*Minufiya J. Agric. Res. Vol.35 No. 1:157-174 (2010)*"http://agri.menofia.edu.eg/megla.html"

# MANUFACTURE OF LOW FAT PREBIOTIC YOGHURT

**A. I. Hamed, K. M. K. Kebary, R. M. Badawi and Nevein S. Omar**
**Department of Dairy Sci. and Technol., Faculty of Agriculture,**
**Minufiya University, Shibin El-Kom, Egypt.**

**(Received: Dec. 14, 2009)**

**ABSTRACT**: ***Effect of replacing milk fat with inulin on the chemical, rheological, microbiological and sensory properties of probiotic yoghurt was studied. Control yoghurt was made from buffalo's milk that standardized to 4.0% fat. Two treatments were made from buffalo's milk standardized to 3.0% fat and inulin was added to them at the rate of 1.0 and 0.5%, respectively. Another two treatments were made from buffalo's milk standardized to 2.0% fat and inulin was added to them at the rate of 2.0 and 1.0% in the same order. The other two treatments were made from buffalo's milk standardized to 1.0% fat and inulin was added to them at the rate of 3.0 and 1.5% successively. Replacement of milk fat with the same amount of inulin did not affect significantly ($p > 0.05$) the total solids, total protein and ash content of low fat prebiotic yoghurt, while total solids content decreased when the amount of inulin was decreased. Replacement of milk fat with inulin caused a significant ($p \leq 0.05$) increase in total carbohydrate content, diacetyl, acetyl methyl carbinol, curd tension and acidity, while total energy and whey syneresis decreased of the resultant yoghurt treatments. Those yoghurt treatments made from 3.0 and 2.0% fat milk with adding 1.0% inulin were the most acceptable samples. Also, adding inulin stimulate the growth of total bacterial lactobacilli and streptococci. On the other hand, total solids, total protein, fat, ash and carbohydrate contents and calorific values did not change in yoghurt samples during storage, at 6 $\pm$ 1°C for 12 days, while titratable acidity and total volatile fatty acids increased at the same conditions. Whey syneresis of all yoghurt treatments decreased until the 6$^{th}$ day of storage then increased later on. Diacetyl and acetyl methyl carbinol increased up to the 6$^{th}$ day of storage then decreased as storage period progressed. Scores of sensory evaluation were almost stable during the first 6 days of storage period then decreased slightly until the end of storage period. Total bacterial, lactobacilli and streptococci counts of all yoghurt treatments increased up to the 3$^{rd}$ day of storage period then decreased until the end of storage period.***

**Key words***: Low fat, yoghurt, prebiotic, inulin, fat repalcers.*

## INTRODUCTION

**Lipids play crucial role in food products. They carry, enhance and release the flavour of the other ingredients. Lipids also interact with other ingredients to develop texture, colour and flavour of foods (Giese, 1996 and**

**De-Roos, 1997). There has been substantial interest development of a new range of dairy products which are similar to the existing products, but the fat content is substantially reduced to avoid the health problems associated with high fat intake such as diabetes, hypertension, atherosclerosis, gallbladder diseases, liver diseases and heart diseases (Williams, 1985). Low fat yoghurt can be achieved by using fat replacers.**

**Inulin is a linear non-digestible polysaccharide of β-(2-1) linked fructose residues with a terminal glucose residue unit (Tarrega and Costell, 2006). Inulin has been used as fat or sugar replacement, a low caloric bulking agents and as a textureising and water binding agent (Tungland and Meyer, 2002; Kip *et al*., 2006). Inulin has been shown to induce crucial physiological and nutritional effects such as hypotriglyceridemia, hypoinsulinemia, improved mineral absorption and stimulation of immune function and reducing colon cancer (Tahiri *et al*., 2003; Flamm *et al*., 2001; Bosscher *et al*., 2006; Huebner *et al*., 2007; Villegeas and Costell, 2007). Also, inulin increased the number and activity of probiotic bacteria such as bifidobacteria (Gibson and Roberfroid, 1995; Kebary *et al*., 2005; Badawi *et al*., 2006).**

**In view of the aforementioned the objectives of this study is to evaluate the possibility of making a good quality low fat yoghurt by replacing milk fat with inulin, which is a prebiotic. For that purpose, we may investigate the effect of using inulin on the quality of yoghurt and to monitor the chemical microbiological, rheological and sensory changes during storage of yoghurt.**

## MATERIALS AND METHODS

### Starter cultures:

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

### Manufacture of yoghurt:

**It was concerned to investigate the effect of replacing milk fat with inulin which is a carbohydrate-based fat replacer and a prebiotic on the quality of yoghurt. Seven yoghurt treatments were made from fresh buffalo's milk obtained from the herd of Faculty of Agriculture, Minufiya University, Shibin El-Kom. Control yoghurt treatment was made from buffalo's milk standardized to 4%. Another three yoghurt treatments were made from buffalo's milk standardized to 3.0, 2.0 and 1.0% fat with adding inulin (obtained from Orafti, Tienen, Belgium) at the rate of 1.0, 2.0 and 3.0%, respectively. The other three treatments were made from buffalo's milk standardized to 3.0, 2.0 and 1.0% fat with adding inulin at the rate of 0.5, 1.0 and 1.5% in the same order.**

Inulin was added to all milk treatments and stirred thoroughly during heat treatment, then filtered through cheese cloth. All milk treatments were heated to 85°C for 20 min, then cooled to 42°C and inoculated with 1.5% Streptococcus thermophilus and 1.5% Lactobacillus delbreuckii subsp. bulgaricus. The inoculated batches were packed in plastic cups and incubated at 42°C for 3.0 – 3.5 hr. until coagulation. All yoghurt treatments were stored in the refrigerator (6°C ± 1) for 12 days and were sampled when fresh and at 3, 6, 9 and 12 days for microbiological, chemical, rheological and sensory evaluation. The whole experiment was triplicated.

## Microbiological analysis:

The total bacterial count was determined using standard plate count agar (Marth, 1978). Lactobacilli was enumerated using MRS medium (DeMan *et al*., 1960), while yeast lactose agar medium was used to enumerate streptococci (Skinner and Quesnel, 1978). Yeasts and moulds were enumerated on Potato Dextrose Agar (acidified) medium (Difco, 1953).

## Rheological analysis:

Syneresis was determined according to the methods of Dannenberg and Kessler (1988) with slight modification. Hundred gram yoghurt in plastic cup was cut into four sections and transferred into a funnel fitted with 120 mesh metal screen. The whey was drained into graduated cylinder. The amount of whey drained off was measured after 120 min. at room temperature (20 ± 1°C).

