*J. Food and Dairy Sci., 3rd Mansoura International Food Congress (MIFC) October: 187 - 195, 2018*

# Improving the Properties of Kariesh Cheese Made by Ultrafiltration Using Biological Treats and Dairy Fortifiers

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## ABSTRACT

The aim of this study is improving the properties of Kariesh cheese that made from ultrafiltrated (UF) fresh buffalo's skim milk by using biological treats and dairy fortifiers. In this work Kariesh cheese was made by: i) Traditional method as control (C1), ii) UF- technique free of additives (C2), iii) UF- technique + adding whey protein concentrate (WPC) or whey powder (WP) to cheese retentate, iv) UF- technique + using exopolysaccharide (EPS)-producing cultures (*Lb. rhamnoses* + *Lb. acidophilus* 1:1) separately or mixed with 2% of WPC or WP from skim milk retentate. The chemical, microbiological, rheological and sensory properties of the resulted cheese samples were studied during 14 days of storage at 6±1°C. The results showed that, the rheological properties of all cheese treatments were improved during the storage period compared to the control that made with traditional method (C1). Also the sensory evaluation (total scores) showed that the best Kariesh cheese treatment was that made with WP at 14th day of storage. However, there was an increase in all chemical parameters except for moisture and pH values. The microbiological examination shows that all cheese treatments (fresh or during storage) were free of coliform. Furthermore, the results show an increase in the total viable counts, number of Lactobacilli and streptococci during storage. The highest numbers of Lactobacilli and Streptococci were found in the treatment made with a mixture of EPS-producing culture and WP.

**Keywords:** Kariesh cheese, whey protein concentrate, ultrafiltration technique, exopolysaccharide producing culture, biological treats, dairy fortifiers, rheological properties and retentate.

## INTRODUCTION

One of the most important leading countries in the manufacturing of dairy products is Egypt; such products are white soft cheese, which plays an important role in the Egyptian diet. Many people eat white cheese with a certain amount of at least one meal a day. In Egypt the most popular and the oldest varieties consumed is Kariesh cheese (Abou-Donia, 2008), which contains most of the skim milk constituents including protein, a small amount of lactose, soluble vitamins, most of calcium and phosphorus (Abou-Donia, 1999). Kariesh cheese origin goes back to the Pharaonic period, it is a soft acid cheese made from skim milk or buttermilk produced from sour cream (Todaro *et al*., 2013). In the past, Kariesh cheese was traditionally produced from milk by separation its cream layer by gravity force after a random fermentation. Recently separators were used to achieve the defatted milk. Then Kareish cheese made from buffalo's skim milk, cow's skim milk or a mixture of both by several manufacturing procedures; such as UF-skim milk retentate, certain bacterial cultures and enzymatic coagulation (Fayed *et al*., 2014). The quality and composition of Kariesh cheese may vary considerably due to such factors; quality and composition of the clotted skim milk, the method of manufacture, time required to complete the whey drain, the quality of salt added and the method of handling the finished cheese (Abou-Donia, 1999 and Todaro *et al*., 2013). Therefore, the aim of this study is to improve the properties of Kariesh cheese made from UF-skim milk by different means such as; using EPS-producing cultures separately or mixed with 2% WPC or WP of the retentate and studying their effect on microbiological, chemical, organoleptic and rheological properties compared to the conventional method of Kariesh cheese production.

## MATERIALS AND METHODS

### Materials

Fresh buffalo's skim milk and buffalo's skim milk retentate were obtained from the Animal Production Research Institute, Giza, Egypt; WPC (Bobs red mill, U.S.A.) was obtained from Health Harvest Co., Cairo, Egypt, WP (Agropur, Dairy Cooperative, Canada) was purchased from El-Warak Co., Fayoum, Egypt. Microbial rennet powder (CHY-MAX, 2280 IMCU/ml) was obtained from Chr. Hansen' Lab., Denmark. Food quality grade calcium chloride was obtained from El-Naser Co., Cairo, Egypt. Dry fine edible grade table salt (sodium chloride) produced by Egyptian salt and minerals company (EMISAL) was obtained from local market, Fayoum, Egypt. Lyophilized strains, of Lactobacillus rhamnoses (NRRL-B-442) and Lactobacillus acidophilus LA-5 (Hansen Lab., Denmark) were obtained from Nevada Co., Alexandria, Egypt. While, Streptococcus salivarius subsp. thermophiles and Lactobacillus bulgaricus were obtained from dairy microbiology laboratory, National Research Centre, Dokki, Giza, Egypt.

### Methods

#### 1- Experimental procedures

#### Manufacture of traditional Kariesh cheese

Kariesh cheese was made as described by Abou-Donia (2008); the flow diagram (Fig.1) outlined the different steps followed for Kariesh cheese making by traditional method.

#### Manufacture of ultrafiltrated Kariesh cheese.

The UF-process was run using UF TECH-SEP (group of Rhone Poulenc) unit equipped with carbon Sep. tubular mineral membrane having area 34.2 $m^2$ and a nominal molecular weight cut off 20 KDa. The UF-Kariesh cheese treatments were made according to Maubois *et al.* (1987) as illustrated in Fig. (2).

