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MANUFACTURE OF SWEETENED FULL-FAT YOGHURT WITH DIFFERENT CALORIES CONTENT

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ABSTRACT

The present study was carried out as an attempt to manufacture and study the properties of sweetened full-fat yoghurt with different calories content by using 9% sucrose (Sug), 0.015% sucralose (Suc), 5% prepared dates powder (DP) and whole cow's milk . Changes in pH values during fermentation period were followed. The resultant yoghurt was analyzed for chemical composition, some physical and sensory properties as well as the energy content for the fresh and stored yoghurt. The results showed that, treatments had insignificant effect on the activity of yoghurt starter culture. Sug and Suc had insignificant effect on the acidity and pH either in fresh or stored yoghurt, whereas the use of DP increased them significantly. No significant increase in acidity or decrease in pH values were recorded during storage period. TS, ash and carbohydrates contents were greatly affected due to adding 9% Sug and 5% DP, whereas fat and protein were not affected by the used additives, while due to storage period the effects were insignificant. Sug and DP treatments had the highest significant energy values (97.26 and 82.76 kcal/100 g in order), while Suc gave an opportunity to prepare sweetened low-calorie yoghurt with insignificant differences compared to the control. The significant increase in curd tension (CT) in Sug-yoghurt was accompanied by lower curd syneresis (CS) in most cases as compared with those of the control samples. Sensory properties were not significantly affected by treatments, but sucralose caused more smoothness and sweetness when compared with sucrose. DP-yoghurt had slightly brown colour which was colour for set yoghurt. In general, all samples were free from bitterness rejected by some panelists and accepted by others, who found it an accepted no, cooked and foreign flavours.

INTRODUCTION

In efforts to offer variety and competition in the market, sweetened yoghurt may attract new yoghurt consumers due to a pleasant level of acidity and a pleasing balance of flavours. Typically, yoghurt is characterized as a smooth, viscous gel with a characteristic taste of sharp acid **(Bodyfelt et al 1988)**. One method of manufacturing plain and flavoured yoghurt involves the addition of sweeteners to the base mix before fermentation to increase consumer acceptance **(McGregor and White, 1986)**. Additionally, in spite of consumption of low-fat and diet types of yoghurt has increased steadily since 1960s in most European and North American countries and also recently in Egypt, the role of fat in yoghurt still quite important for its impact on palatability of the product and it is also responsible for the smoothness and richness of the body and texture as well as flavour. Such improved attributes are of great importance for the consumer. **Mehanna et al (2000)** decreased the TS content of buffalo's milk aiming to produce low-calorie zabady. In modern Egyptian dairies, full-fat yoghurt (FFY) is made from whole standardized cow's milk to get impact of fat on improving quality of yoghurt. Concerning sucrose, it is well known that sucrose is a non-reducing sugar and it is stable in a heated neutral solution of up to 100°C. It consists of glucose and fructose which are both reducing sugars. It has been said that sucrose is not tolerated by diabetics and that it contributes to heart disease but this has been publicly refuted **(Glinsman et al**

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1986). However, its caloric value (4kcal/g) may appear too high, but it is the standard bulk sweetener. Most food applications were originally developed with sweetness and other functional properties of sucrose in mind. The most important finding was possibility of making sweetened FFY with high and low energy content by using sucrose and sucralose respectively. Sucralose is a zero – calorie artificial sweetener with an approximately 600 times as sweet as sucrose and was approved by the IDF for use as a food additive in 1998 **(IDF, 1998)**.

The objectives of the current study were 1) to manufacture and study quality of yoghurt made from whole cow's milk supplemented with 9 % sucrose (Sug) to give sweetened high-calorie yoghurt which could be suitable for children and young people who need more energy and with 0.015 % sucralose (Suc) to give sweetened low-calorie yoghurt of nearly the same chemical composition of plain yoghurt from full-fat cow's milk (C) but with sweetness which is normally required from great sector of consumers or with the use of 5 % dates powder (DP) to give more healthy, sweetened and flavoured yoghurt and 2) to determine the acceptance of such products as compared with C.

MATERIALS AND METHODS

Materials

Milk: Fresh cow's milk was obtained from the herds of the Faculty of Agriculture, Kafrelshiekh University (KU).Yoghurt starter culture: *Streptococcus thermophilus* and *Lactobacillus delbrueckii* spp. *bulgaricus* (YC-XII-Yo-Flex), were obtained from Chr. Hansen Laboratories, Copenhagen, Denmark) in a freeze-dried from (FD) and was DVS culture.Pectin (low-methoxyl): It was obtained from Misr Food Additives (MIFAD) Company, Cairo, Egypt. Dates, sucrose and sucralose: Dates and sucrose were purchased from the local market, whereas sucralose was obtained as a gift from Jaffan, Bros, Cairo branch, Cairo.