Curd tension was determined by a penetrometer supplied by "Koehler" Instrument Company Inc. New York, USA was used. The test was performed as mentioned by El-Shabrawy *et al*. (2002) as follows: the penetrometer cone was adjusted to touch the surface of yoghurt sample. Then, the cone was released to skin into the sample for 5 sec. The penetration depth was recorded in units of 0.1 mm penetrometer reading which is related inversely to the firmness of the sample.

## Chemical analysis:

Fat content, titratable acidity and pH values were determined according to Ling (1963). The pH value was measured using pH meter (Jenway LTD, Felsted Dunmow, Essex, UK). Total solids, ash and total protein were determined according to the Official Method (A.O.A.C., 2000). The method of Kosikowski (1996) was used to determine the total volatile fatty acids (TVFA), while Diacetyl and acetyl methyl carbinol (DA + AMC) were determined according to the method of Brandel (1960). Carbohydrate was calculated according the following equation:

Carbohydrate (%) = Total solids % – (Fat % + Protein % + Ash %)

**Total energy of yoghurt was calculated based on conversion factors as follows; protein 4, carbohydrate 4 and fat 9 and expressed as kcal / 100 g yoghurt.**

## Sensory evaluation:

**Yoghurt was judged by ten panelists from the Staff of Department of Dairy Science and Technology and Department of Food Science and Technology, Faculty of Agriculture, Minufiya University using the 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 Costal Program. Significant differences were determined at $p \leq 0.05$ .**

## RESULTS AND DISCUSSION

**Results indicated that there were significant differences among yoghurt treatments. These difference probably due to the reduction of fat content and the amount added from inulin (Tables 1, 6). Control yoghurt made from 4% fat milk was not significantly different ($p > 0.05$) from treatments $T_1$, $T_3$, $T_5$ those made by replacing milk fat with the same ratio of inulin and were higher than other treatments. Treatment $T_6$ contained the lowest total solid content. It is obvious that the amount added from inulin affected significantly ($p \leq 0.05$) the total solids content of yoghurt treatments (Tables 1, 6). Total solids of all yoghurt treatments did not change significantly ($p > 0.05$) during storage period (Tables 1, 6). These results are in agreement with those of Abd El-Salam *et al*. (1996), Kebary and Hussein (1999), Kebary *et al*. (2004), Kebary *et al*. (2007), Badawi *et al*. (2008), El-Sonbaty *et al*. (2008) and Kebary *et al*. (2009).**

**Total protein content of all yoghurt treatments did not change significantly ($p \geq 0.05$) as storage proceeded (Tables 1, 6). Similar results were reported by Khader (1994), Kebary and Hussein (1999), Kebary *et al*. (2007), Badawi *et al*. (2008), El-Sonbaty *et al*. (2008) and Kebary *et al*. (2009). There were no significant ($p > 0.05$) differences among yoghurt treatments, which means. Replacement of milk fat with inulin did not have significant effect (p > 0.050 on protein content of yoghurt treatments similar results were reported by Kebary and Hussein (1999) and Hussein *et al*. (2004) and Badawi *et al*. (2008).**

**Fat content of all yoghurt treatments did not change significantly as storage proceeded (Tables 1, 6). These results are in accordance with those of Kebary *et al*. (1996), Kebary and Hussein (1999), Farrag (2002), Kebary *et al*. (2007), Badawi *et al*. (2008), El-Sonbaty *et al*. (2008) and Kebary *et al*. (2009).**

**Fat content of yoghurt from different batches decreased significantly ($p \leq 0.05$) by reducing the fat content of milk used in the manufacture of yoghurt. Similar results were reported by Kebary and Hussein (1999), Hussein *et al*. (2004) and Badawi *et al*. (2008).**

**Ash content of all yoghurt treatments did not change significantly ($p > 0.05$) as storage period proceeded (Tables 2, 6). These results are in agreement with those of Kebary and Hussein (1999) and Ibrahim *et al*. (2001). Yoghurt treatments were not significantly ($p > 0.05$) different from each other (Tables 2, 6), which means replacement of milk fat with inulin did not affect significantly ($p > 0.05$) the ash content of the resultant yoghurt. Similar results were reported by Salama and Hassan (1994), Kebary and Hussein (1999), Hussein *et al*. (2004), Kebary *et al*. (2004) and Badawi *et al*. (2008).**

**Carbohydrates content of all yoghurt treatments decreased slightly ($p \leq 0.05$) as storage period progressed (Tables 2, 6). This reduction in total carbohydrate might be due to the fermentation of lactose during storage. These results are in agreement with those reported by Salama and Hassan (1994) and Kebary and Hussein (1999). Carbohydrate content increased significantly ($p \leq 0.05$) by substituting the milk fat with inulin (Tables 2, 6). There were positive correlation between the carbohydrates content and the rate of adding inulin, which means carbohydrates content increased by increasing the rate of adding inulin. Yoghurt treatments those made from the same milk were significantly different from each other because of the amount added from inulin, while yoghurt treatments $T_1$ and $T_4$ were not significantly different from each other because they made with the same amount of inulin. These results are in accordance with those reported by Kebary and Hussein (1999).**

**Total calories of all yoghurt treatments did not change significantly ($p > 0.05$) as storage period progressed (Tables 2, 6) (Kebary and Hussein, 1999).**

**Replacement of milk fat with inulin caused a significant ($p \leq 0.05$) reduction of calorific value of the resultant yoghurt treatments. This reduction was proportional to the rate of replacement (Tables 2, 6). On the other hand, yoghurt treatments those made from the same milk were significantly different from each other which might be probably due to the amount added from inulin. These results are in agreement with those of Kebary and Hussein (1999).**

**Titratable acidity of all yoghurt treatments increased gradually ($p \leq 0.05$) as storage period progressed (Tables 3, 6). These results are in agreement with those of Abd El-Salam *et al*. (1996), Harby and El-Sabie (2001), Kebary *et al*. (2004) and Badawi *et al*. (2004), Kebary *et al*. (2009).**

**Table 1- 2**

**Replacement of milk fat with inulin caused a significant increase in titratable acidity (Tables 3, 6). These results might be due to the higher carbohydrates content that enhances the growth of lactic acid bacteria and subsequently developing the acidity. Also, it has been claimed that inulin stimulates the growth of lactic acid bacteria (Gibson and Roberfroid, 1995 and Kebary *et al*., 2004). Similar results were reported by Hussein and Kebary (1999); Badawi *et al*. (2008).**