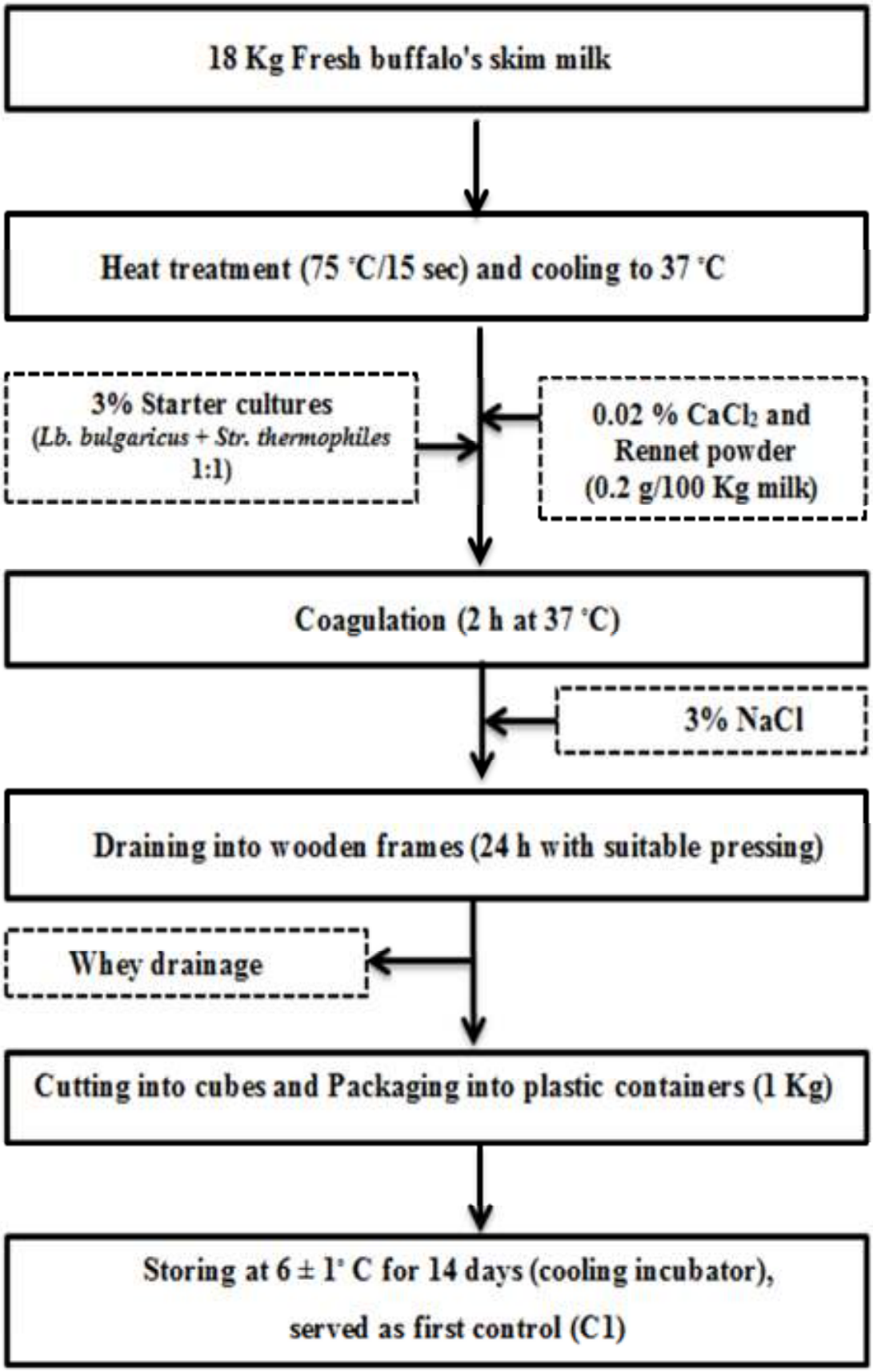


**Fig. 1. Flow diagram showing steps undertaken in the manufacture of traditional Kariesh cheese.**

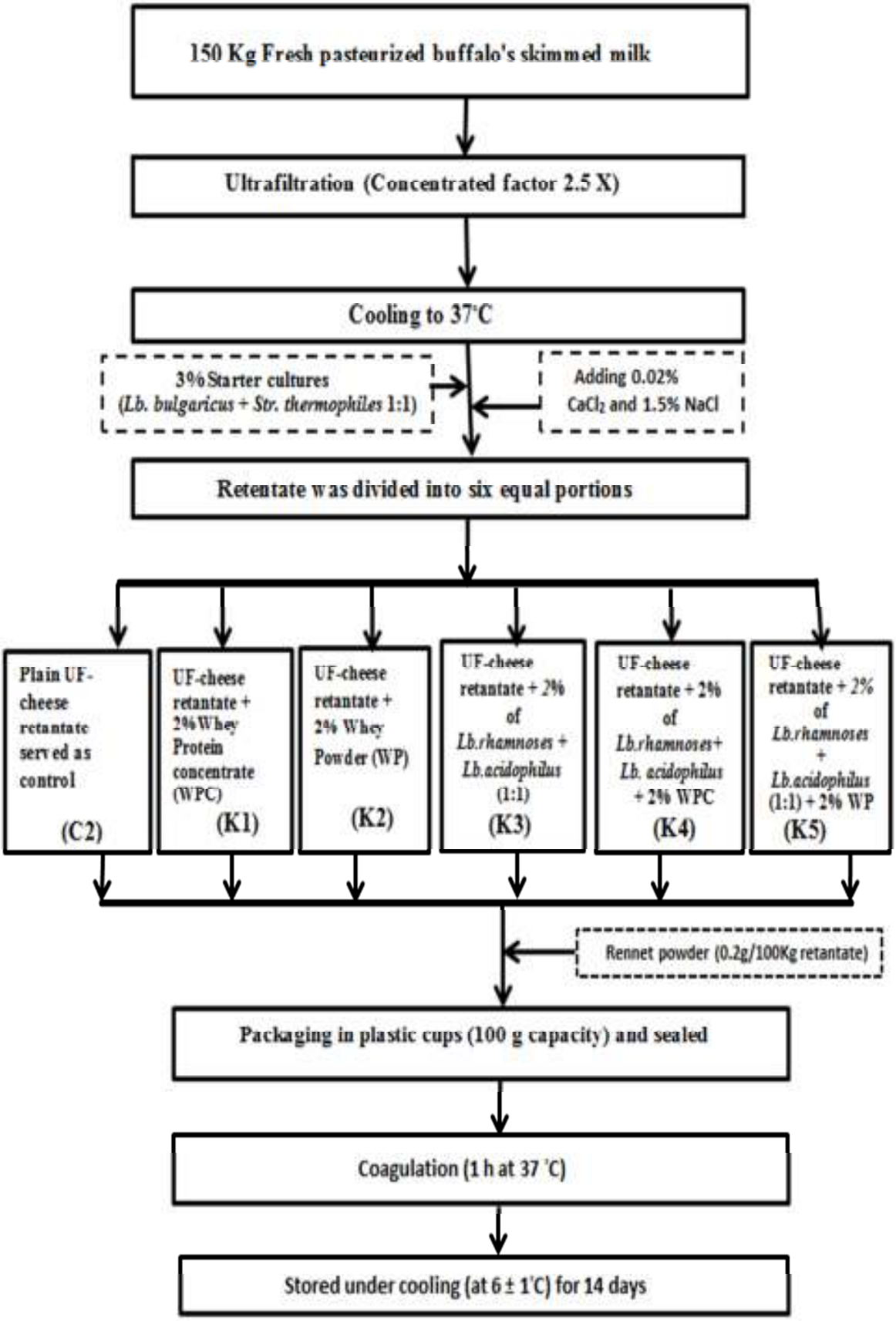


**Fig. 2. Flow diagram showing steps undertaken in the manufacture of different UF-Kariesh cheese treatments.**

**2. Methods of analysis**

**Chemical and physical analysis**

The titratable acidity (TA), ash, fat, moisture, total nitrogen (TN %) and water soluble nitrogen (WSN %) contents were estimated as described in AOAC (2000). The pH values were measured by using laboratory pH meter type; Thermo Scientific Orion Star (A214). Sodium chloride (NaCl %) was determined by direct titration according to Bradley *et al*. (1992).

**Microbiological examinations**

Total viable counts (TVC Log cfu/g) and spore forming bacterial counts of cheese samples were enumerated with plate count agar medium and also coliform groups were detected on MacConkey's agar medium, Potato dextrose agar medium was used for counting yeast and mold (Log cfu/g) as described in Oxoid (2006). Lactobacilli and Streptococci were enumerated (Log cfu/g) by using MRS and M17 media according to Khosravi-Darani *et al.* (2015).

**Texture profile parameters**

Texture profile analysis (TPA) was performed in the Dairy Research Department, Food Technology Research Institute, Agriculture Research Center. The TPA of cheese samples was done using a Universal Testing Machine (TMS-Pro), Food Technology Corporation, Sterling, Virginia, USA, data were collected on computer and the texture profile parameters were calculated from TMS. Pro DEV TPA texture analyzer and computer interface.

**Organoleptic properties**

All resultant Kariesh cheese samples were organoleptically evaluated when fresh and during storage period by ten of the staff members at Dairy Dept., and Food Sci. Dept., Fac. Agric., Fayoum Univ. They were selected on the basis of interest and experience in sensory evaluation. Cheese samples were sensory evaluated for flavour (45 points), body & texture (35 points) and color & appearance (20 points) according to El-Shafei *et al*. (2008).