Preparation of dates (*phoenix dactylifera l.*) powder. This was carried out as suggested by **Magouz (2012)**. Chemical analysis of the prepared powder was carried out according to AOAC (1984).

Experimental procedures

Fresh cow's milk was treated by 0.2% pectin (LM) and heated to 90°C/15 min. before cooling to 70°C. The milk was divided into 4 equal portions to represent: Control (C), sucrose 9% (Sug), sucralose 0.015% (Suc) and dates powder 5% (DP) treatments, which were cooled to 42°C, inoculated with yoghurt starter (DVS, 0.02%) and incubated at 42°C until reaching pH of ~4.6 (complete coagulation) followed by cooling overnight in the refrigerator at 5±1°C **(Tamime and Robinson, 1999)**.

Methods

Determination of the activity of yoghurt starter culture

This was tested by following up the changes in pH values at different intervals (0.0, 30, 60, 90, 120,, 150 and 180 min.) during fermentation period at 42°C up to reaching pH of ~4.6.

Chemical analysis of yoghurt

All yoghurt samples were analyzed for titratable acidity and total nitrogen (TN) as described by **Ling (1963)**. Moisture and total solids content were determined according to **BSI (1952)**. Fat content was determined by Gerber's method as described by **BSI (1955)**. Ash content was measured as described in **AOAC (1984)**. pH values were measured using a digital pH meter (HANAA HI 8519). Carbohydrate content was calculated using the following equation: Carbohydrate = TS – (fat + protein + ash).

Physical analysis of yoghurt

Curd tension (CT) was estimated according to **Chandrasekhara et al (1957)** as described by Abd **El-Salam et al (1991)**. Curd syneresis (CS), the rate of curd syneresis at room temperature (25-30°C) was evaluated as described by **Mehanna and Mehanna (1989)**. Energy content of yoghurt was expressed in Kcal/100 g. as described by **Barrantes et al (1994)** using energy conversion factors of 4.0,4.0 and 9.0 for protein ,carbohydrates and fat contents respectively and also in Kj/100 g. as described by **Walstra and Jenness (1984)** using the following equation:

$$E = 370\,F + 170\,P + 168\,L + 18$$

Where: E = Total energy (kj/kg) F= Fat content (%) P = Protein content (%) L= Lactose or carbohydrate content (%)

Sensory evaluation

All the resultant yoghurt samples were sensory evaluated according to **El-Shibiny et al (1979)**. Samples were judged by 10 persons of the staff members and their assistants at the dairy department, KU.

Statistical analysis

Analysis of variance and Duncan's test as well as the average and standard error were carried out using a SPSS computer program **(SPSS, 1999)**.

RESULTS AND DISCUSSION

Changes in pH values during fermentation period

Fig. (1) shows the changes in pH during fermentation as an index for impact of the applied treatments on the activity of yoghurt starter culture. Results showed that the pH values gradually decreased as incubation time increased with insignificant differences among treatments and also at any given fermentation time as compared with (C). **McGregor and White (1986)** found that the time required to reach pH 4.4 decreased with the increase of sweeteners added, which attributed to stimulate the growth of Lactobacilli during incubation. **Shah and Ravula (2000)** found that the incubation time increased as the sugar level increased, especially, with 12 and 16% due to the decrease in water activity. Concerning impact of DP, the present results agree with **Magouz (2012)**. **Al-Faris et al (2005) and Borchani et al (2010)**.

Chemical Composition

Titratable acidity% (TA) and pH values

As shown in **Fig. (2)**, Sug and Suc had an insignificant effect on the TA and pH either while fresh or during storage, whereas the use of DP increased acidity of the fresh yoghurt. No significant increase in TA% or decrease in pH values were recorded during storage period. DP-yoghurt had the highest TA (0.90%) in fresh yoghurt and 0.95% in the stored samples, while Sug-yoghurt had the lowest TA (0.76%) in fresh and 0.85% in the stored samples. Similar results were noticed by **Farooq and Haque (1992)**. The results of DP agree with those given by **Magouz (2012)**.