**Total volatile fatty acids (TVFA) content increased significantly ($p \leq 0.05$) in all yoghurt treatments as storage period progressed (Tables 3, 6). Similar results were reported by Kebary *et al*. (1996), Kebary *et al*. (2007), Badawi *et al*. (2008) and El-Sonbaty *et al*. (2008). TVFA of all treatments increased slightly during the first nine days of storage while they increased markedly and significantly ($p < 0.05$) during the last three days of storage period. This could be attributed to the lipase activity of lactic acid bacteria. These results are in accordance with those reported by Rasic and Kurman (1978), El-Shibiny *et al*. (1979), Salama (2002) and Guven *et al*. (2005). There were slight differences among yoghurt treatments. Yoghurt treatments those made from milk containing 1% fat contained the lowest TVFA and were significantly different from yoghurt treatment made from milk containing 3% fat and control yoghurt treatment. The amount added from inulin to the same milk did not affect significantly the TVFA content of the resultant yoghurt (Tables 3, 6).**

**Diacetyl and acetyl methyl carbinol (DA + AMC) content of all yoghurt treatments increased during the first six days of storage then decreased up to the end of storage period (Table 6 and Fig. 1). Samples at the 6$^{th}$ day of storage had the highest amount of diacetyl and acetyl methyl carbinol and were significantly different from other samples at any time of storage period. These results are in agreement with those reported by Badran (1986). These results might be attributed to the reduction of DA, AMC to acetone (Cogan, 1974). Replacement of milk fat with inulin up to 1.0% caused a significant increase in DA + AMC. $T_1$ and $T_5$ contained the highest amount of total DA + AMC (Table 6 and Fig. 1). These results might be due to the stimulation effect of inulin on the growth of lactic acid bacteria and subsequently increasing the production of DA + AMC and above this concentration might affect on water activity and suppress the growth of lactic acid bacteria and production of DA + AMC (Banwart, 1981).**

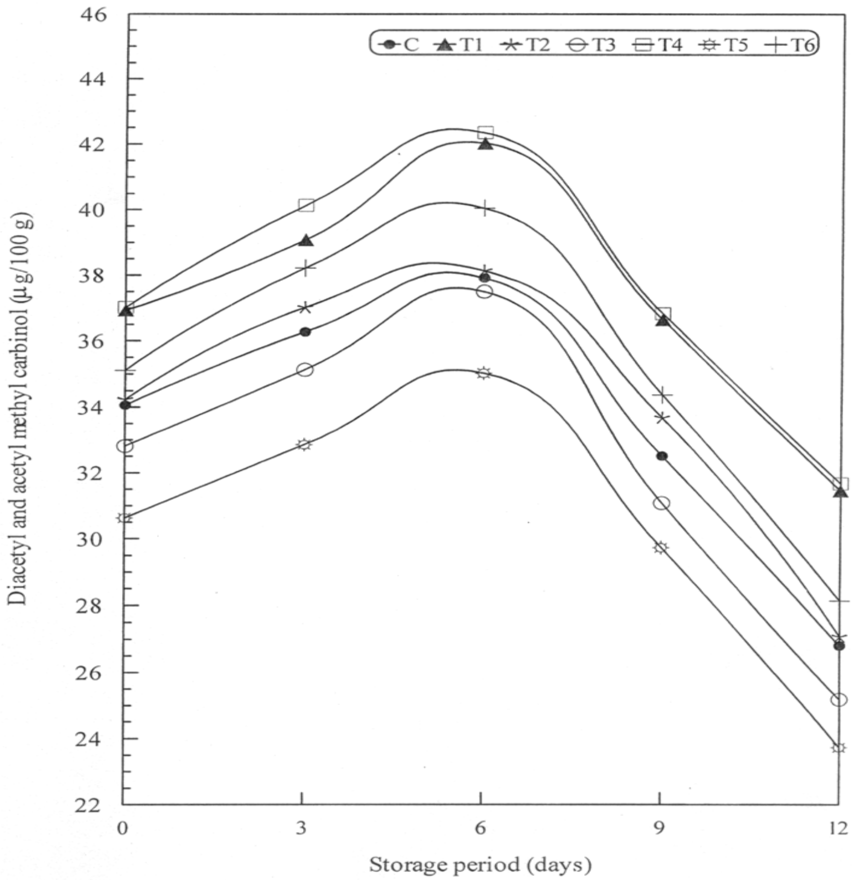


**Fig. (1). Effect of replacing milk fat with inulin on diacetyl and acetyl methyl carbinol (μg/100 g) during storageyoghurt at 6 ± 1°C for 12 days.**

**Incorporation of inulin caused a significant increase ($p \leq 0.05$) in curd tension of low fat yoghurt (Tables 3, 6). It has been claimed that inulin has been used as a texturizing agent (Tungland and Meyer, 2002, Kip *et al*., 2006 and Guggisberg *et al*., 2009). On the other hand, decreasing the total solid content decreased significantly ($p \leq 0.05$) the curd tension of the resultant yoghurt (Tables 3, 6). Treatment $T_5$ exhibited the highest curd tension while treatment $T_6$ was the least curd tension (Tables 3, 6).**

**Replacement of milk fat with inulin caused a significant ($p \leq 0.05$) reduction of whey syneresis from curd and this reduction was proportional to the rate of replacement especially when fat was replaced with the same amount of inulin (Table 6 and Fig. 2). Similar results were reported by Kebary and Hussein (1999) and Farooq and Haque (1992). These results might be due to addition of inulin**

**leads to form a complex with casein micelles and prevent them from excessive fussion and form a fine meshed gel network which is less susceptible to whey separation and / or increasing the water holding capacity (Danneberg and Kessler, 1988). Yoghurt treatments made from the same milk were significantly different from each other ($p \leq 0.05$) (Table 6 and Fig. 2), which might be due to the lower inulin content and / or lower total solids. Syneresis from all yoghurt treatments decreased gradually ($p \leq 0.05$) as storage period progressed and reached their minimum values at the sixth day of storage period, then increased up to the end of storage period (Table 6 and Fig. 2). These results are in agreement with those reported by Farooq and Haque (1992), Kebary and Hussein (1999) and Kebary *et al*. (2009).**