**Statistical analysis**

The obtained data were statistically analyzed by using general linear model of SPSS (2007). Mean of the values, were compared with main effects by Duncan's multiple range tests (Duncan, 1955) when significant F values were obtained $P \leq 0.001$.

## RESULTS AND DISCUSSION

**1. Gross chemical composition of different Kariesh cheese treatments**

Moisture, fat and fat /dry matter contents of Kariesh cheese as affected by manufacture procedure and cold storage period were presented in Table (1). The results reveal that, moisture content of all cheese samples were in the normal range for moisture of Kariesh cheese (El-Shibiny *et al*., 1984). Generally, it is noticed that moisture content of Kariesh cheese was gradually decreased in all cheese samples during the cold storage period due to the evaporation of moisture. This result was agreed with that obtained by Mahmoud *et al.* (2013); Elbanna *et al*. (2015) and Stankey *et al*., (2017). Also, there is a significant difference ($P \leq 0.001$) in moisture content among treatments during the cold storage period. From the obtained results, it is also noticed that using UF-process in Kariesh cheese manufacture increased the moisture content comparing to that made by traditional method. This could be due to the UF-process which led to retention of whey proteins into the retentate and hence increasing the holding of moisture into the cheese matrix. Whereas, whey proteins; were characterized with their relatively high water holding capacity (Fayed, 1986 and Fayed *et al*., 2014). These results were agreed with the results obtained by Korish & Abd El-Hamid (2012) and Hamad (2015). Moreover, moisture content for traditional Kariesh cheese ($C_1$) falls in the range of the values stated by Egyptian Standards (ES, 2005). It is worth mention that using EPS-producing cultures decreases the moisture content of the resultant cheese compared with control ($C_2$) either when fresh or during cold storage period.

These results were in agreement with Abou Ayana and Ibrahim (2015). On the other hand, addition of *Lb. acidophilus* and *Lb. rhamnosus* to Kariesh cheese retentate (K3) lead to a little decrease in moisture content at 14 days old, comparing to the treatments K1, K2, K4, K5 and control (C2). This might be due to the development of acidity, which leads to curd contraction that helps to expel the whey from the curd (Effat *et al*., 2001). Regarding, the fat content of Kariesh cheese in Table (1) show significant differences ($P \leq 0.001$) within cheese samples. Furthermore, fat values were gradually increased along the cold storage period; this may be due to the corresponding evaporation that occurred in moisture content. It is noticed that the fat content of Kariesh cheese made from skim milk retentate ($C_2$) in fresh time was higher than that made by traditional method ($C_1$). The occurred reduction in fat of Kariesh cheese that made by traditional method may relate to the loss of some fat during the whey drainage. Similar findings were reported by Abou-Donia (2008); Hamad (2015) and Korish & Abd El-Hamid (2012). Same impact was recorded for the results of F/DM content as illustrated in the same previous Table; these results were in agreement with that reported by Sakr and Mehanna (2011).

**Table 1. Moisture, fat and fat /dry matter (%) of Kariesh cheese during storage period at 6±1°C**

| Storage period (days) | Treatments* | | | | | | |
|---|---|---|---|---|---|---|---|
| | $C_1$ | $C_2$ | $K_1$ | $K_2$ | $K_3$ | $K_4$ | $K_5$ |
| | Moisture (%) | | | | | | |
| Fresh | 72.00$^{g}$ | 78.02$^{a}$ | 77.88$^{a}$ | 77.86$^{a}$ | 77.82$^{a}$ | 77.98$^{a}$ | 77.9$^{8a}$ |
| 7 | 71.90$^{g}$ | 77.88$^{a}$ | 76.63$^{d}$ | 76.76$^{d}$ | 76.98$^{c}$ | 77.50$^{b}$ | 77.56$^{b}$ |
| 14 | 71.60$^{h}$ | 76.62$^{d}$ | 76.31$^{e}$ | 76.53$^{d}$ | 76.05$^{f}$ | 76.76$^{d}$ | 76.70$^{d}$ |
| SE± | 0.073 | | | | | | |
| | Fat (%) | | | | | | |
| Fresh | 0.53$^{g}$ | 0.90$^{d}$ | 0.90$^{d}$ | 0.80$^{e}$ | 0.80$^{e}$ | 0.90$^{d}$ | 0.80$^{e}$ |
| 7 | 0.65$^{f}$ | 1.00$^{c}$ | 1.00$^{c}$ | 0.90$^{d}$ | 0.90$^{d}$ | 1.00$^{c}$ | 1.00$^{c}$ |
| 14 | 0.90$^{d}$ | 1.10$^{b}$ | 1.20$^{a}$ | 1.00$^{c}$ | 1.00$^{c}$ | 1.10$^{b}$ | 1.00$^{c}$ |
| SE± | 0.02 | | | | | | |
| | Fat/ dry matter (%) | | | | | | |
| Fresh | 1.89 | 4.09 | 4.07 | 3.61 | 3.60 | 4.09 | 3.63 |
| 7 | 2.31 | 4.52 | 4.28 | 3.87 | 3.91 | 4.44 | 4.46 |
| 14 | 3.17 | 4.64 | 5.07 | 4.26 | 4.18 | 4.73 | 4.29 |

**:*C1: Kariesh cheese made by traditional method (Control 1), C2: Kariesh cheese made from buffalo's UF-skim milk retentate (Control 2)**

**K1, K2 and K3: Kariesh cheese made from buffalo's UF-skim milk retentate fortified by 2% of WPC, WP or added EPS-producing cultures (Lb. acidophilus+ Lb. rhamnoses 1:1), respectively.**

**K4: Kariesh cheese made from the Mix of K1 + K3 treatments .**

**K5: Kariesh cheese made from the Mix of K2 + K3 treatments.**

**a, b,….and h: Means in the same column with different superscript letters are significantly different (P≤ 0.001)**

**SE: standard error**

Results in Fig. (3) Illustrate total nitrogen (TN %) in different Kariesh cheese treatments during cold storage period, there is a significant differences (P ≤0.001) in Kariesh cheese made with different methods. In all Kariesh cheese treatments there are an increase in TN (%) during cold storage period, which may related to the decrease in moisture content with progress of storage. Similar trends were revealed by Hamad (2015); Elbanna *et al.* (2015) and Abd El-Salam *et al*. (2017). The results also indicated that the lowest TN content was noticed in Kariesh cheese made by traditional method where it recorded 2.44% after 14th days of storage. While, the highest total nitrogen content at the same previous age was recorded in Kariesh cheese made with added WPC ($K_1$); where it recorded 2.63%, followed by that made with added WP ($K_2$), where it recorded 2.61% at the same previous age. Similar results were obtained by Abd El-Salam (2015).

