by using modified starch or CMC or mixture of both improved significantly the rheological characteristics of the product with lower synersis rates.

REFERENCES

Al-Muammar, M.N. and Khan, F. (2012). Obesity: The preventive role of the pomegranate (Punica granatum). Nutrition 28: 595.

AOAC (1990). Official Methods of Analysis, 15th ed., Association of Official Analysis Chemists Inc., USA.

Arjmand, A. (2011). Antioxidant activity of pomegranate (Punica granatum L.) polyphenols and their stability in probiotic yoghurt. Msc thesis, RMIT University. Australia.

Bayarri, S.; Carbonell, I.; Barrios, E.X. and Costell, E. (2011). Impact of sensory differences on consumer acceptability of yoghurt and yoghurt-like products. Intern. Dairy J., 21: 111.

Burits, M. and Bucar, F. (2000) Antioxidant activity of Nigella sativa essential oil. Phytother. Res. 14: 323.

Cheng, H. (2010). Volatile Flavor Compounds in Yogurt: A Review. Critical Reviews in Food Science and Nutrition, 50: 938.

Cuendet, M.K.H. and Potterat, O. (1997). Iridoidglucosides with free radical scavenging properties from Fagraea blumei Helvetica Chimica Acta. 80: 1144.

El-Samahy, S.K.; Gaballah, A.A; Embaby, H.E.; Hamed, Y.S. and Khalil, R.A.M. (2014). Improving the nutritional value and quality of yoghurt drink by using Cactus pear (*Opuntia dillenii*) pulp. Egyptian J. Dairy Sci., 42: 133.

El-Sayed, E.M.; Abd El-Gawad, I.A.; Murad, H.A. and Salah, S.H. (2002). Utilization of laboratory-produced xanthan gum in the manufacture of yogurt and soy yogurt. Eur. Food Res. Technol. 215:298.

El-Zahar, K. and Abdel-Galeel, A. (2008). Proteolysis of protein of low fat yoghurt from buffaloe`s milk during storage. Effect of starter culture and heat treatment of milk. Egyptian J. Dairy Sci., 36: 207.

ES (2016). Egyptian Standards, Fermented milks, ES: 8042/2016.

Faria, A. and Colhau, C. (2011). The bioactivity of pomegranate: impact on health and disease. Critical Review in Food Science and Nutrition, 51: 626.

Foroughinia, S.; Abbasi, S. and Hamidi, Z. (2007). Effect of individual and combined addition of salep, tragacanth and guar gums on the stabilization of Iranian Doogh. Iranian Journal of Nutrition Science and Food Technology, 2: 15, (in Farsi).

Gil, M. I.; Tomas-Barberan, F. A.; Hess-Pierce, B.; Holcroft, D. M. and Kader, A. A. (2000). Antioxidant activity of pomegranate juice and its relationship with phenolic composition and processing. Journal of Agricultural and Food Chemistry, 48: 4581.

Goff, H. D. and Guo, Q. (2019). The Role of Hydrocolloids in the Development of Food Structure., in Handbook of Food Structure Development, 2019, pp. 1-28, DOI: 10.1039/9781788016155-00001.

Han, J.; Chang, Y.; Britten, M. and Lacroix, M. (2019). Interactions of phenolic compounds with milk proteins. European Food Res. and Techno, 245: 1881.

Haque, Z. U. and Ji, T. (2003). Cheddar whey processing and source: II. Effect on non- fat ice cream and yogurt. Inter. J. of Food Sci. and Techno., 38: 463.

Houzé, G.; Cases, E.; Colas, B. and Cayot, P. (2005). Viscoelastic properties of acid milk gel as affected by fat nature at low level. Inter. Dairy J., 15: 1006.

Ibrahim, A. and Khalifa, S.A. (2015). The effects of various stabilizers on physiochemical properties of camel milk yoghurt. J. Amer. Sci., 11: 15.

Imeson, A. (1997). Thickening and gelling agents for food, 2nd edition. Blackie Academic and Professional, London, UK.

Imhof, R. and Bosset, J.O (1994). Relationships between Micro-Organisms and Formation of Aroma Compounds in Fermented Dairy Products. Zeitschrift Für Lebensmittel-Untersuchung Und -Forschung 198: 267.

Khalil, R.A.M (2013). The Use of Pomegranate Juice as a Natural Source for Antioxidant In Making Functional Yoghurt Drink. Egyptian J. Dairy Sci., 41:134.

Li, W.; Hosseinian, F.S; Tsopmo, A.; Friel, J.K. and Beta, T. (2009). Evaluation of antioxidant capacity and aroma quality of breast milk. Nutrition, 25: 105.

Lindmark-Mansson, H. and Akesson, B. (2000). Antioxidative factors in milk. British J. of Nutrition, 84: 103.

Lucey, J.A., Tamehana, M., Singh, H., & Munro, P. A. (1999). Stability of model acid milk beverage: effect of pectin concentration, storage temperature and milk heat treatment. Journal of Texture Studies, 30: 305.