Total solids (TS) contents

Generally, it could be seen from **Fig. (3)** that Sug and DP significantly increased TS content to 20.77% and 17.24%, respectively, whereas no significant differences were observed between Suc (12.11%) and C (12.07%), which could be attributed to the amount of Suc added, was only 0.015% (w/w). No significant differences between treatments were recorded due to storage. This agrees with the finding of **Magouz (2012)**.

Fat contents

Fig. (4) shows that no significant differences were observed in fat content due to the applied treatments and storage period since the Sug and Suc had no oil, whereas the DP had only 0.35% oil content as determined in the present study. This agrees with the finding of **Magouz (2012)**.

Ash contents

Concerning the ash content, **Fig. (5)** reveals that changes in ash content in fresh and stored FFY due to treatments were significant, whereas it was insignificant during the storage period. The maximum significant values were recorded with DP being 0.88 and 0.92% in the fresh and stored yoghurt in order. This agrees with the finding of **Magouz (2012)** and could be due to the prepared DP contained 3.59% ash.

Protein contents

Data presented in **Fig. (6)** displayed that protein content was insignificantly affected by the applied treatments in fresh yoghurt, but slightly ($P>0.05$) increased in the stored yoghurt. Such insignificant impact could be attributed to the Sug and Suc, which were free from protein, whereas analysis of DP revealed that it contained only 3.14% protein. Similar observations were found by **Magouz (2012)**.

Carbohydrate contents

Fig. (7) shows that- as expected- adding 9% sucrose and 5 % DP significantly increased carbohydrate content of the fresh and stored yoghurt. These results agree with those given by **Magouz (2012)**. Whereas adding 0.015% sucralose had insignificant effect, as compared with C. No significant differences were observed due to storage period. However, the value of 76.39% of carbohydrate content found in the prepared DP was responsible for the increase of carbohydrate in the DP-yoghurt as compared with C.