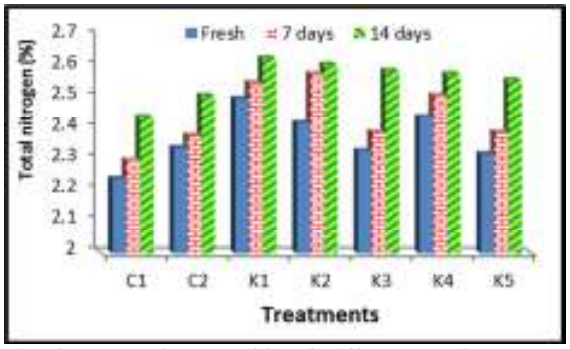


**Fig. 3. Total nitrogen (%) of different Kariesh cheese treatments and control during storage period at 6±1°C.**

The results obtained in Figs. (4) and (5), explained water soluble nitrogen (WSN%) and WSN/TN% of different Kariesh cheese samples during cold storage period. There is a significant difference (P≤ 0.001) in WSN content of different Kariesh cheese treatments where, it was high comparing with that made by traditional method ($C_1$).

Generally, the WSN% and WSN/TN% were gradually increased during cold storage period in all Kariesh cheese treatments. These results were in agreement with findings of Mahmoud *et al*. (2013) and Celik and Tarakci (2017).

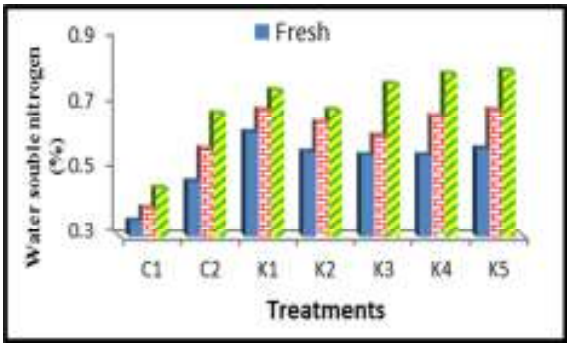


**Fig. 4. Water soluble nitrogen (%) in different Kariesh cheese treatments and control during storage period at 6±1°C.**

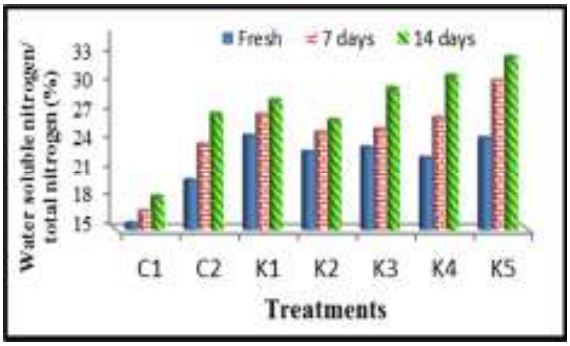


**Fig. 5. Water soluble nitrogen / total nitrogen (%) in different Kariesh cheese treatments and control during storage period at 6±1°C.**

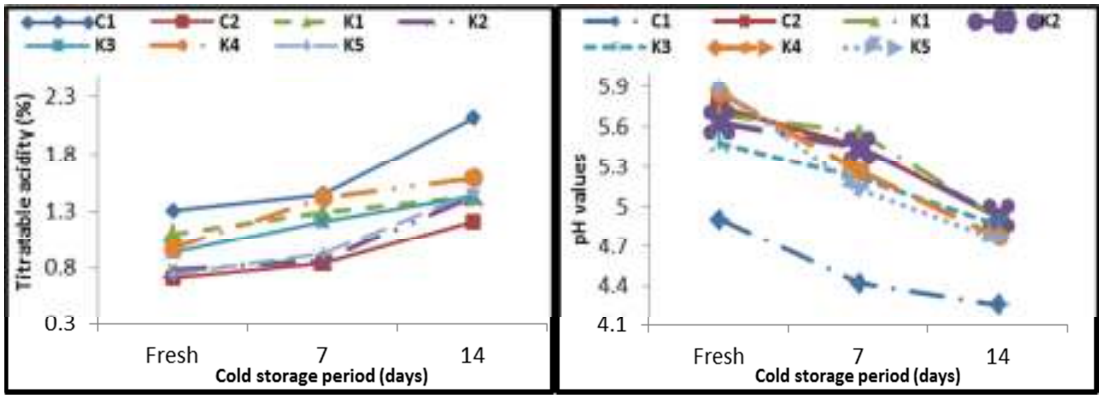


**Fig. 6. Changes in the titratable acidity (%) and pH values of different Kariesh cheese treatments and control during cold storage period at 6±1°C.**

The changes in titratable acidity (TA %) and pH values of different Kariesh cheese treatments illustrated in Fig. (6). There was a significant difference (P ≤ 0.001) among all cheese treatments in TA% and pH values during the cold storage period. The values of TA% were increased while, the pH values were gradually decreased in all Kariesh cheese samples during storage period at 6±1°C, this decrease in pH values could be resulted from acid formation during storage; for example lactic acid which produced from the fermentation of lactose by lactic acid bacteria (LAB). The present results were in line with that observed by Abd El- Salam *et al*. (2017).

The highest values of TA% were in Kariesh cheese made with the traditional method, followed by (K4), where the values were, 2.12 and 1.59% at 14 days old, respectively. Moreover, the results of pH values in Kariesh

cheese made by traditional method were low comparing to the other treatments. These results were in agreement with that given by Hamad (2015). The relatively higher pH values of all UF-Kariesh cheese may be due to the considerable high buffering capacity that UF- cheese possessed comparing with C1 (Fayed *et al*., 2014).

Results in Table (2) show, the salt, salt/moisture and ash content of UF-Kariesh cheese treatments made by different treatments and that made by traditional method. There was a significant difference ($P \leq 0.001$) within Kariesh cheese samples and during cold storage period; it is noticed that salt and ash content were increasing in all Kariesh cheese samples during cold storage period. Similar finding were reported by Fayed *et al*. (2014); Hamad (2015) and Abd-Elhamid (2017). The highest salt content was in Kariesh cheese made with traditional method (C1), while the lowest salt content was noticed in UF- Kariesh cheese (C2).

**2. Microbiological examination of different Kariesh cheese treatments**

Coliform group was not found either in cheese milk or in the treated cheese samples whether fresh or during cold storage period (14 days). This might be due to the efficient heat treatment of milk which inhibits the vegetative cells, also the sanitation and hygienic conditions during the manufacture process of Kariesh cheese and cold storage period. These results were in agreement with Metry (2010) and Abd El-Salam *et al*. (2017).

Regarding the total viable counts (TVCs); it is shown in Table (3). In all Kariesh cheese treatments the TVCs were increasing during the cold storage period. The lowest reading (5.81 Log cfu/g) in fresh time was recorded for control Kariesh cheese (C2) that made from UF- skim milk. While, the highest one (7.93 Log cfu/g) was recorded for Kariesh cheese treatment that made from UF-skim milk with added 2% mixture of both strains; *Lb. acidophilus and Lb. rhamnoses* (1:1).