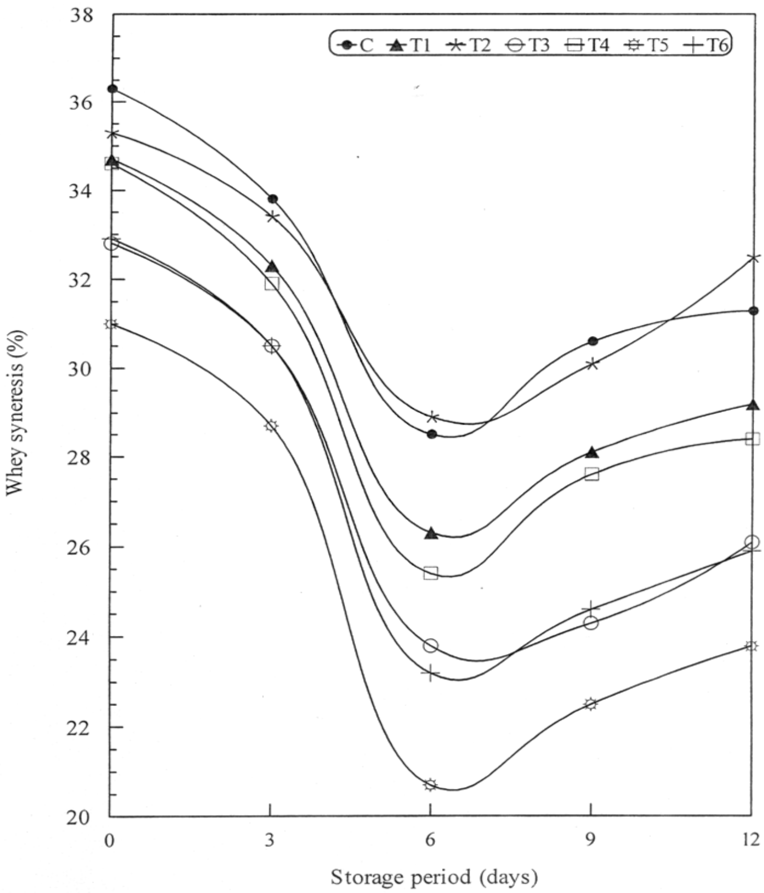


**Fig. (2). Effect of replacing milk fat with inulin on whey syneresis (%) during storage yoghurt at 6 ± 1°C for 12 days.**

Total bacterial, lactobacilli and streptococci counts followed similar results. Total bacterial, lactobacilli and streptococci counts increased as storage period progressed up to the third day, then decreased up to the end of storage period (Table 4). These results are in agreement with those reported by Kebary *et al*. (1996), Kebary and Hussein (1999), Kebary *et al*. (2004), Kebary *et al*. (2007), Badawi *et al*. (2008) and El-Sonbaty *et al*. (2008).

The counts of total bacterial, lactobacilli and streptococci increased by increasing the rate of adding inulin (Table 4). These results might be due to the stimulation effect of inulin on the growth of microflora, which consider as a prebiotic (Gibson and Roberfroid, 1995, Kebary *et al*., 2005, Donkor *et al*., 2007 and Oliveira *et al*., 2009).

Data in Table (4) show that samples were free from yeasts and moulds during the first six days of storage period. After that they appeared towards the end of storage period. These results are in agreement with those reported by Mehriz *et al*. (1993) who found that, moulds and yeasts were only detected at the end of storage period. Also, the appearance of yeasts and moulds after the $9^{th}$ day of storage might be due to the post contamination. Khanna and Singh (1979) found that, the yeasts and moulds were absent in yoghurt during first 12 days of storage and this might be due to the severe heat treatments and antibacterial activity of the ABT.

Scores of organoleptic properties (flavour, body & texture, appearance, acidity and total scores) followed similar trends (Table (5).

Although many yoghurt treatments were accepted by the panelists, the most acceptable treatments were $T_1$ and $T_5$ those made from 3 and 2% fat buffalo's milk with adding 1.0% inulin (Tables 5, 6). These results supported by the chemical analysis where $T_1$ and $T_5$ contained the highest TVFA and DA + AMC. On the other hand, scores of organoleptic properties of all yoghurt treatments did not change significantly ($p > 0.05$) during the first six days of safe storage period, then the scores decreased ($p \leq 0.05$) up to the end of storage period (Tables 5, 6). These results are in agreement with those reported by Hassan *et al*. (1999), Kebary and Hussein (1999), Zedan *et al*. (2001) and Kebary *et al*. (2004).

It can be concluded that replacement of milk fat with inulin decreased the whey syneresis and increased diacetyl and acetyl methyl carbinol content and improved the acceptability of yoghurt. Treatments were those made by adding 1.0% inulin, therefore yoghurt treatment that made from 2.0% fat buffalo's milk and adding 1.0% inulin will be used as control yoghurt in the second part of this study where it was chosen as the most acceptable yoghurt treatment and contained lower fat content.

**Table 3-4**

**Table 5-6**

## REFERENCES

Abd El-Salam, M. H., H. M. El-Etriby and N. M. Shahein (1996). Influence of some stabilizers on some chemical and physical properties of yoghurt. Egyptian J. Dairy Sic., 24: 25 – 36.

A.O.A.C. (2000). Official Method of the Association of Analytical Chemists. 17$^{th}$ ed. Published by the Association of Official Agriculture Chemists, Washington, D.C.

Badawi, R. M., A. I. Hamed, K. M. K. Kebary and Hweda A. El-Sayed (2008). Effect of replacing milk fat with fat replacers on the quality of stirred yoghurt. Egyptian, J. Diary Science, 36 (2): 197 – 206.

Badawi, R. M., K. M. K. Kebary and S. A. Hussein (2004). Impact of substituting non-fat dry milk with pictin on cow's milk yoghurt quality. Proc. 9$^{th}$ Egyptian Conf. for Dairy Sci. and Tech., pp. 133 – 151.

Badawi, R. M., S. F. Mahmoud, I. I. Badran and S. A. Hussein (2006). Quality of low sodium Domiati cheese made with adding bifidobacteria. Minufiya. J. Agric. Res., 31 (1): 21 – 35.

Badran, I. I. (1986). Studies on the use of soybean protein in yoghurt making. M.Sc. Thesis, Food Sci., Dept., Faculty of Agric., Minufiya Univ., Egypt.

Banwart, G. J. (1981). Basic food microbiology, AVI Publishing Company INC., Westport. Connecticut, USA.

Bosscher, D., J. VanLoo and A. Frank (2006). Inulin and oligofructose as functional ingredients to improve bone mineralization. Intr. Dairy J., 16: 1092 – 1079.

Brandel, E. (1960). Determination of DA + A.M.C of the starter culture. Milchwissenchaftlich Berichte, Wolf, Passing, 10 (4): 289 – 303.

Cogan, T. (1974). Aroma and flavour production by starters. Dairy Res., Rev. Ser., 6: 5.

