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Low Fat Flavored Stirred Yogurt Treated with different Stabilizers for Improving Its Properties and Quality

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ABSTRACT

The aim of this study is investigating the effect of the addition of various stabilizers on physicochemical and organoleptic properties of flavored stirred yogurt. The stirred flavored yogurt was prepared by adding strawberry juice (15%) and different stabilizers to previously standardized buffalo's milk (2% fat).The added stabilizers were; carboxy methyl cellulose (CMC), starch, gelatin, gum Arabic and gum tragacanth at levels of 0.5, 0.5, 0.5, 1 and 0.3%, respectively. The chemical composition, sensory properties and some physical measurements of the flavored stirred yogurt samples were studied during 10 days of storage at 5±1ºC. The results showed lower moisture and higher ash contents, compared with control. The pH values were significantly different ($P \leq 0.05$) among the treated and control samples; the highest pH value was noticed in control samples, while the lowest was in samples treated with gum tragacanth. Samples treated with starch clarifying higher water holding capacity, more viscosity and lower syneresis, compared with all other treatments and control. Samples of stirred yogurt enriched with starch gained the highest total scores, comparing with other treatments and control.

Keywords: Flavored stirred yogurt, Stabilizers, Starch, CMC, Syneresis and Water holding capacity.

INTRODUCTION

One of the most consuming dairy products all over the world is yogurt. *Streptococcus thermophilus*, *Lactobacillus delbrueckii subsp. bulgaricus* are usually used in preparing the starter used in yogurt making. When a sufficient quantity of lactic acid is produced the milk coagulates and becomes in a set form. While stirred yogurt is prepared similarly but after the fermentation was occurred the coagulum is "broken" by agitation, then cooling and packing. This type of yogurt its texture will be less firm than a set yogurt (Thompson *et al*., 2007, Aswal *et al.*, 2012 and Abdelmoneim *et al*., 2016).

Drinkable yogurts are a standout among the healthy dairy beverages being in the markets today. Many flavors and range from runny to viscous, sourly unsweetened to overwhelmingly saccharine. It is increasingly popular from various age groups, not just children (Gad and Mohamed, 2014 and Newbold and Koppel, 2018).

Syneresis is one of the most defects which could be prevented by adding hydrocolloids to drinkable yogurt for increasing its viscosity. Stabilizers are irreplaceable substances in food and classified as food additives. They are commonly used in cultured products for controlling texture and reducing whey separation as they impart good resistance to syneresis and give a smooth sensation in the mouth through binding water and reducing the flow of water in the food matrix space (Amatayakul *et al.*, 2006, Dilrukshi and Ranasinghe, 2014 and Baer *et al.*, 1997).

Blending stabilizers are used to overcome one of the problem related with the specific compound. Stabilizer used solely can be suitable for the manufacture of fruit flavored yogurt but may not be suitable for the manufacture of other types of yogurt. These additives have the property to form gel networks which makes yogurt more resistance for water separation and had firmer texture. Stabilizers like guar gum, locust bean gum (carob bean gum), xanthan gum, carboxy methyl cellulose, carrageenan, gelatin, pectin, starch, sodium and propylene glycol alginates are used as stabilizers in yogurt production (Verbeken *et al*., 2003 Lal *et al.*,2006, Maha *et al.*,2011 Tasneem *et al.*,2014)

Stabilizers can form a network of linkages between themselves and the milk constituents as it contains hydrogen or carboxyl radicals present in their structure (Tamime and Robinson, 1999).Serum separation is the main textural defect occurred in drinking yogurt during storage, and it is industrially known as "Wheying off". So the aim of this study is manufacturing of flavored low fat stirred yoghurt by adding different stabilizers to improve its properties and studying its effect on the chemical, physical and organoleptic properties.

MATERIALS AND METHODS

Fresh raw buffaloes' milk (fat 6.5%, protein 4.88%, total solids 17.10% and pH 6.70) was obtained from the herd of animal production farm, Faculty of Agriculture Fayoum University, Egypt. Carboxy methyl cellulose of analytical grade and was purchased from Sigma Company. Pure fine grade stabilizers; starch, gelatin and Arabic gum were purchased from local market at Fayoum, Egypt. While gum tragacanth, was imported from United States (USA).