**Table 2. Salt, salt / moisture and ash (%) of different Kariesh cheese treatments and control during cold storage period at 6±1°C**

| Storage period(days) | Treatments* | | | | | | |
|---|---|---|---|---|---|---|---|
| | $C_1$ | $C_2$ | $K_1$ | $K_2$ | $K_3$ | $K_4$ | $K_5$ |
| | | | | Salt (%) | | | |
| Fresh | $2.93^{b}$ | $1.75^{h}$ | $1.87^{fgh}$ | $1.77^{gh}$ | $2.00^{efgh}$ | $2.13^{ef}$ | $2.10^{efg}$ |
| 7 | $3.07^{b}$ | $2.07^{efgh}$ | $2.50^{cd}$ | $2.03^{efgh}$ | $2.50^{cd}$ | $2.20^{def}$ | $2.20^{def}$ |
| 14 | $3.37^{a}$ | $2.10^{efg}$ | $2.93^{b}$ | $2.33^{de}$ | $2.77^{bc}$ | $2.53^{cd}$ | $2.33^{de}$ |
| SE± | | | | 0.104 | | | |
| | | | | Salt/ moisture (%) | | | |
| Fresh | 4.04 | 2.24 | 2.40 | 2.27 | 2.57 | 2.73 | 2.69 |
| 7 | 4.27 | 2.66 | 3.26 | 2.64 | 3.25 | 2.84 | 2.84 |
| 14 | 4.71 | 2.74 | 3.84 | 3.04 | 3.64 | 3.30 | 3.04 |
| | | | | Ash (%) | | | |
| Fresh | $2.96^{g}$ | $3.06^{fg}$ | $3.15^{efg}$ | $3.19^{cdef}$ | $3.05^{fg}$ | $3.15^{efg}$ | $3.16^{defg}$ |
| 7 | $3.13^{efg}$ | $3.33^{bcde}$ | $3.30^{bcde}$ | $3.38^{bc}$ | $3.32^{bcde}$ | $3.34^{bcde}$ | $3.37^{bcd}$ |
| 14 | $3.28^{bcde}$ | $3.40^{bc}$ | $3.65^{a}$ | $3.72^{a}$ | $3.42^{b}$ | $3.65^{a}$ | $3.64^{a}$ |
| SE± | | | | 0.064 | | | |

**a, b,……and h: Means in the same column with different superscript letters are significantly different (P≤ 0.001).**
**SE: standard error *See Table (1)**

Yeast and mould counts as recorded in Table (3) were found in all Kariesh cheese treatments from the beginning of storage and increased gradually with the progress of cold storage period. Regarding Kariesh cheese made by UF- technique ($C_2$) it recorded the lowest (3.89 Log cfu/g) numbers of yeast and mould in the fresh age, while, it recorded the highest number by the end of storage, followed by that made by traditional method; where both recorded 6.47 and 6.46, respectively. On the other hand $K_4$ treatment recorded the lowest counts (5.93 Log cfu/g) of yeast and mould by the end of storage. These results were in agreement with El-Shafei *et al*. (2008) and Awad *et al.* (2015). Spore forming bacterial counts (Log cfu/g) is shown in Table (3); there is an increase in spore forming bacteria for all cheese treatments during storage. The increase in numbers of spore forming bacteria may attribute to low salt content in these types of cheese. The results were in agreement with El-Sissi (2002).

The changes in the viability of Streptococci and Lactobacilli (Log cfu /g) in different Kariesh cheese treatments during cold storage period are shown in in the same Table. The numbers of Streptococci and Lactobacilli were increased significantly ($P \leq 0.001$) with extending cold storage period in all Kariesh cheese treatments. The highest numbers for Lactobacilli was in $K_3$ at 14 days of storage, while highest number for Streptococci was recorded in $K_5$ at the same previous age. The lowest numbers for Streptococci and Lactobacilli were in $C_2$ at 14 days of storage. Similar results were reported by Kebary *et al*. (2015). The viable counts of Lactobacilli in all fresh UF-Kariesh cheeses were varied from 6.58 to 8.80 log cfu/g, whereas it reached to 8.80 and 8.47 log cfu/g in cheese treated with EPS-producing cultures ($K_3$) and in that made by traditional method ($C_1$), respectively.

**Table 3. Microbial examination (Log cfu/g) of Kariesh cheese from different treatments and control during cold storage period at 6±1°C**

| Storage period (days) | Treatments* | | | | | | |
|---|---|---|---|---|---|---|---|
| | $C_1$ | $C_2$ | $K_1$ | $K_2$ | $K_3$ | $K_4$ | $K_5$ |
| | | | | Total viable counts (Log cfu/g) | | | |
| Fresh | $6.82^{cde}$ | $5.81^{g}$ | $6.37^{ef}$ | $6.14^{fg}$ | $7.93^{b}$ | $6.60^{def}$ | $6.10^{fg}$ |
| 7 | $7.85^{b}$ | $6.80^{cde}$ | $8.02^{b}$ | $7.92^{b}$ | $8.56^{a}$ | $7.03^{cd}$ | $7.21^{c}$ |
| 14 | $8.82^{a}$ | $7.21^{c}$ | $8.71^{a}$ | $8.79^{a}$ | $8.72^{a}$ | $8.68^{a}$ | $8.77^{a}$ |
| SE± | | | | 0.17 | | | |
| | | | | Yeast & mould counts (Log cfu/g) | | | |
| Fresh | $5.01^{cde}$ | $3.89^{h}$ | $4.75^{ef}$ | $4.38^{g}$ | $4.80^{cdef}$ | $4.72^{ef}$ | $3.97^{i}$ |
| 7 | $5.09^{cd}$ | $4.61^{fg}$ | $4.77^{def}$ | $4.52^{fg}$ | $4.95^{cde}$ | $5.12^{c}$ | $4.55^{fg}$ |
| 14 | $6.46^{a}$ | $6.47^{a}$ | $6.12^{b}$ | $6.16^{ab}$ | $6.00^{b}$ | $5.93^{b}$ | $6.02^{b}$ |
| SE± | | | | 0.10 | | | |
| | | | | Spore forming bacterial counts (Log cfu/g) | | | |
| Fresh | $2.21^{ef}$ | $2.21^{ef}$ | $2.36^{def}$ | $2.15^{ef}$ | $2.09^{f}$ | $2.31^{def}$ | $2.33^{def}$ |
| 7 | $2.70^{cd}$ | $3.03^{bc}$ | $2.60^{cde}$ | $2.49^{def}$ | $2.10^{f}$ | $2.48^{def}$ | $3.00^{bc}$ |
| 14 | $3.79^{a}$ | $3.38^{b}$ | $2.99^{bc}$ | $2.73^{cd}$ | $2.99^{bc}$ | $3.27^{b}$ | $3.37^{b}$ |
| SE± | | | | 0.14 | | | |
| | | | | Lactobacilli counts (Log cfu/g) | | | |
| Fresh | $6.64^{i}$ | $6.58^{i}$ | $7.60^{fg}$ | $7.18^{h}$ | $7.99^{de}$ | $7.60^{fg}$ | $8.07^{de}$ |
| 7 | $7.67^{ef}$ | $7.59^{fg}$ | $7.71^{ef}$ | $7.29^{h}$ | $8.01^{cd}$ | $7.61^{fg}$ | $8.27^{bcd}$ |
| 14 | $8.47^{b}$ | $8.25^{bcd}$ | $8.37^{bc}$ | $8.42^{bc}$ | $8.80^{a}$ | $8.39^{bc}$ | $8.29^{bcd}$ |
| SE± | | | | 0.10 | | | |
| | | | | Streptococci counts (Log cfu/g) | | | |
| Fresh | $5.71^{g}$ | $5.90^{g}$ | $6.66^{f}$ | $6.85^{f}$ | $8.31^{abc}$ | $8.10^{bc}$ | $8.12^{bc}$ |
| 7 | $7.65^{e}$ | $7.58^{e}$ | $7.72^{de}$ | $7.58^{e}$ | $8.41^{ab}$ | $8.16^{abc}$ | $8.21^{abc}$ |
| 14 | $8.01^{ed}$ | $7.99^{cd}$ | $8.28^{abc}$ | $8.20^{abc}$ | $8.42^{ab}$ | $8.25^{abc}$ | $8.47^{a}$ |
| SE± | | | | 0.11 | | | |