Macit, E. and Bakirci, I. (2017). Effect of different stabilizers on quality characteristics of the set-type yogurt. African J. of Biotechnology, 16: 2142.

Ntazinda, A.; Cheserek, M.J.; Sheng, L.; Meng, J. and Lu, R. (2014). Combination effect of sodium carboxymethyl cellulose and soybean soluble polysaccharides on stability of acidified skimmed milk drinks. Dairy Sci. & Technol., 94:283.

Okoth, E.; Kinyanjui, P.; Kinyuru, J. and Juma, F. (2012). Effects of substituting skimmed milk powder with modified starch in yoghurt production. J. Agric. Sci. Technol. 13:15.

Poyrazoglu, E.; Gokmen, V. and Artik, N. (2002). Organic acids and phenolic compounds in pomegranates (Punica granatum L.) grown in Turkey. J. Food Comp. Anal., 15: 567.

Saha, D. and Bhattacharya,. (2010). Hydrocolloids as thickening and gelling agents in food: a critical review. J. Food Sci. Technol., 47: 587.

Santagati, N. A.; Duro, R. and Duro, F. (1984). Study on pigments present in pomegranate seeds. Journal of Commodity Science, 23: 247.

Schonbrun, R. (2002). The effects of various stabilizers on mouth feel and other attributes of drinkable yoghurt. M.SC thesis, University of Florida, USA.

Seeram, N.P., Zhang, Y., Reed, J.D., Krueger, C.G. & Vaya, J. (2006). Pomegranate phytochemicals. In N.P. Seeram, R.N. Schulman & D. Heber, Pomegranates: ancient roots to modern medicine (pp. 3-46). New York: CRC Press.

Silva, E.M.; Souza, J.N.S.; Rogez, H.; Rees, J.F. and Larondelle, Y. (2006). Antioxidant activities and polyphenolic contents of fifteen selected plant species from the Amazonian region. Food Chem. 101: 1012

Singleton, V.L. and Rossi, J.A. (1965) Colorimetry of total phenolics with hosphomolybdic–phosphotungstic acid reage-nts. American J. Enol. Vitic., 16: 144.

Snedcor, G.W. and Cochran, W.G. (1967) Statistical Methods, 6th ed., Iowa state University press, Iowa, U.S.A.

Steijns, J.M. (2008). Dairy products and health: Focus on their constituents or on the matrix. Intern. Dairy J., 18: 425.

Tamime, A.Y. and Robinson, R.K. (2007). Yogurt Science and Technology. Boca Raton Boston New York Washington, DC. 35-41.

Walstra, P. (1996). Dispersed systems: basic considerations. Food Science and Technology-New York-MArcel Dekker, pp. 95-156.

Wu, J.; Gao, H.; Zhao, L.; Liao, X. Chen, F.; Wang, Z. and Hu, X. (2007). Chemical compositional characterization of some apple cultivars. Food Chem. 103: 88.

Yu, H.; Sabato, S.F.; D'Aprano, G. and Lacroix, M. (2004). Effect of the addition of CMC on the aggregation behavior of proteins. Radiat Phys Chem., 71:131.

أثر إستخدام مثبتات مختلفة على الخواص الفسيوكيماوية والحسية فى صناعة مشروب يوجهورت وظيفى يحتوى على عصير الرمان

تم دراسة إستخدام عدد من المثبتات فى صناعة مشروب يوجهورت وظيفى يحتوى على عصير الرمان للتغلب على التأثير السلبى للرمان على الخواص الريولوجية. إستخدم لبن معدل (1.5% دهن) مدعم بلبن فرز مجفف بنسبة 2.2% لصناعة اليوجهورت والمثبتات المستخدمة تتضمن إستخدام 1.5% نشا معدل، 0.2% صمغ الزانثان، 0.3% كربوكسى ميثيل سليلوز الصوديوم وخلط منهم, وتم إعداد المخاليط المختلفة لمشروبات اليوجهورت باستخدام 55% يوجهورت، 15% عصير الرمان مع 30% محلول سكرى مبرد مع المثبتات المختلفة ليعطى نسبة 8% سكر فى المنتج النهائى. تم معاملة المخاليط المختلفة حراريا على 75+1هم ثم التبريد. وتم تتبع أثر أنواع المثبتات المختلفة على الصفات الريولوجية، % لانفصال السيرم، المواد الفينولية والنشاط المضاد للأكسدة

للمنتجات المختلفة خلال 12 يوم من التخزين المبرد للمنتج. وأوضحت النتائج المتحصل عليها أن المثبتات المختلفة كان لها تأثير متفاوت فى الصفات الريولوجية وكذا معدل إنفصال السيرم مع عدم وجود فروق معنوية فى محتواه من البروتين، الدهن وقيم الأس الهيدروجينى. ووجد أن مشروب اليوجهورت المصنع باستخدام النشا المعدل كربوكسى ميثيل سليلوز الصوديوم والخليط ما بينهم كان لها تأثير إيجابى معنوى على الصفات الريولوجية مع تقليل معدل إنفصال الشرش والصفات الحسية.