Preliminary experiments were conducted to optimize the level of different stabilizers used in the making of flavored low fat stirred yogurt. The added levels were from 0.1-1% for CMC, starch and gelatin, while gum Arabic and gum tragacanth used with levels of 0.5-2% and 0.1-0.5%, respectively. Depending on the consumer's acceptance the main added levels of each stabilizer was chosen for making the stirred yogurt. Flavored low fat stirred yogurt was made as shown in (Fig.1) by adding the previous stabilizers

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individually to the standardized buffalo's milk (2% fat) at 50ºC.The added levels of carboxy methyl cellulose (CMC), starch, gelatin, gum Arabic and gum tragacanth were, 0.5% (T1), 0.5% (T2), 0.5% (T3), 1% (T4) and 0.3% (T5), respectively. Inoculation of milk with 2% of a fresh starter culture was occurred and then incubation at 40ºC until curdling (~2hr), followed by cooling to 5ºC. Each treatment was blended to break the curd then, 15% of strawberry juice and 8% of sugar was added and the resultant flavored stirred yogurt packing and stored at 5ºC till analysis. Chemical composition, sensory properties and some physical measurements of the resulted flavored stirred yogurt samples were examined during 10 days of storage at 5±1ºC.

Fat (Gerber method), moisture (oven drying method), ash (muffle furnace at 550ºC), pH values (using pH meter with a glass electrode Model pH-Kent EIL 7020) and total nitrogen (micro-Kjeldahel method) were determined as described in AOAC (2012).

Water holding capacity (WHC) of the examined samples was by taking 20 g of the yogurt as explained by Wu *et al.* (2001). The WHC was then calculated as follows:

$$\textbf{WHC (\%)} = [1-W_t / W_i] \times 100$$

Where

w_t is weight (g) of the pellet and w_i is initial weight (g) of the sample.

The syneresis of yogurt samples was measured as mentioned by Gonçalvez *et al*. (2005). Viscosity of the homogenized samples was measured using a DV-E Viscometer with spindle No. 4 at 60 rpm (Brookfield, model LVDVE 230, serial number E5896). The results were recorded in centipoises (CP) after 50 s of shearing at 25°C (Gassem and Frank, 1997).

Flavored low fat stirred yogurt was sensory evaluated when fresh (day 1) and after 5and 10 days of storage by 10 members of Dairy Department, Fayoum University, Egypt as described by Bodyfelt *et al.* (1988).

Statistical analysis

All obtained data were expressed as mean value + standard error and analyzed by general linear model of SPSS (2007). The mean of the values, were compared with the main effects using Duncan’s multiple range tests (Duncan’s, 1955) when significant F values were obtained $P \leq 0.05$.

RESULTS AND DISCUSSION

Results illustrated in (Table 1) show the moisture, fat and ash contents of different yogurt samples during the cold storage. The highest moisture content of 83.53 % was detected in control yogurt when fresh, while the lowest content of 82.46 % was observed in the treatment enriched with gum Arabic (T4) at the same previous age. The moisture contents of treated yogurt samples were significantly different ($P \leq 0.05$), compared with the control. Lower moisture contents were detected in treated flavored stirred yogurt samples than control during the cold storage at 5±1°C. Among the treated samples and by the end of storage period; the highest moisture content (82.41 %) was recorded in T4 treatment, while the lowest water content of 82.13 % was recorded in T3 treatment. This change was related to stabilizers addition and their contributions to moisture contents of yogurt samples, through increasing the total solids of milk (Andiç *et al.,* 2013). The present results are in accordance with those of Mehanna *et al.* 2013 and Ibrahim and Khalifa 2015).

Variations in the fat content of stirred yogurt samples were found to be highly significant ($P \leq 0.05$) during storage and non-significant ($P \geq 0.05$) among the examined treatments (Table 1). The highest fat content was 2.13 % which recorded in the control stirred yogurt and T2 treatment when fresh, while the lowest fat content of 2.03% was obtained in T3 treatment. The fat content increased at the end of cold storage of different stirred yogurt samples. This increase in fat content could be attributed to the gradual decrease of moisture content in all samples of stirred yogurt treatments throughout the storage period. Similar results were obtained by Ibrahim and Khalifa (2015); Macit and Bakirci (2017); Wijesinghe *et al.* (2018).