Danneberg, F. and H. G. Kessler (1988). Effect of denaturation of B-lactoglobulin on texture properties of set-type non-fat yoghurt. I. Synersis. Milchwissens Chaft, 43: 632.

De Man, J. C., M. Rogosa and M. E. Sharpe (1960). A medium for the cultivation of lactobacilli. J. Applied Bacteriol., 23 (1): 130 – 135.

De-Roos, K. B. (1997). How lipids influence food flavour. Food Technol., 51: 60 – 62.

Difco manual (1953). Dehydrated culture media and reagents 9$^{th}$ ed. Difcolaboratories, Detriot, Michigan.

Donkor, O. N., S. L. I. Nilmini, P. Stolic, T. Vasiljevic and N. P. Shah (2007). Survival and activity of selected probiotic organisms in set-type during cold storage. Intr. Dairy J., 17 (6): 657 – 665.

El-Shabrawy, S. A., R. A. Awad and S. A. Saad (2002). Manufacture and properties of flavoured processed cheese spread with different fruit flavour. J. Annal Agric. Sci., Ain-Shams Univ., Cairo, 10: 641.

**El-Shibiny, S., H. F. El-Dein and A. A. Hofi (1979). Effect of storage on the chemical composition of zabady. Egyptian J. Dairy Sci., 7: 1 – 7.**
**El-Sonbaty, A. H., K. M. K. Kebary, R. M. Badawi and Hweda, A. El-Sayed (2008). Effect of stabilizers on the quality of stirred yoghurt. Egyptian J. Dairy Sci., 36 (2): 185 – 195.**
**Farooq, K. and Z. U. Haque (1992). Effect of sugar esters on the textural properties of non-fat low calorie yoghurt. J. Dairy Sci., 75: 2676 – 2680.**
**Farrag, A. F. (2002). Influence of particulated Whey protein concent rate on the rcheological and sensory properties of low fat yoghurt. J. Agric. Sci., Mansowra Univ., 27 (1): 379 – 393.**
**Flamm, G., W. Glinsmann, D. Kritchevsky, L. Prosky and M. Roberfroid (2001). Inulin and oligofructose as a dietary fiber: A review of the evidence. Critical Rev. Food Sci. and Nut., 41 (5): 353 – 362.**
**Gibson, G. R. and M. B. Roberfroid (1995). Dietary modulation of the human colonic microbiota: Introducing the concept of prebiotics, J. of Nut., 125: 1401 – 1412.**
**Giese, J. (1996). Fats, oils and fat replacers. Food Technol., 50 (4): 78 – 84.**
**Guggisberg, D., J. Cutbert-Steren, P. Piccinali, U. Bütikofer and P. Eberhard (2009). Rheological, microstructural and sensory characterization of low-fat and whole milk set yoghurt as influenced by inulin addition. Intr. Dairy J., 19: 107 – 115.**
**Guven, M., K. Yasar, O. B. Karaca and A. A. Hayaloglu (2005). The effect of inulin as fat replacer on the quality of set-type low-fat yoghurt manufacture. Int. J. of Dairy Technol., 58 (3): 180 – 184.**
**Harby, S. and W. El-Sabie (2001). Studieson skimmilh yoghurt using some stabilizers. Proc. 8th Egyptian. Conf. Dairy Sci. and Tech., pp.537.**
**Hassan, F. A. M., W. A. Helmy and A. E. Enab (1999). Utilization of some local polysaccharide in manufacture of yoghurt. Egyptian J. Dairy Sci., 27: 517.**
**Huebner, J., R. L. Wehling and R. W. Hutkins (2007). Functional activity of commercial prebiotics. Intr. Dairy J., 17: 775.**
**Hussein, S. A. and K. M. K. Kebary (1999). Improving viability of bifidobacteria by microentrapment and their effect on some pathogenic bacteria in stirred yoghurt. J. Dairy Sci. & Tech., 28 (2) 113 – 131.**
**Hussein, S. A., R.M. Badawi and I.I. Badran (2004). Quaality of fat free youghurt made with fat replacers. Minufiyad. Agric. Res., 29 (6): 1265 – 1315.**
**Ibrahim, M. K. E., M. A. El-Assar, Sh. G. Osman and W. M. Salama (2001). Manufacture of low fat soft cheese enriched with whey protein concentrate. Egyptian J. Dairy Sci., 29: 107 – 117.**
**Kebary, K. M. K. and S. A. Hussein (1999). Manufacture of low fat Zabady using different fat substitutes. Acta Alimentaria 28: 1 – 14.**
**Kebary, K. M. K., A. M. Moussa, A. I. Hamed and E. T. Yousef (1996). Quality of**

zabady made with Bifidobacterium bifidum DI. The proceeding of 36th Science week, Supreme Council of Science, Alepo University, Syria, Book 3, Part 1: 79 – 91.

Kebary, K. M. K., R. M. Badawi, I. I. Badran and S. A. Hussein (2005). Influence of some nutrients and bile salt on the production of antimicrobial agents by bifidobacteria. Egyptian J. Dairy Sci., 33: 157 – 170.

Kebary, K. M. K., R. M. Badawi, S. A. Hussein, I. I. Badran and A. F. Abd El-Latef (2009). UF Tallaga cheese quality made by incorporating bifidobacteria and salting rates. Minufiya J. Agric. Res., 34 (1): 17 – 33.

Kebary, K. M. K., S. A. Hussein and R. M. Badawi (2004). Impact of fortification of cow's milk with a modified starch on yoghurt quality. Egyptian J. Dairy Sci., 32 (1): 111 – 124.

Kebary, K. M. K., S. A. Hussein, R. M. Badawi and I. I. Badran (2007). Incorporation of bifidobacteria in low fat Labneh. Proc. 10th Egyptian Conf. Dairy Sci. and Technol., pp. 359 – 375.

Khader, S. A. (1994). Studies on the special dairy products. M.Sc. Thesis, Fac. of Agric., Minufiya Univ., Egypt.

Khanna, A. and J. Singh (1979). A comparison of yoghurt starter in cow's and buffalo's milk. J. Dairy Res., 46: 681.

Kip, P., D. Meyer and R. H. Jellema (2006). Inulins improve sensoricand textural properties of low-fat yoghurts. Inter. Dairy J. 16 (9): 1098 – 1103.

Kosikowski, F. V. (1966). Cheese and fermented milk foods. 2nd printing. Edward Brothers, Inc., Ann. Arbor., Mi., U.S.A.

Ling, E. R. (1963). A Text Book of dairy Chemistry, Vol. 2 Practical 3rd ed. Chapman & Hall, Ltd., London.