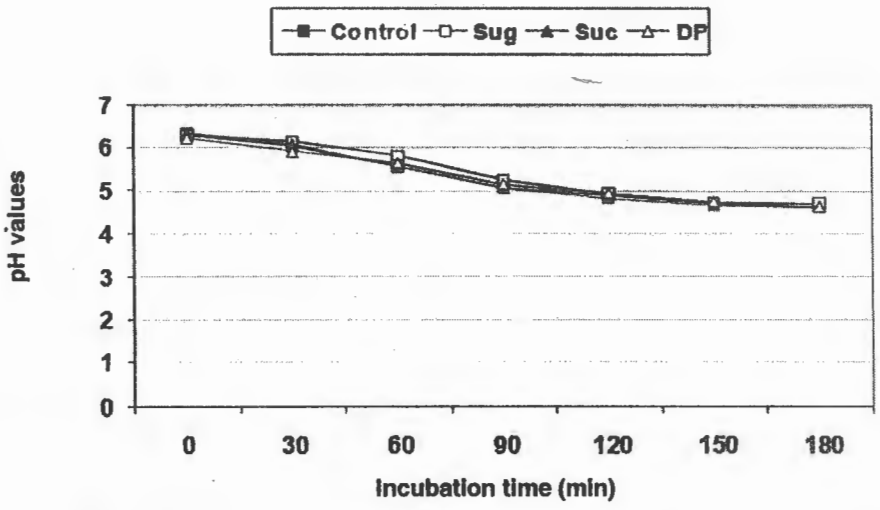

Fig. 1. Impact of using different sweeteners on pH values during incubation time

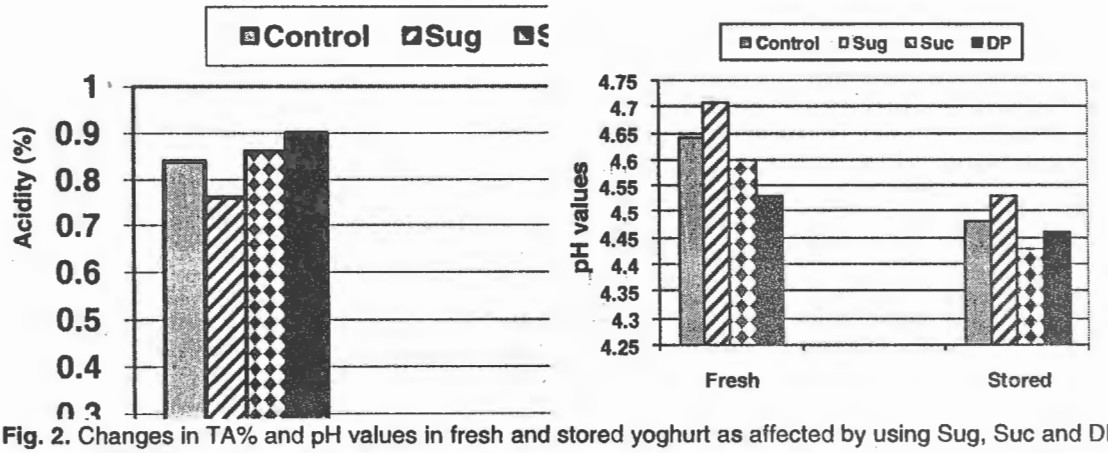

Fig. 2. Changes in TA% and pH values in fresh and stored yoghurt as affected by using Sug, Suc and DP compared with C

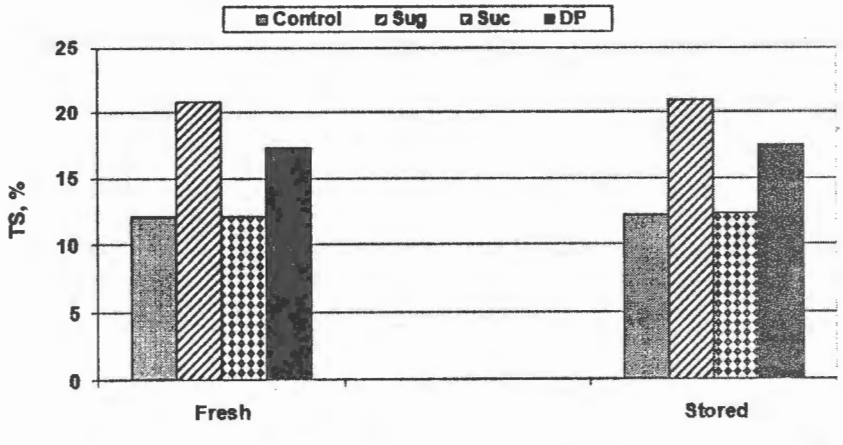

Fig. 3. Changes in TS % of fresh and stored yoghurt as affected by using Sug, Suc and DP compared with C.

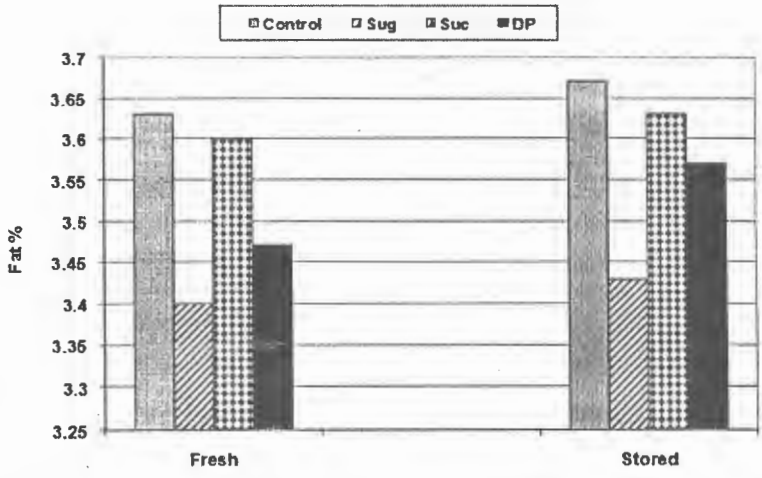

Fig. 4. Changes in fat % of fresh and stored yoghurt as affected by using Sug, Suc and DP compared with C.

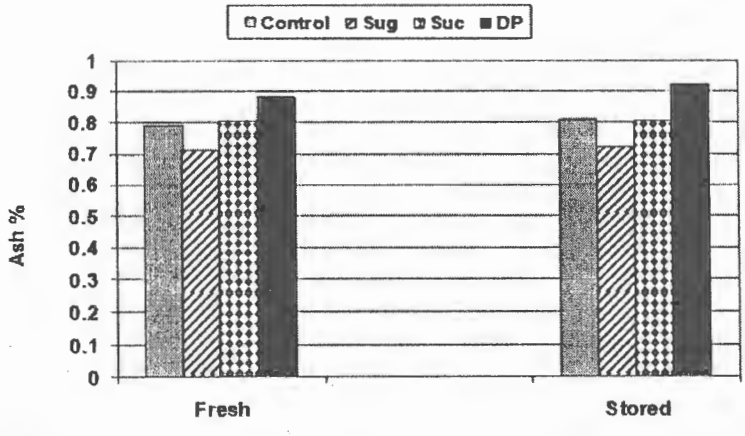

Fig. 5. Changes in ash % of fresh and stored yoghurt as affected by using Sug, Suc and DP compared with C.