The ash content (Table 1) increased in all samples of flavored treated stirred yogurt and control during the cold storage, which might be due to the loss of water and subsequent increase of the dry matter. Similar trend was observed by Alakali *et al.* (2008); Andiç *et al.* (2013); Bhattarai *et al*. (2015). The statistical analysis of treatment effect show significant difference ($P \leq 0.05$) in ash content, among the treated variants with stabilizers and control. The highest ash content was noticed in control stirred yogurt (0.67%), followed by T5 treatment (0.66 %), while the lowest readings of 0.62 and 0.63 were recorded in T2 and T4 treatments, respectively. On the other hand the interaction between treatments and the storage period was not significant (($P \geq 0.05$).

Regarding the protein content of the examined treatments (Table 1) it could be noticed that the storage period has a significant effect ($P \leq 0.05$) among the low fat flavored stirred yogurt samples and control. Slight increase in protein content might be due to the decrease in water content of yogurt samples during storage period. The added stabilizer resulted in a slight effect on the protein content of different yogurt samples as reported by Andiç*et al.* (2013); Ibrahim and Khalifa (2015).

Significant difference ($P \leq 0.05$) in the total carbohydrate contents could be observed between yogurt treatments with different stabilizers. Furthermore, an increase in total carbohydrate was observed in all yogurt treatments, which might be related to the decrease in the moisture content and increase in the dry matter contents with progress of storage. The highest TC content (11.12 %) was recorded in stirred yogurt sample being made with gum Arabic (T4) treatment when fresh, while the lowest TC content was noticed in control which recorded 9.69 %. On the other hand, by the end of storage period; T3 treatment recorded the highest TC content (10.76 %), while the control yogurt recorded the lowest TC content (10.24%), which came in harmony with Gad and Mohamad (2014).

There was a significant difference ($P \leq 0.05$) in pH values among the treatments made with different stabilizers and also during the storage period. There was a decrease for pH in all yogurt samples up to the end of storage period. This decrease might be related to conversion of lactose to lactic acid by the action of lactic acid bacteria (Ehirim and Onyeneke, 2013). The control sample had the highest pH value; 4.50 at fresh time, while, T5 treatment had the lowest pH value; 4.44, which in agreement with Bhattarai *et al.* 2015 and Ibrahim and Khalifa (2015), who reported that, the decline of pH value may be due to the continued fermentation process and also to the acidity of some the added stabilizers.