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

Mehriz, A. M., M. N. A. Hassan, A. A. Hefny and A. H. Aziz (1993). Manufacture and some properties of ABT cultured and sweet acidophilus milks. Egyptian J. Dairy Sci., 21: 259 – 272.

Oliveira, R. P. D., P. Perego, A. Converti and M. N. Deoliveira (2009). Effect of inulin on growth and acidification performance of different probiotic bacteria in co-cultures and mixed cultures in: Thstreptococcus thermophilus. J. Food Engineering, 91: 133 – 139.

Rasic, J. L. and J. A. Kurmann (1978). Yoghurts scientific grounds, technology, manufacture and preparations. Technical Dairy Publishing House, Copenhagen, Denmark, pp. 99 – 137.

Salama, F. M. (2002). Preparation of therapeutic and diabetic stirred yoghurt-like fermented milk products. Egyptian J. Dairy Sci., 30 (2): 177 – 190.

Salama, F. M. M. and F. A. M. Hassan (1994). Manufacture of new yoghurt like products. Egyptian J. Dairy Sci., 22: 31 – 38.

**Skinner, F. A. and L. B. Quesnel (1978). Streptococci. Academic Press, New Work, p. 390.**

**Steel, R. G. D. and J. H. Torrie (1980). Principles and Procedures of Statistics. A biometrical approach. 2nd Ed. McGraw-Hill Book Co., New York.**

**Tahiri, M., J. C. Tressol, J. Arnoud, F. R. J. Bornet, C. Bouteloup - Dermange and Feillet - Coudray, C. (2003). Five - week intake of sthort - chain fructooligosaccharides increase intestinal absorption and status of magnesium in post menopausal women, J. of Chemistry, Cambridge, UK, pp. 201 – 210.**

**Tarrega, A. and E. Costell (2006). Effect of inulin addition on rheological and sensory properties of fat-free starch-based dairy results. Intr. Dairy J., 16: 1104 – 1112.**

**Tungland, B. C., D. Meyer (2002). Nondigestible oligo- and polysaccharides (dietary fiber): Their physiology and role in human health and food, Comprehensive Reviews in Food Science and Food Safety, 1: 73 – 92.**

**Villegas, B. and E. Costell (2007). Flow behaviours of inulin-milk beverages of inulin-milk beverages. Influences of inulin average chain length and of milk fat content. Intr. Dairy J., 17: 776 – 781.**

**Williams, S. R. (1985). Nutrition and Diet therapy. Times Mirror / Mosluy, College publishing, St. Louis, Toronto and Stanta Clara.**

**Zedan, M. A., A. N. Zedan, K. M. K. Kebary and S. F. Mahmoud (2001). Effects of fortification of cow's milk with acetylated whey protein concentrates on the quality of set yoghurt. Egyptian J. Dairy Sci., 29: 285.**

# تصنيع اليوجورت الداعم للحيوية

**عبده إبراهيم حامد ، خميس محمد كامل كعبارى ، رجب محمد بدوى ، نيفين سعيد عمر**

قسم علوم وتكنولوجيا الألبان – كلية الزراعة – شبين الكوم – جامعة المنوفية

**الملخص العربي :**

**يهدف هذا البحث لدراسة إمكانية تصنيع يوجورت منخفض الدهن داعم للحيوية وذلك باستخدام الإنيولين ولقد تم تصنيع اليوجورت الكنترول من لبن جاموسى يحتوى ٤% دهن ، كما تم تصنيع معاملتان من لبن يحتوى ٣% دهن واثنتان أخرتان من لبن ٢% دهن وأخرتان من لبن يحتوى ١% حيث أضيف لهم الإنيولين بنسبة ١٠٠، ٥٠% من كمية الدهن التى تم تخفيضها ولقد أوضحت النتائج المتحصل عليها أثناء تخزين اليوجورت لمدة ١٢ يوم على درجة حرارة ٦ ± ١°م ما يلى :**

- **لم يؤثر استبدال دهن اللبن بواسطة الإنيولين على نسب كلٍ من الجوامد الصلبة الكلية – البروتين الكلى والرماد عندما تم استبدال الدهن بالإنيولين بنفس الكمية ، بينما عندما تم تخفيض كمية الإنيولين المضافة أدت إلى انخفاض نسبة الجوامد الكلية .**
- **أدى استبدال دهن اللبن بواسطة الإنيولين إلى زيادة نسب كلٍ من الكربوهيدرات ، الداى أسيتيل والأسيتايل ميثيل كربينول والحموضة وقوة الخثرة ، بينما أدى إلى انخفاض انفصال الشرش والطاقة .**
- **أدى إضافة الإنيولين إلى تشجيع نمو البكتريا وازدياد العدد الكلى للبكتريا وأعداد البكتريا العضوية والكروية خلال فترة التخزين لمدة ١٢ يوم على درجة حرارة ٦ ± ١°م .**
- **لم تتغير نسب كل من الجوامد الصلبة الكلية – البروتين الكلى – الدهن – الرماد – الكربوهيدرات أثناء التخزين ، بينما ازدادت نسب الحموضة والأحماض الدهنية الطيارة الكلية .**
- **انخفض انفصال الشرش من اليوجورت حتى اليوم السادس من التخزين على درجة حرارة مرتفعة ثم ازداد بعد ذلك بتقدم فترة التخزين .**

- **لم يحدث تغير معنوى فى درجات التحكيم حتى اليوم السادس ثم بدأت فى الانخفاض حتى نهاية فترة التخزين.**
- **ازدادت أعداد البكتريا الكلية Lactobacilli و Streptococci حتى اليوم الثالث ثم انخفضت بالتدريج حتى نهاية فترة التخزين .**
- **حصلت عينات اليوجورت المصنعة من لبن يحتوى على ٣ ، ٢% دهن مع إضافة ١% إنيولين على أعلى درجات التحكيم .**

Table (1): Effect of replacing milk fat with inulin on total solids, total protein and fat contents (%) during storage yoghurt at 6 ± 1°C for 12 days.