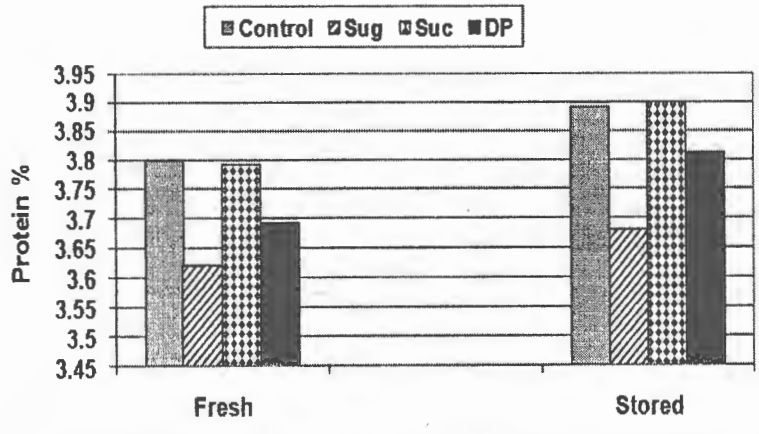

Fig. 6. Protein contents of the fresh and stored yoghurt as affected by using Sug, Suc and DP compared with C.

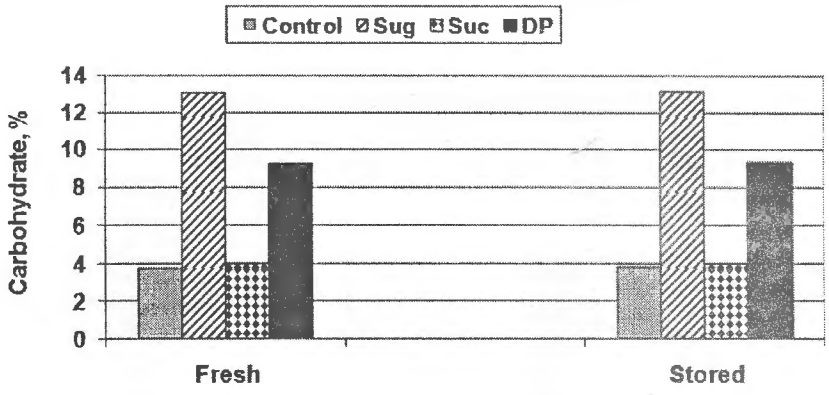

Fig. 7. Carbohydrate contents of the fresh and stored yoghurt as affected by using Sug, Suc and DP compared with C.

Energy content

It could be seen from data presented in **Fig. (8)** that the additional of Sug and DP resulted in the highest significant energy values (97.26 and 82.76 kcal/100 g in order) due to increase of carbohydrate content. Whereas Suc gave an opportunity to prepare sweetened low-calorie yoghurt with insignificant differences in compostion compared to the plain FFY. The same trend was recorded when energy content was expressed as kj/100 g. Storage had insignificant effect in this respect. The insignificant increase in energy content due to storage agrees with the finding of **Mehanna et al (2000)**.

Physical properties

Curd tension (CT)

Data in **Fig. (9)** showed that, Sug and DP caused significant effect on CT, Sug-yoghurt had the highest CT (65.87g) due to the increase of TS while, DP-yoghurt had the lowest CT (30.2 g) due to the presence of some unknown materials decreased yoghurt gel and firmness. Such values were insignificantly increased in stored yoghurt. These results agree with **El-Nawasany, (2012)**. On the other hand, impact of using DP on CT disagrees with the finding of **Magouz (2012)**. This may be attributed to differences in dates variety used.

Curd syneresis (CS)

Fig. (10) shows that CS significantly increased by increasing the holding time of syneresis (10, 20, 30 and 60 min). Differences in CS due to treatments were insignificant. DP showed more effect on decreasing CS in the stored yoghurt which could be attributed to richness of DP with 76.39% carbohydrate and 12.14% fibers as recorded from analysis of the prepared DP. Correlation between CT and CS and their changes on storage agree with the previous studies given by **Mehanna et al (2000); Sakr, (2004) and El-Nawasany (2012)**. Significant impact of DP on decreasing CS was observed by **Magouz (2012)**.