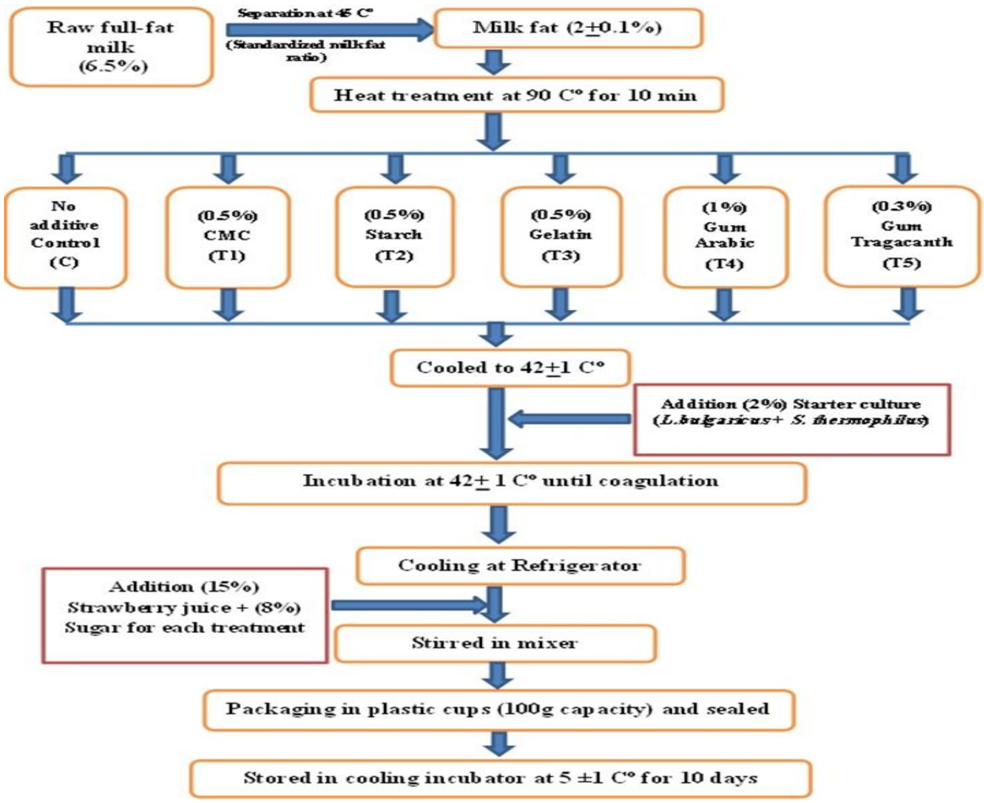

Fig. 1. Flow diagram explains manufacture steps of the low fat flavored stirred yogurt treated with different stabilizers.

Table 1. Effect of adding different stabilizers on chemical composition of low fat flavored stirred yogurt during storage at 5±1ºC

Components	Storage period (days)	C	T_1	T_2	T_3	T_4	T_5	Mean**
Moisture content (%)	Fresh	83.53^{a}	82.97^{d}	82.92^{e}	82.99^{d}	82.46^{i}	83.22^{b}	83.01^{a}
	5	83.01^{c}	82.66^{h}	82.70^{g}	82.69^{g}	82.06^{n}	82.84^{f}	82.66^{b}
	10	82.15^{lm}	82.16^{l}	82.29^{k}	82.13^{m}	82.41^{j}	82.17^{l}	82.22^{c}
SE±				0.008				0.003
Mean		82.90^{a}	82.60^{d}	82.64^{c}	82.60^{d}	82.31^{e}	82.74^{b}	±0.004
Fat content (%)	Fresh	2.13	2.07	2.13	2.03	2.07	2.10	2.09^{c}
	5	2.27	2.17	2.17	2.10	2.13	2.17	2.17^{b}
	10	2.37	2.27	2.27	2.17	2.27	2.27	2.261^{a}
SE±				0.031				0.013
Mean		2.25^{a}	2.17^{b}	2.19^{b}	2.10^{c}	2.14^{bc}	2.18^{b}	±0.018
Ash content (%)	Fresh	0.63	0.62	0.60	0.61	0.59	0.62	0.61^{c}
	5	0.66	0.64	0.61	0.63	0.62	0.65	0.64^{b}
	10	0.71	0.68	0.64	0.67	0.67	0.70	0.68^{a}
SE±				0.006				0.002
Mean		0.67^{a}	0.65^{c}	0.62^{f}	0.64^{d}	0.63^{e}	0.66^{b}	±0.003
Total protein (%)	Fresh	4.02	3.96	3.83	3.89	3.76	3.96	3.90^{c}
	5	4.21	4.08	3.90	4.02	3.96	4.15	4.05^{b}
	10	4.53	4.34	4.08	4.28	4.28	4.47	4.33^{a}
SE±				0.037				0.015
Mean		4.25^{a}	4.13^{c}	3.93^{f}	4.06^{d}	4.00^{e}	4.19^{b}	±0.02
Total carbohydrate (TC) (%)	Fresh	9.69^{h}	10.39^{ef}	10.52^{cde}	10.48^{de}	11.12^{a}	10.11^{g}	10.38^{b}
	5	9.85^{h}	10.45^{de}	10.63^{bcd}	10.56^{cde}	11.23^{a}	10.2^{g}	10.49^{a}
	10	10.24^{fg}	10.56^{cde}	10.72^{bc}	10.76^{b}	10.41^{ef}	10.4^{ef}	10.51^{a}
SE±				0.036				0.026
Mean		9.93^{e}	10.47^{c}	10.62^{b}	10.60^{b}	10.92^{a}	10.23^{d}	±0.03
pH values	Fresh	4.50	4.48	4.46	4.46	4.48	4.44	4.47^{a}
	5	4.47	4.44	4.42	4.42	4.44	4.41	4.43^{b}
	10	4.39	4.38	4.34	4.35	4.37	4.33	4.36^{c}
SE±				0.003				0.001
Mean		4.45^{a}	4.43^{b}	4.41^{c}	4.41^{c}	4.43^{b}	4.39^{d}	±0.002