| Treatments[¤] | Total solids content (%) of yoghurt samples (days) | | | | | Total protein content (%) of yoghurt samples (days) | | | | | Fat content (%) of yoghurt samples (days) | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 0 | 3 | 6 | 9 | 12 | 0 | 3 | 6 | 9 | 12 | 0 | 3 | 6 | 9 | 12 |
| C* | 13.96 | 13.92 | 13.98 | 13.96 | 13.98 | 3.56 | 3.53 | 3.57 | 3.59 | 3.58 | 4.1 | 4.1 | 4.2 | 4.2 | 4.3 |
| $T_1$ | 13.83 | 13.87 | 13.91 | 13.93 | 13.91 | 3.61 | 3.59 | 3.60 | 3.63 | 3.61 | 3.1 | 3.1 | 3.2 | 3.2 | 3.2 |
| $T_2$ | 13.42 | 13.50 | 13.48 | 13.51 | 13.53 | 3.61 | 3.63 | 3.63 | 3.62 | 3.63 | 3.0 | 3.0 | 3.1 | 3.1 | 3.2 |
| $T_3$ | 13.88 | 13.90 | 13.88 | 13.91 | 13.95 | 3.59 | 3.61 | 3.60 | 3.62 | 3.59 | 2.0 | 2.1 | 2.1 | 2.2 | 2.2 |
| $T_4$ | 12.97 | 13.03 | 13.09 | 13.06 | 13.08 | 3.66 | 3.65 | 3.65 | 3.66 | 3.68 | 2.1 | 2.1 | 2.2 | 2.2 | 2.2 |
| $T_5$ | 13.91 | 13.92 | 13.91 | 13.92 | 13.96 | 3.58 | 3.60 | 3.58 | 3.61 | 3.60 | 1.1 | 1.1 | 1.1 | 1.2 | 1.2 |
| $T_6$ | 12.53 | 12.52 | 12.56 | 12.54 | 12.57 | 3.64 | 3.64 | 3.68 | 3.67 | 3.71 | 1.2 | 1.2 | 1.2 | 1.3 | 1.3 |

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

C: Control yoghurt made from 4% fat.

$T_1$, $T_2$, $T_3$, $T_4$, $T_5$, $T_6$: Yoghurt treatments made from 3, 2, 1% fat milk with adding (1.0, 0.5%; 2.0, 1.0% and 3.0, 1.5%) inulin, respectively.

Table (2): Effect of replacing milk fat with inulin on ash, carbohydrate and total calories during storage yoghurt at 6 ± 1°C for 12 days.

| Treatments ¤ | Ash content (%) of yoghurt samples (days) | | | | | Carbohydrate content (%) of yoghurt samples (days) | | | | | Total calories (k. calori / 100 g) of yoghurt samples (days) | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 0 | 3 | 6 | 9 | 12 | 0 | 3 | 6 | 9 | 12 | 0 | 3 | 6 | 9 | 12 |
| C* | 0.97 | 0.99 | 1.01 | 1.01 | 1.02 | 5.28 | 5.17 | 5.06 | 4.99 | 4.85 | 72.46 | 72.22 | 72.88 | 72.80 | 73.34 |
| $T_1$ | 0.96 | 0.97 | 0.98 | 1.01 | 1.01 | 6.16 | 6.21 | 6.13 | 6.09 | 6.09 | 66.98 | 67.10 | 67.72 | 67.68 | 67.60 |
| $T_2$ | 0.99 | 1.01 | 0.99 | 1.01 | 1.03 | 5.82 | 5.86 | 5.76 | 5.78 | 5.67 | 64.72 | 64.96 | 65.46 | 65.6 | 66.00 |
| $T_3$ | 0.98 | 0.98 | 0.98 | 1.02 | 1.02 | 7.31 | 7.21 | 7.20 | 7.07 | 7.14 | 61.60 | 62.18 | 62.10 | 62.56 | 62.72 |
| $T_4$ | 0.98 | 1.02 | 1.01 | 1.03 | 1.03 | 6.23 | 6.26 | 6.23 | 6.17 | 6.17 | 58.46 | 58.54 | 59.32 | 59.12 | 59.20 |
| $T_5$ | 0.97 | 0.99 | 0.99 | 1.02 | 1.02 | 8.26 | 8.23 | 8.24 | 8.10 | 8.14 | 57.26 | 57.22 | 57.18 | 57.60 | 57.76 |
| $T_6$ | 0.99 | 1.01 | 1.03 | 1.03 | 1.05 | 6.70 | 6.67 | 6.65 | 6.54 | 6.51 | 52.16 | 52.04 | 52.12 | 52.54 | 52.58 |

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

* See Table (1).

**Table (3): Effect of replacing milk fat with inulin on titratable acidity, total volatile fatty acids and curd tension during storage yoghurt at 6 ± 1°C for 12 days.**

| Treatments¤ | Titratable acidity (%) of yoghurt samples (days) | | | | | Total volatile fatty acids (ml NaOH 0.1 N/100 g) of yoghurt samples (days) | | | | | Penetration distance of fresh yoghurt treatments |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | 0 | 3 | 6 | 9 | 12 | 0 | 3 | 6 | 9 | 12 | |
| C* | 0.92 | 0.98 | 1.01 | 1.09 | 1.23 | 13.6 | 14.1 | 14.2 | 14.9 | 15.8 | 26.1 |
| $T_1$ | 0.92 | 1.01 | 1.09 | 1.18 | 1.29 | 13.3 | 13.5 | 13.9 | 14.3 | 14.7 | 25.9 |
| $T_2$ | 0.93 | 0.99 | 1.05 | 1.13 | 1.25 | 13.2 | 13.6 | 13.8 | 14.1 | 14.5 | 26.1 |
| $T_3$ | 0.95 | 1.04 | 1.15 | 1.21 | 1.33 | 12.5 | 12.8 | 12.9 | 13.4 | 13.8 | 24.6 |
| $T_4$ | 0.96 | 1.07 | 1.14 | 1.18 | 1.28 | 12.6 | 12.8 | 13.0 | 13.3 | 13.6 | 26.8 |
| $T_5$ | 0.96 | 1.08 | 1.13 | 1.26 | 1.35 | 12.0 | 12.3 | 12.4 | 12.9 | 13.1 | 24.5 |
| $T_6$ | 0.96 | 1.09 | 1.16 | 1.26 | 1.31 | 12.1 | 12.7 | 12.7 | 13.1 | 13.3 | 27.4 |

¤ Each value in the table was the mean of three replicates.
* See Table (1).