Sensory evaluation

In spite of the statistical analysis revealed no significant differences in the scores given for the organoleptic properties of yoghurt due to the applied treatments, DP caused the lowest scores for appearance, firmness, smoothness and wheying-off, where as Suc-yoghurt ranked the highest corresponding scores **(Table, 1)**. In fresh yoghurt Suc-yoghurt had relatively the highest total score (98.6) compared with C (97.2) and Sug (97.9). This could be attributed to the use of Suc gave more sweetness and more pleasant appearance and smoothness for the resultant yoghurt. On the other hand, DP-yoghurt had relatively lower score (95.2), which could be attributed to some panelists disliked the slightly brown colour and also the yoghurt had a weaker body as compared with C and the other treatments. Storage greatly improved properties of the DP-yoghurt, which means DP-yoghurt needs more time to hold more water and improve firmness of the yoghurt. The unique taste of the dates was recorded as a good flavouring agent for set yoghurt. All the prepared yoghurt samples were free from the defects of flavour and aroma given in the literature **(Rasic and Jurmann, 1978 and Tamime and Robinson, 1999)**.

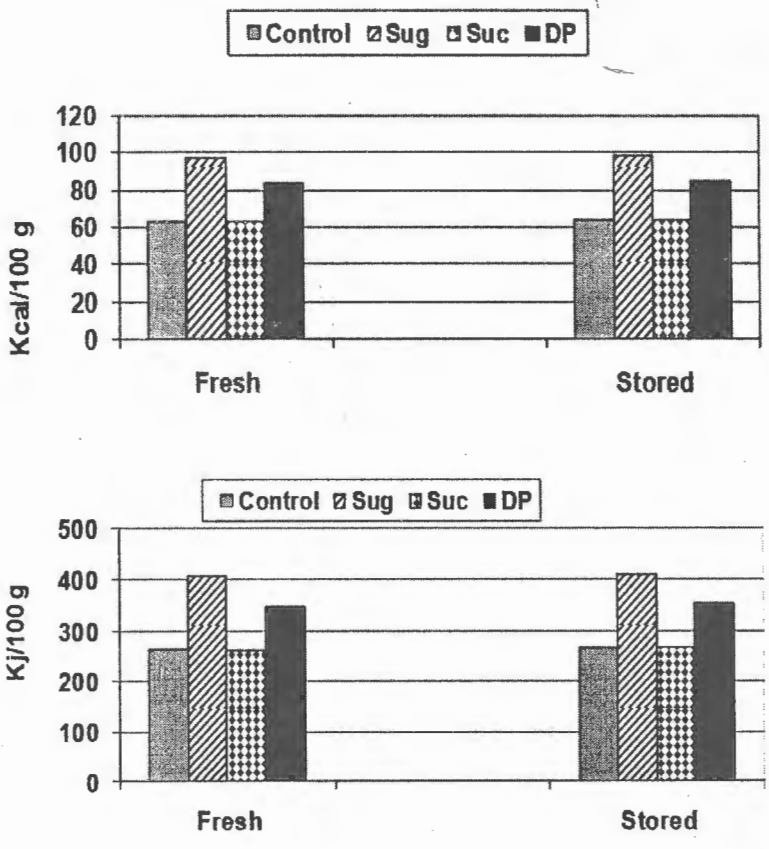

Fig. 8. Kcal and Kj/100 g of the fresh and stored yoghurt as affected by using Sug, Suc and DP compared with C.

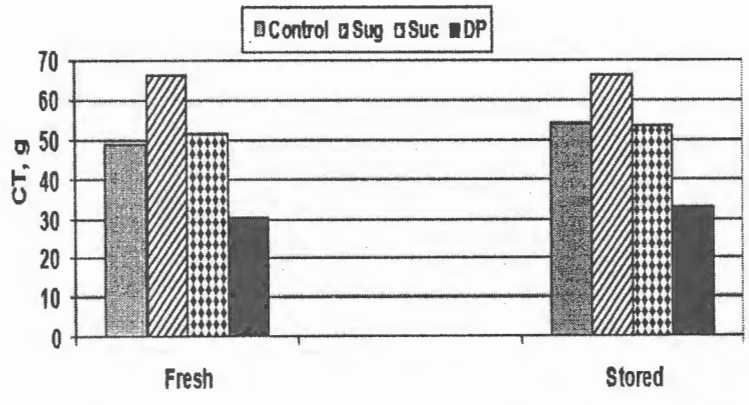

Fig. 9. Curd tension (CT/ g) of fresh and stored yoghurt as affected by using Sug, Suc and DP compared with C.