a, b,………..and m: Means having different superscripts within each row are significantly different ($P \leq 0.05$), SE: Standard error, C: Low fat flavored stirred yogurt without stabilizers (Control),T1, T2, T3, T4 and T5; represent treatments of stabilized Low fat flavored stirred yogurt enriched with 0.5% CMC, 0.5% Starch, 0.5% Gelatin, 1% Gum Arabic and 0.3% Gum Tragacanth, respectively.

The physical parameters of stirred yogurt samples during storage period are shown in Figs. (2-4). It obvious that viscosity (Fig. 2) of control and the stirred yogurt treated with different stabilizers; decreased during the cold storage, while syneresis (Fig. 3) increased. On the other hand the water holding capacity (WHC) (Fig. 4) was decreased. The highest viscosity (340 cp) was recorded in T2 treatment, while the lowest viscosity (76 cp) was recorded for T4 treatment in the fresh time. By the end of storage period, T2 treatment still keep the highest viscosity (233 cp), while the lowest one (58 cp) was recorded in T4 treatment. These results were in agreement with findings of Williams *et al.* (2004) who reported that adding starch as stabilizer in making of yogurt impart increasing of viscosity.

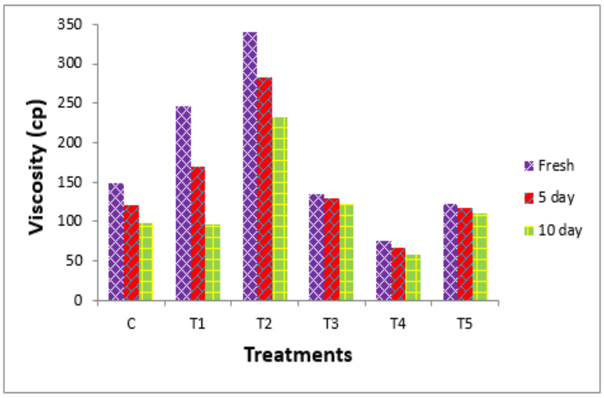

Fig .2. Effect of adding different stabilizers viscosity of low fat flavored stirred yogurt during storage at 5±1ºC.

In addition, the syneresis (Fig. 3) detected in yogurt samples made with different stabilizers was decreased when compared to that of control.

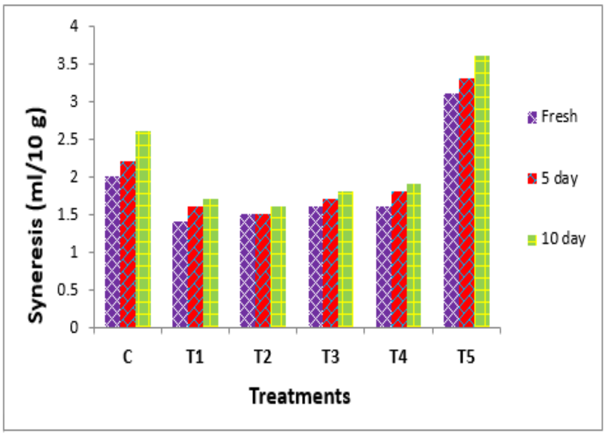

Fig .3. Effect of adding different stabilizers on syneresis (ml/10g) of low fat flavored stirred yogurt during storage at 5±1ºC.