**Table (4): Effect of replacing milk fat with inulin on total bacterial, lactobacilli, streptococci and mould & yeast counts during storage yoghurt at 6 ± 1°C for 12 days.**

| Treatments ¤ | Total bacterial counts (cfu♦ × $10^6$ / gm) of yoghurt samples (days) | | | | | Lactobacilli count (cfu × $10^6$ / gm) of yoghurt samples (days) | | | | | Streptococci count (cfu × $10^6$ / gm) of yoghurt samples (days) | | | | | Mould and yeast (cfu × $10^2$ / gm) of yoghurt samples (days) | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 0 | 3 | 6 | 9 | 12 | 0 | 3 | 6 | 9 | 12 | 0 | 3 | 6 | 9 | 12 | 0 | 3 | 6 | 9 | 12 |
| C* | 173 | 197 | 165 | 121 | 72 | 78 | 176 | 145 | 93 | 64 | 61 | 115 | 88 | 56 | 38 | ND | ND | ND | 13 | 19 |
| $T_1$ | 178 | 205 | 183 | 148 | 83 | 84 | 198 | 153 | 101 | 77 | 63 | 123 | 88 | 59 | 42 | ND | ND | ND | 10 | 16 |
| $T_2$ | 175 | 201 | 193 | 146 | 86 | 80 | 191 | 155 | 99 | 76 | 65 | 128 | 91 | 66 | 63 | ND | ND | ND | 10 | 17 |
| $T_3$ | 193 | 223 | 195 | 152 | 83 | 91 | 209 | 162 | 112 | 83 | 71 | 125 | 93 | 63 | 51 | ND | ND | ND | 15 | 18 |
| $T_4$ | 186 | 215 | 199 | 149 | 91 | 83 | 203 | 156 | 102 | 67 | 65 | 130 | 93 | 71 | 60 | ND | ND | ND | 8 | 16 |
| $T_5$ | 205 | 231 | 206 | 151 | 80 | 95 | 213 | 167 | 123 | 92 | 78 | 137 | 98 | 70 | 56 | ND | ND | ND | 12 | 15 |
| $T_6$ | 197 | 236 | 213 | 163 | 96 | 91 | 209 | 161 | 118 | 72 | 74 | 143 | 97 | 75 | 68 | ND | ND | ND | 10 | 18 |

¤ Each value in the table was the mean of three replicates.
* See Table (1). ND : Not detected. ♦ cfu = Colony forming unit.

**Table (5): Effect of replacing milk fat with inulin on organoleptic score of yoghurt.**

| Treatments¤ | Flavour (45) of yoghurt samples (days) | | | | | Body and texture (35) | | | | | Appearance (10) | | | | | Acidity (10) | | | | | Total scores (100) | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 0 | 3 | 6 | 9 | 12 | 0 | 3 | 6 | 9 | 12 | 0 | 3 | 6 | 9 | 12 | 0 | 3 | 6 | 9 | 12 | 0 | 3 | 6 | 9 | 12 |
| C* | 41 | 41 | 40 | 39 | 37 | 30 | 29 | 29 | 29 | 27 | 8 | 7 | 7 | 7 | 6 | 8 | 8 | 7 | 7 | 6 | 87 | 85 | 83 | 82 | 76 |
| $T_1$ | 42 | 42 | 41 | 40 | 38 | 32 | 32 | 31 | 31 | 29 | 8 | 8 | 8 | 7 | 7 | 9 | 9 | 8 | 8 | 7 | 91 | 91 | 88 | 85 | 81 |
| $T_2$ | 40 | 40 | 40 | 38 | 35 | 30 | 30 | 29 | 28 | 28 | 8 | 7 | 7 | 7 | 6 | 7 | 7 | 7 | 6 | 6 | 85 | 84 | 83 | 79 | 75 |
| $T_3$ | 39 | 39 | 39 | 37 | 35 | 29 | 29 | 29 | 27 | 26 | 8 | 7 | 7 | 7 | 6 | 7 | 7 | 7 | 6 | 6 | 83 | 82 | 82 | 77 | 73 |
| $T_4$ | 40 | 40 | 39 | 38 | 37 | 30 | 29 | 28 | 26 | 26 | 7 | 7 | 7 | 6 | 6 | 8 | 8 | 8 | 7 | 7 | 85 | 84 | 84 | 77 | 76 |
| $T_5$ | 43 | 42 | 41 | 40 | 39 | 32 | 32 | 32 | 31 | 29 | 8 | 8 | 7 | 7 | 7 | 9 | 9 | 8 | 8 | 8 | 92 | 92 | 88 | 86 | 83 |
| $T_6$ | 41 | 41 | 40 | 39 | 37 | 30 | 30 | 29 | 28 | 27 | 8 | 7 | 7 | 6 | 6 | 9 | 8 | 8 | 7 | 7 | 88 | 86 | 84 | 80 | 77 |

**¤ Each value in the table was the mean of three replicates.**
*** See Table (1).**

**Table (6): Statistical analysis of low fat yoghurt properties.**

| Yoghurt properties | Effect of treatments: Mean squares | Multiple comparisons● C♦ | $T_1$ | $T_2$ | $T_3$ | $T_4$ | $T_5$ | $T_6$ | Effect of storage period (days): Mean squares | Multiple comparisons● 0 | 3 | 6 | 9 | 12 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Total solids (%) | 4.544* | A | A | B | C | C | A | D | 0.014 | A | A | A | A | A |
| Protein (%) | 0.020 | A | A | A | A | A | A | A | 2.43 | A | A | A | A | A |
| Fat (%) | 18.166* | A | B | B | C | C | D | D | 0.080 | A | A | A | A | A |
| Ash (%) | 2.157 | A | A | A | B | A | A | A | 7.872 | A | A | A | A | A |
| Carbohydrate (%) | 5.004* | F | D | E | D | D | A | C | 0.366* | A | A | A | AB | B |
| Calorific value | 886.18 | A | B | C | D | E | E | F | 5.429 | A | A | A | A | A |
| Titratable acidity (%) | 0.026* | E | C | D | B | C | A | A | 0.371 | D | CD | C | B | A |
| TVFA | 7.770* | A | AB | AB | ABC | ABC | C | C | 5.922* | D | C | C | B | A |
| DA + AMC | 100.008* | C | A | C | D | A | E | B | 382.606* | C | B | A | D | E |
| Syneresis after 2 h (%) | 96.029* | A | B | A | C | B | D | C | 264.625* | A | B | E | D | C |
| Curd tension (%) | 3.344* | C | B | C | AB | D | A | E | | | | | | |
| Organoleptic properties: | | | | | | | | | | | | | | |
| Flavour | 91.771* | C | A | D | D | A | E | BC | 53.70* | A | A | AB | B | C |
| Body and texture | 24.971* | BC | A | BC | B | A | C | BC | 26.786* | A | A | AB | B | C |
| Appearance | 1.743* | BC | A | C | BC | A | BC | C | 7.414* | A | A | AB | B | C |
| Acidity | 6.943* | C | A | BC | D | A | D | AB | 7.175* | A | AB | BC | C | D |
| Total scores | 158.571* | BC | A | C | C | A | D | B | 347.443* | A | A | AB | B | C |

**♦ 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**
*** Significant at 0.05 level ($p \leq 0.05$).**