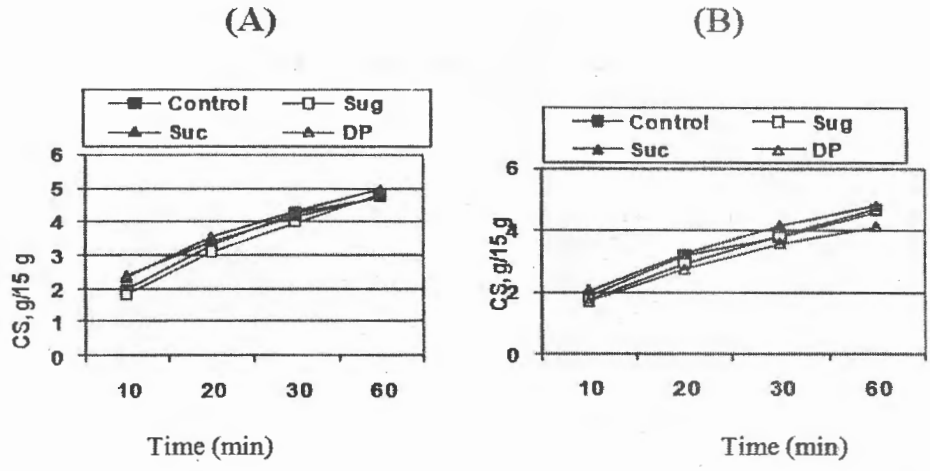

Fig. 10. Curd syneresis (g/15 g) of fresh (A) and stored (B) of yoghurt as affected by using Sug, Suc and DP compared with C.

Table 1. Sensory evaluation of fresh and stored FFY as affected by using Sug, Suc and DP compared with C. (Average ± SE of 10 panelists)*.

Property	Treatments			
	C	Sug	Suc	DP
Fresh yoghurt:				
Appearance (10)	9.7±0.15[a]	9.3±0.26[a]	9.7±0.15[a]	8.5±0.37[b]
Firmness (10)	9.3±0.21[a]	9.3±0.34[a]	9.6±0.16[a]	8.9±0.22[a]
Smoothness (10)	9.5±0.17[a]	9.2±0.33[a]	9.7±0.15[a]	9.1±0.32[a]
Wheying-off (10)	9.3±0.26[a]	9.2±0.29[a]	9.7±0.15[a]	8.9±0.30[a]
Flavour (60)	59.4±0.27[a]	59.8±0.13[a]	59.9±0.10[a]	59.8±0.20[a]
Total score (100)	**97.2**	**96.8**	**98.6**	**95.2**
Stored yoghurt:				
Appearance (10)	9.5±0.22[a]	9.5±0.17[a]	9.5±0.10[a]	9.3±0.30[a]
Firmness (10)	9.5±0.30[a]	9.2±0.13[a]	9.8±0.13[a]	9.0±0.22[a]
Smoothness (10)	9.3±0.30[a]	9.9±0.10[a]	10.0±0.0[a]	9.2±0.13[a]
Wheying-off (10)	9.6±0.16[a]	9.8±0.13[a]	10.0±0.0[a]	9.6±0.22[a]
Flavour (60)	58.64±0.34[a]	59.5±0.22[a]	59.7±0.15[a]	59.2±0.20[a]
Total score (100)	**96.54**	**97.9**	**99.0**	**96.3**

- Values in parentheses represent the maximum attainable score, whereas flavour represents acid, bitterness, flat, foreign, cooked and unclean flavours.

* Average (a and b) within the same row with different superscripts differed significantly (P ≤0.05).

It may be of interest to note that sucralose (C12H19CL3O8) is a chemically sucrose molecule in which three of the hydroxyl groups normally found in sucrose are replaced by chlorine atoms. The resulting chemical is metabolized by the body so as to not yield calories or increase blood sugar. According to U.S. Food and Drug Administration,11 to 27 percent of ingested sucralose is absorbed by the human body **(FDA,1998)**.However, sucralose, as a chemical with three chlorine-carbon bonds, belongs to a class of chemicals as chlorocarbons or organochlorines, but it is well known that sucralose is not toxic in small quantities and it is extremely insoluble in fat, it cannot accumulate in fat like chlorinated hydrocarbons and does not break down or dechlorinate **(Daniel et al 2000)**.The chemistry of organ chlorides differs from that of inorganic chloride salts, therefore comparison of sucralose to the safety of chloride salts such as those made by the IFIC are nor relvant **(IFIC, 2004)**. In general the FDA's approval **(FDA,1998)** is based on its finding that sucralose is safe for human consumption.