Yogurt sample with gum Tragacanth (T5) had the highest syneresis values (3.1 ml/10g sample) between all low fat stirred yogurt samples, while the lowest syneresis value (1.4 ml/10g) was recorded for T1 treatment (CMC yogurt) at fresh time of cold storage. By the end of storage period, T5 treatment still had the highest syneresis value (3.6 ml/10g), while the control yogurt comes in the second place with (2.6 ml/10g) and T2 had the lowest syneresis reading (1.6 ml/10g).

The apparent serum separation (syneresis) in yogurt might be due to more aggregation occurred of casein particles during storage, so using of such stabilizers are necessary to prevent serum separation in fermented milks (Lucey *et al.*, 1999).

The water holding capacity (Fig. 4) of (T2) recorded the highest reading (86 %) in fresh age, while T5 treatment had the lowest reading (69 %) at the same age of storage. It is worth mention that there was an apparent difference between stabilized low fat stirred yogurt samples and control in all physical parameters. Stabilizers have two basic functions in yogurt; binding of water and improvement in texture (Thaiudom and Goff, 2003).

Yogurt samples with added stabilizers demonstrated higher water holding capacity (Fig. 4) than control samples. Wu *et al.* (2001) demonstrated that the water holding capacity was related to the ability of the proteins to retain water within the yogurt structure.

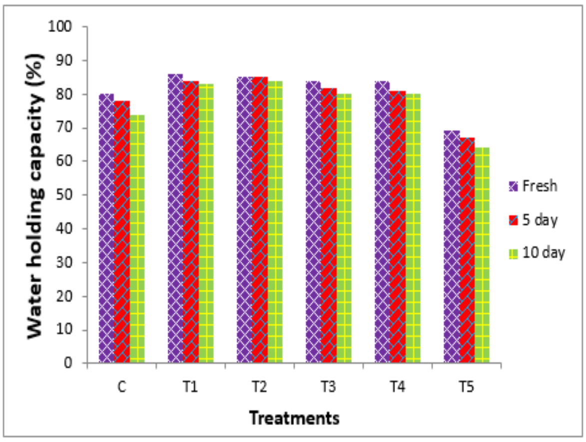

Fig .4. Water holding capacity of the flavored stirred yogurt

Data in Table (2) reveal the average scores for sensory evaluation of low fat stirred yogurt samples, as affected by different stabilizers and the storage period at 5 ±1°C. The interaction between the treatments treated with different stabilizers and the storage period show no significant differences (P≥0.05) on body&texture and color &appearance, but showed significant differences (P≤0.05) on flavor and total scores. The yogurt enriched with starch gained the highest flavor and total score points, followed by the yogurt made with T1, T3, control and T4, while T5 had the lowest flavor and total score points. Mervat *et al.* (2007) stated that yogurt prepared with stabilizer ranked higher score for texture and appearance compared to the control yogurt. This trend of results was also recorded during storage and the flavor mean scores decreased significantly as storage period progressed. The sensory scores decreased in all yogurt samples at the end of storage period (Table 2).

Starch containing yogurt was noted to have the higher texture score followed by T1, while T5 had the lowest texture score points. The scores of all yogurt samples enriched with different stabilizers gain higher total score points by the panelists than control yogurt at fresh age, which agree with Ibrahim and Khalifa 2015; Bhattarai *et al.* 2015 and Wijesinghe *et al.* (2018).

Table 2. Sensory evaluation of the low fat stabilized flavored stirred yogurt during storage at 5±1ºC