**a, b,……..and g: Means in the same column with different superscript letters are significantly different (P≤ 0.001).**
***See Table (1) SE: standard error**

**2.Rheological properties of Kariesh cheese**

Rheological textural properties of Kariesh cheese as affected by manufacture procedure and cold storage period were presented in Table (4). The data indicated that hardness, cohesiveness, adhesiveness, springiness and gumminess, were differed within samples of the different Kariesh cheese treatments. In most Kariesh cheese treatments, it is noticed that some parameters like hardness, cohesiveness and adhesiveness were increasing, while springiness and gumminess was decreasing in some of the Kariesh cheese treatments during cold storage period. Hardness in all fresh Kariesh cheese treatments was lower than control cheese ($C_1$), this may related to the high moisture content in these treatments comparing to that in control cheese ($C_1$). On the other hand, at 14 days of storage the hardness decreased highly in control cheese ($C_1$), followed by $K_2$ and $K_5$. This decrease in hardness in the last two Kariesh cheese treatments may relate to the added whey powder in these treatments during its manufacture. Inversely hardness increased highly in $C_2$ and slightly in $K_1$, $K_3$ and K4 at 14 days old of storage.

**Table 4. Rheological properties of Kariesh cheese treatments and control during cold storage period at 6±1°C**

| Rheological parameters | Storage period (days) | Treatments* | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | $C_1$ | $C_2$ | $K_1$ | $K_2$ | $K_3$ | $K_4$ | $K_5$ |
| Hardness (N) | Fresh | 20.80 | 12.20 | 4.00 | 8.60 | 7.40 | 5.50 | 5.10 |
| | 14 | 4.50 | 16.20 | 8.90 | 2.50 | 9.40 | 6.10 | 3.10 |
| Cohesiveness (~) | Fresh | 0.41 | 0.77 | 0.87 | 0.75 | 0.74 | 0.73 | 0.70 |
| | 14 | 0.67 | 0.79 | 0.81 | 0.88 | 0.76 | 0.73 | 0.92 |
| Adhesiveness (N) | Fresh | 6.89 | 1.19 | 1.17 | 1.31 | 1.34 | 1.09 | 1.45 |
| | 14 | 0.70 | 1.93 | 1.95 | 1.75 | 1.57 | 2.15 | 1.97 |
| Springiness (mm) | Fresh | 10.51 | 10.04 | 5.41 | 9.50 | 9.49 | 9.59 | 10.00 |
| | 14 | 5.99 | 9.49 | 8.77 | 12.69 | 9.96 | 9.56 | 5.33 |
| Gumminess (N) | Fresh | 8.60 | 9.40 | 3.50 | 6.40 | 5.50 | 4.00 | 3.50 |
| | 14 | 3.00 | 12.70 | 7.20 | 2.20 | 7.10 | 4.40 | 2.90 |
| Chewiness (mj) | Fresh | 89.9 | 94.14 | 18.14 | 61.21 | 51.9 | 38.44 | 35.20 |
| | 14 | 17.91 | 120.8 | 63.12 | 28.20 | 71.09 | 42.42 | 15.22 |

***See Table (1)**

The results reveal that, the values of cohesiveness was increasing during cold storage period in all Kariesh cheese treatments but decreased in $K_1$ and no changes found in K4 during cold storage period. The cohesiveness value of Kariesh cheese made by traditional method was 0.41 which was similar with that found by Emam (2013) and Hussein and Shalaby (2014). Also similar findings were confirmed by Fayed *et al.* (2014). Furthermore, adhesiveness values in fresh age for all Kariesh cheese treatments were lower than that of control ($C_1$), while by the end of storage (14 days) it decreased in Kariesh control ($C_1$); whereas it reached 0.70 N, but increased slightly in all other Kariesh treatments. Regarding the springiness, as shown in Table (4), it decreased sharply during cold storage period in Kariesh cheese treatments that made by mixture of WP (2%) and mixed culture from *Lb. acidophilus*+ *Lb. rhamnoses* (2%) followed by that made by traditional method. Moreover, a little decrease in springiness was noticed during cold storage period in K4 treatment followed by $C_2$. On the other hand springiness was very high in fresh age for $C_1$, $K_5$ and $C_2$ where it's recorded 10.51, 10.04 and 10.0mm, respectively. The lowest springiness values at 14 days old was noticed in both $K_2$ treatment and control ($C_1$) where it recorded 5.33 and 5.99mm, respectively. By the end of storage (14 days); springiness was decreased in Kariesh cheese treatments except in $K_1$, $K_2$, and $K_3$ treatments it increased and reached to 8.77, 9.96 and 12.69mm, respectively.

Results obtained in Table (4) demonstrate that gumminess values were differed in all Kariesh cheese samples; where Kariesh cheese manufactured by UF-technique ($C_2$) gained the highest gumminess values, where it was 9.4 N in fresh and reached to 12.70 N at day 14 of storage. While, the other Kariesh cheese treatments had the lowest values in both ages. It is worth mention that $K_1$ and $K_5$ recorded the lowest gumminess values (3.50N ) in fresh age and the rate of decreasing at 14 day was more in K2 (2.20 N) , followed by $K_5$ (2.90 N) and C1 (3.0 N).

Chewiness revealed similar trend; it was very high in $C_1$ and $C_2$ in fresh age comparing with other Kariesh cheese treatments. It is worth mention that the rheological parameters such as hardness, adhesiveness, gumminess and chewiness following the same behavior in Kariesh cheese treatments, meaning that when hardness was high in any of Kariesh samples, the previous parameters were also high and vice versa. Similar results were reported by Francois *et al*. (2004) and Trancoso-Reyes *et al*. (2014), who mentioned that using EPS-producing cultures in cheese manufacture improved most of the rheological properties and proteolysis of low-fat cheese. This result is also in agreement with Elbanna *et al.* (2015) who reported that addition of the EPS that produced from *lb. pentosus* H2 strain improves the rheology, texture, stability and mouth feel of all low fat yoghurt and UF- soft cheese treatments which fortified by EPS compared to control.

**4. Organoleptic properties of Kariesh cheese**

Organoleptic properties during storage of Kariesh cheese treatments made by various methods were listed in Table (5). There were no significant differences within some Kariesh cheese samples in most of sensory evaluation. In general, the flavour scores of Kariesh cheese treatments was slightly increased during cold storage period, except Kariesh cheese made by traditional method ($C_1$) was high in fresh age and then decreased by the end of storage and recorded the lowest values. The highest scores were 43.00 at 14 days old in cheese fortified with WP ($K_2$) followed by $K_5$ treatment at the same previous age. Regarding the appearance; results stated that, Kariesh cheese made using only skim milk retentate ($C_2$) or that made from skim milk retentate with added WP ($K_2$) gained the highest appearance scores in fresh age and at 14 days of storage, respectively where both recorded 19.20, followed by that made using EPS- producing culture ($K_3$) at 7 days old of storage. While, the cheese made by traditional method recorded the lowest appearance scores along the storage period. From these results; the appearance scores of Kariesh cheese were improved when the UF-technique was used and when EPS-producing culture or whey powder was added. Concerning the body and texture; there was no significant difference found during the cold storage period among Kariesh cheese treatments. Whereas, the highest value was 33.20 at 14 days old for Kariesh cheese made by adding EPS-

producing cultures ($K_3$) and the lowest value was 31.10 at 7 day old in Kariesh cheese made by traditional method ($C_1$).