Finally, sweetness of the DP-yoghurt is mainly due to the prepared DP contained 76.39% soluble carbohydrates of unknown types of sugars. A high percentage of total sugars (44 – 88%) were given by Al-Shahib and Marshall (2003) for different varities of dates. It ranged from 56.1- 62.2% and included fructose and glucose **(Al-Farsi et al 2005)**. The recorded soluble carbohydrates content given by **Magouz (2012)** for DP was 80.13%. Richness of dates with reducing sugars in the form of glucose, fructose, mannose and maltose and non-reducing sugars (primarily sucrose) as well as small amounts of polysaccharides such as cellulose and starch **(Shinwari,1993)** should be taken into consideration for the use of dates fruits as a natural sweetener. Additionally, the use of dates in making yoghurt gives more health benefits since it contains minerals, vitamins and dietary fibers.

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تصنيع يوجورت محلى كامل الدسم ذو محتوى مختلف من الطاقة

[٢٩]

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الكلمات الدالة: يوجورت محلى، سكروز، سكرالوز، مسحوق التمر، محتوى الطاقـة، التركيـب، التقيـيم الحسى

الموجـــز

اجرى هذا البحث بهدف محاولة تصنيع ودراسة خواص يوجورت كامل الدسم محلى ذو محتوى مختلف من السعرات الحرارية وذلك باستخدام لبن بقرى كامل الدسم (ك) أو المضاف له ٩% سكروز معاملة (أ)، ٠,٠١٥%سكرالوز معاملة (ب) أو باستخدام ٥% مسحوق بلح التمر معاملة (ج). تم تقدير التغييرات في قيم الرقم الهيدروجينى خلال فترة التخمير. وتم تقييم اليوجورت الطازج والمخزن من خلال التحاليل الكيميائية وبعض الخصائص الفيزيائية وحساب المحتوى من الطاقة والتقييم الحسي. دلت النتائج على عدم وجود تأثير معنوى للإضافات على نشاط بادئ اليوجورت اثناء عملية التخمير. أعطت المعاملات (أ) و(ب) تأثير غير معنوي على قيم الحموضة و قيم الرقم الهيدروجينى في حين أن المعاملة (ج) سببت زيادة معنوية، ولم تتأثر القيم معنويا نتيجة التخزين. ارتفع المحتوى من الجوامد الكلية والرماد والكربوهيدرات ارتفاعا معنويا نتيجة إضافة 9 % سكروز و ٥ % مسحوق التمر ولم تكن لإضافة سكرالوز تأثيرا معنويا مقارنة بالكنترول، فى حين لم تؤثر الاضافات على المحتوى من الدهن والبروتين ولم يكن التغير نتيجة التخزين معنويا. زادت قيم الجذب الخثرى لليوجورت زيادة معنوية فى المعاملة (أ) وانخفضت فى المعاملة (ج) وقابلت هذه الزيادة فى قيم الجذب الخثرى نقص غير معنوى فى انفصال الشرش من الخثرة، ولم يكن للإضافات تأثيرا معنويا على انفصال الشرش من الخثرة سواء لليوجورت الطازج أو المخزن. تأثر محتوى اليوجورت من الطاقة تأثرا معنويا احصائيا بالإضافات حيث كانت قيم كيلو كالورى/١٠٠ جم يوجورت طازج أعلى فى المعاملات (أ) و (ج) (٩٧.٢٦)، (٨٢.٧٦) على التوالى بينما أعطى السكرالوز يوجورت محلى ذو محتوى أقل من الطاقة لا يختلف عن محتوى الطاقة بالكنترول. لم تؤثر الإضافات تأثيرا معنويا على معظم الخواص الحسية لليوجورت وكانت درجته أكثر وضوحا وتميزا فى المعاملة (ب) حيث أعطت أعلى قبول من حيث النعومة والحلاوة، فى حين أن بعض المحكمين اعترض على المظهر العام فى المعاملة (ج) التى اتصفت باللون البنى الخفيف، فى حين أن البعض الاخر أوضح انه لونا محببا وجذابا خاصة لصغار السن والاطفال. وبصفة عامة كانت كل العينات خالية من المرارة والطعم المطبوخ والطعوم الغريبة.

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