organoleptic scores	Storage period (days)	Treatments*						Mean
		C	T_1	T_2	T_3	T_4	T_5	
Flavor (45)	Fresh	42.3	43.0	43.3	42.9	42.3	42.3	42.68^{a}
	5	41.9	42.0	43.0	41.9	41.8	41.5	42.02^{a}
	10	40.6	41.8	42.3	41.7	40.5	39.7	41.10^{b}
SE±				0.15				0.27
Mean		41.60^{b}	42.27^{ab}	42.87^{a}	42.17^{ab}	41.53^{b}	41.17^{b}	±0.38
Body & texture (40)	Fresh	38.9	39.1	39.2	39.0	38.9	38.8	38.97
	5	38.8	39.0	39.1	38.8	38.7	38.8	38.87
	10	38.6	38.9	39.0	38.7	38.6	38.2	38.67
SE±				0.83				0.14
Mean		38.77	39.00	39.10	38.83	38.73	38.57	±0.20
Color & appearance (15)	Fresh	14.4	14.5	14.6	14.5	14.6	14.5	14.52
	5	14.4	14.3	14.5	14.4	14.4	14.4	14.40
	10	14.2	14.2	14.4	14.3	14.4	14.3	14.30
SE±				0.04				0.08
Mean		14.33	14.33	14.50	14.40	14.47	14.40	±0.11
Total (100)	Fresh	95.6	96.6	97.1	96.4	95.8	95.6	96.18^{a}
	5	95.1	95.3	96.6	95.1	94.9	94.7	95.28^{a}
	10	93.4	94.9	95.7	94.7	93.5	92.2	94.07^{b}
SE±				0.2				0.35
Mean		94.70^{b}	95.60^{ab}	96.47^{a}	95.40^{ab}	94.73^{b}	94.17^{b}	±0.49

A and b : Means in the same row with different superscript letters are significantly different (P≤ 0.05), *See Table (1), SE: Standard error

CONCLUSION

The results revealed that using stabilizers in the manufacture of the low fat flavored stirred yoghurt could be applied for improving the physical and sensory properties. The best stabilizer used was starch; as yogurt samples treated with starch gained the highest flavor and total score points for the sensory evaluation. Also yogurt samples treated with starch recorded more viscosity and less syneresis than all other treatments and control.

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الزبادي منخفض الدهن ذو النكهة المعامل بمثبتات مختلفة لتحسين خصائصه وجودته

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يعتبر الزبادي من أكثر منتجات الألبان شيوعًا التي تستهلك في جميع أنحاء العالم. و يُصنَّف الزبادي الذي في صورة مشروب على أنه زبادي مقلب ذي لزوجة منخفضة ويعطي نفس الفوائد الصحية والغذائية التي للزبادي المتماسك. ونجد أن إنفصال الشرش أثناء التخزين المعروف باسم "Wheying off هو العيب الأساسي في الزبادي القابل للشرب. وتستخدم المثبتات بشكل شائع لمنع فصل الشرش من الزبادي عن طريق زيادة اللزوجة. وتهدف هذه الدراسة إلي تحسين الخواص الكيميائية والحسية واللزوجة للزبادي منخفض الدهن المقلب والمطعم بعصير الفراولة. حيث تم تحضير الزبادي بنكهة الفراولة بإضافة عصير الفراولة (15٪) ومثبتات مختلفة إلى اللبن الجاموس المعدل في نسبة الدهن مسبقًا (2٪ دهون). وكانت المثبتات المضافة هي كربوكسي ميثيل السليلوز (CMC)، النشا، الجيلاتين، الصمغ العربي وصمغ التراجاكانث بمستويات 0.5، 0.5، 0.5، 1، 0.3٪،على التوالي. وتمت دراسة التركيب الكيميائي والخصائص الحسية وبعض القياسات الطبيعية لعينات الزبادي ذوالنكهة الناتجة خلال 10أيام من التخزين عند درجة حرارة 5 ± 1 درجة مئوية. أظهرت النتائج أن عينات اللبن الزبادي المقلب منخفض الدهن ذوالنكهة المضاف لها مثبتات تحتوي على نسبة رطوبة أعلى ومحتويات رماد أعلى من الكنترول. وكان هناك اختلاف معنوي في قيم الأس الهيدروجيني بين المعاملات المضاف لها المثبتات المختلفة والكنترول. تم تسجيل أعلى قيمة لدرجة الأس الهيدروجيني في الكنترول، بينما لوحظت أقل قيمة في عينات الزبادي المضاف لها صمغ التراجاكانث. فيما يتعلق بالخصائص الفيزيائية للعينات المضاف لها النشا، تظهر قدرة عالية على الاحتفاظ بالمياه وزيادة اللزوجة وأقل في الشرش المنفصل عن عينات الكنترول. كما أظهرت عينات اللبن الزبادي المضاف لها النشا أعلى الدرجات الكلية للتقييم الحسي مقارنة بالمعاملات الأخرى والكنترول.