The obtained total score points recorded that treatment $K_5$ gained the highest scores (92.10) in fresh age while, at 14th days of storage; UF-Kariesh cheese that made with WP ($K_2$) achieved the greatest total score points (94.90) followed by UF-Kariesh cheese that made by EPS-producing cultures ($K_3$) (94.10) at the same previous age. Moreover, it is noticed that Kariesh cheese made by traditional method ($C_1$) is the only treatment that decreased in its total score points along the cold storage period and reached 89.40 by the end of storage. It is worth mention that total scores of $K_5$ treatment also increased during storage and reached 93.70 at 7 and 14 days old. These results in accordance of Pinto *et al*. (2007), Jimenez-Guzman *et al.* (2009); Ayyad *et al*. (2015); Elbanna *et al*. (2015) and Celik & Tarakci (2017). Statistical analysis indicated that there were no significant difference in accordance to flavour or body & texture within all Kariesh cheese treatments or during the cold storage period.

**Table 5. Sensory evaluation of different Kariesh cheese treatments and control during cold storage period at 6±1°C.**

| Treatments* | Storage period (days) | Flavour (45) | Body & texture (35) | Colour & appearance (20) | Total scores (100) |
|---|---|---|---|---|---|
| $C_1$ | Fresh | 42.10 | 32.10 | 17.80 | 92.00 |
| | 7 | 42.20 | 32.70 | 17.20 | 92.00 |
| | 14 | 41.10 | 31.10 | 17.10 | 89.30 |
| $C_2$ | Fresh | 40.30 | 31.60 | 19.10 | 91.30 |
| | 7 | 41.40 | 31.80 | 19.20 | 92.10 |
| | 14 | 41.50 | 32.10 | 19.20 | 92.80 |
| $K_1$ | Fresh | 40.40 | 31.90 | 17.80 | 90.70 |
| | 7 | 41.20 | 31.80 | 18.40 | 90.80 |
| | 14 | 42.10 | 31.80 | 18.60 | 92.50 |
| $K_2$ | Fresh | 40.90 | 31.90 | 18.60 | 91.30 |
| | 7 | 41.10 | 32.30 | 18.50 | 92.00 |
| | 14 | 43.00 | 32.70 | 19.20 | 94.90 |
| $K_3$ | Fresh | 40.90 | 32.30 | 18.40 | 91.60 |
| | 7 | 42.00 | 32.60 | 18.80 | 93.75 |
| | 14 | 42.10 | 33.20 | 19.15 | 94.10 |
| $K_4$ | Fresh | 41.20 | 31.50 | 18.00 | 90.70 |
| | 7 | 41.20 | 32.20 | 18.00 | 91.40 |
| | 14 | 41.80 | 31.70 | 18.30 | 91.80 |
| $K_5$ | Fresh | 41.20 | 32.40 | 18.50 | 92.10 |
| | 7 | 42.30 | 32.80 | 18.50 | 93.70 |
| | 14 | 42.80 | 32.40 | 18.60 | 93.70 |
| SE± | | 0.62 | 0.52 | 0.38 | 1.15 |

***See Table (1)** **SE: Standard error**

## REFERENCES


Abd El-Hamid, A. M. (2017). Physicochemical, rheological and sensory properties of Egyptian Kariesh cheese containing wheat bran. Society of Dairy Technol., 69 (3): 425-432.

Abd El-Salam, B. A. (2015). Effect of milk fat replacement with vegetable oil and/or whey protein concentrate on microstructure, texture and sensory characteristics of fresh soft cheese. Int. J. Dairy Sci., 10 (3): 117-125.

Abd El-Salam, B. A.; Amer, A. E. A. and Salem, A. S. (2017). Encapsulation of adapted probiotic strains and their use in the manufacture of Kariesh cheese. Egyptian J. Dairy Sci., 45 (1): 35-42.

Abou Ayana, I. A. A and Ibrahim, A. E. (2015). Attributes of low- fat yogurt and Kareish cheese made using exopolysaccharides producing lactic acid bacteria. AM. J. Food Technol., 10 (1): 48-57.

Abou-Donia, S. A. (1999). Importance of fermented milks and related cheese in the Egyptian diet. Proceedings of the Alexandria symposium on "starter culture and their use in dairy industry". Alex. 15-17 Nov., pp.: 108-114.

Abou-Donia, S. A. (2008). Origin, history and manufacturing process of Egyptian dairy products: An overview. Alex. J. Food Sci. Technol., 5 (1): 51-62.

AOAC. (2000). Association of Official Analytical Chemists. Official methods of analysis. 17th Ed, Washington DC, USA.

Awad, R. A.; Salama, W. M. and Ragb, W. A. (2015). Enhancing yield and acceptability of Kareish cheese made of reformulated milk. Annals Agric. Sci., 60 (1): 87–93.

Ayyad, K. M.; Ghaffar, A. I.; Salem, A. S. and Ismail, M. (2015). Production of probiotic low fat labneh by using exopolysaccharides- producing strains. Egyptian J. Dairy Sci., 43 (1): 41-51.

Bradley, R. L.; Arnold, E.; Barbano, D. M.; Smith, D. E and Vines, B. K. (1992). Chemical and physical methods: in standard methods for the examination of dairy products. 16th Ed., New York, U.S.A.

Celik, O. F. and Tarakci, Z. (2017). The effects of starter cultures on chemical, biochemical and sensory properties of low-fat Tulum cheese during ripening. Int. J. Dairy Technol., 70 (4): 583-591.

Duncan, D. (1955). Multiple range and multiple F tests Biometrics, 11:1-45.

Effat, B. A.; Salem, M. M. E. and El-Shafei, K. (2001). Effect of using different starters on quality of Kareish cheese. Egyptian J. Food Sci., 29(1): 95-108.

Elbanna, K.; Metry, W. and Elgarhy, H. (2015). Exopolysaccharide from *lactobacillus pentosusstrain* H2 and its impact on rheological properties and the sensory evaluation of low fat yoghurt and UF-soft cheese. Int. J. Nutr. Food Sci., 4 (5): 555-564.

El-Shafei, K. M.; Abed El- Gawad, M. A.; Dabiza, N. M. A. and Effat. B. A. (2008). A mixed culture of *Propionibacterium thoenii* P.127, *Lactobacillus rhamnosus* and *lactobacillus plantarum* as protective culture in Kareish cheese. Pol. J. Food Nutr. Sci., 5 (8) 4:433-441.

El-Shibiny, S.; Abd El-Salam, M. H.; Mahfouz, M. B. and El-Alamy, H. A. (1984). Effect of coagulation method on composition and quality of skim milk (Karish) cheese made by ultrafiltration technique. Egyptian J. Dairy Sci., 12 (2): 243-250.

El-Sissi, M. G. M. (2002). Utilization of blue cheese slurry for accelerated ripening of Domiati cheese. Egyptian J. Dairy Sci., 30 (1): 83-99.

Emam, A. O. A. (2013). Comparative studies on Kariesh cheese made using different manufactureing procedures. M. Sc. Thesis, Fac. Agric., Ain Shams Univ. 32-82.

ES. (2005). Egyptian Standards for Domiati cheese. 1008-3. Ministry of Industry and Technol. Development, Egyptian Organization for Standardization and Quality Control.

Fayed, A. E. (1986). Protein fortification of some dairy products. Ph.D. Thesis, Food Sci. Dept., Fac. Agric., Ain Shams Univ., 139-143.

Fayed, A. E.; Farahat, A. M.; Metwally, A. E.; Massoud, M. S. and Emam, A. Q. (2014). Health stimulating properties of the most popular soft cheese in Egypt Kariesh made using skimmed milk UF-retentate and probiotics. Acta Sci. Pol., Technol. Aliment., 13(4): 359-373.

Francois, Z. N.; Ahmed, N.; Fleicite, M. T. and El-Soda, M. (2004). Effect of ropy and capsular exopolysaccharides producing strain of *Lactobacillus plantarum*162 RM on characteristics and functionality of fermented milk and soft Kareish type cheese. African. J. Biotech., 3: 512-518.

Hamad, M. N. F. (2015). Effect of adding glucono-δ-lactone, different of starters, rennet on the chemical composition, yield and economic study of Kareish cheese. Int. J. Food Sci. Nut. Eng., 5 (3): 130-140.

Hussein, G. A. D. and Shalaby, S. M. (2014). Microstructure and textural properties of Kareish cheese manufactured by various ways. Annals Agric. Sci., 59 (1): 25 –31.

Jimenez-Guzman, J.; Flores-Najera, A.; Cruz-Guerrero, A. and Garcia-Garibay, M. (2009). Use of an exopolysaccharide-producing strain of *Streptococcus thermophilus* in the manufacture of Mexican Panela cheese. LWT. Food Sci. Technol., 42: 1508 – 1512.

Kebary, K. K.; El-Shazly, H. A. and Youssef, I. T. (2015). Quality of probiotic UF Domiati cheese made by *Lactobacillus rhamnosus*. Int. J. Curr. Microbiol. App. Sci., 4 (7): 647-656.

Khosravi-Darani, K.; Taheri, P. and Ahmadi, N. (2015). Effect of process variables on the probiotic and starter culture growth in symbiotic yogurt beet. Res. & Reviews: J. Food and Dairy Technol., 3 (2): 13-24.

Korish, M and Abd El-Hamid, A. M. (2012). Improving the textural properties of Egyptian Kareish cheese by addition of hydrocolloids. Inter. J. Dairy Technol., 65: 237–242.

Mahmoud, S. F.; El-Halmouch, Y. and Montaser, M. M. (2013). Effect of probiotic bacteria on Karish cheese production. Life Sci. J., 10 (2): 1279-1284.

Maubois, J. L.; Pierre, A.; Fauquant, J. and Piot, M. (1987). Industrial fractionation of main whey proteins. Int. Dairy Fed. Bull., 212: 154-159.

Metry, W. A. (2010). Assessment of safety and quality of Tallaga cheese from different locations in Egypt. Egyptian J. Dairy Sci., 38(2): 231-242.

Oxoid (2006). The Oxoid Manual, 6th Ed. Culture media, ingredients and other laboratory services. 6th Ed. Published by Unipath Limited, Wade Road, Basingstoke Hampshire, R G 24 OPW, England.

Pinto, S.; Rathour, A. K.; Prajapati, J. P.; Jana, A. H. and Solanky, M. J. (2007). Utilization of whey protein concentrates in processed cheese spread. Natural Product Radiance, 6 (5): 398-401.

Sakr, H. S. M. and Mehanna, N. M. (2011). Quality of low fat Ras cheese made from milk fortified with whey protein concentrate. Egyptian J. Dairy Sci., 39(2): 253-262.

SPSS. (2007). Statistical package for social sciences for windows. Version 16.0 SPSS company Inc., Chicago, 11, USA., p.444.

Stankey, J. A.; Lu, Y.; Abdalla, A.; Govindasamy-lucey, S.; Jaeggi, J. J.; Mikkelsen, B. Q.; Pedersen, K. T. and Andersen, C. B. (2017). Low-fat Cheddar cheese made using microparticulated whey proteins: Effect on yield and cheese quality. Int. J. Dairy Technol., 70 (1): 1-11.

Todaro, A.; Adly, F. A. and Omar, O. A. H. (2013). History, processing and quality enhancement of traditional Egyptian Kariesh cheese: a review. Food Sci. Technol., 1:1–6.

Trancoso-Reyes, N., Gutiérrez-Méndez, N., Sepulveda, D. R., and Hernández-Ochoa, L. R. (2014). Assessing the yield, microstructure, and texture properties of miniature Chihuahua type cheese manufactured with a phospholipase A1 and exopolysaccharide-producing bacteria. J. Dairy Sci., 97:598-608.

## تحسين خواص الجبن القريش المصنعة بطريقة الترشيح الفائق بإستخدام معاملات حيوية ومدعمات لبنية

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تهدف هذه الدراسة إلى تحسين خواص الجبن القريش المصنعة من اللبن الفرز الجاموسى الطازج المركز بتقنية الترشيح الفائق من خلال إستخدام معاملات حيوية ومدعمات لبنية. ولذلك تم تصنيع الجبن القريش بمعاملات مختلفه على النحو التالى: ١- جبن قريش مصنع بالطريقه التقليدية (كنترول أول). ٢- جبن قريش مصنع بتقنية الترشيح الفائق (كنترول ثاني) بدون إضافات. ٣- جبن قريش مصنع بتقنية الترشيح الفائق مع إضافة ٢% مركز بروتين الشرش أو ٢% شرش مجفف، على التوالى إلى اللبن الفرز المركز. ٤- جبن قريش مصنع بتقنية الترشيح الفائق مع إضافة ٢% من مخلوط (1:1) مزارع بكتيرية منتجة للسكريات العديده ( *Lb. rhamnoses* *Lb. acidophilus* LA-5 & NRRL-B-442 ) بمفردها أو مضاف معها ٢% مركز بروتين الشرش أو ٢% شرش مجفف، على التوالى إلى اللبن الفرز المركز. بعد التصنيع تم تخزين الجبن الناتج لمدة ١٤ يوم على درجة حرارة ٦±١°م وتم خلالها دراسة الخواص الحسية والميكربيولوجية والكيميائيه والريولوجية للجبن الناتج خلال فترات التخزين المختلفة. وقد أظهرت النتائج المتحصل عليها ما يلى: حدوث تحسن للخواص الريولوجية للجبن القريش الناتج من المعاملات المختلفه بالمقارنه بالجبن المصنع بالطريقة التقليدية (كنترول أول). كما أظهرت نتائج مجموع درجات التقييم الحسى أن أفضل المعاملات هى الجبن القريش المصنعة بتقنية الترشيح الفائق والمضاف لها ٢% شرش مجفف وذلك عند نهاية فترة التخزين (١٤ يوم). كما حدث زيادة فى نسبة المكونات بالجبن الناتجة فيما عدا المحتوى الرطوبى وقيم الرقم الهيدروجينى حدث بها إنخفاض خلال فترة التخزين. كما أظهر الفحص الميكروبيولوجي للمعاملات المختلفة من الجبن (سواء الطازجة أو خلال فترة التخزين) أنها خالية من بكتريا القولون، كما أوضحت النتائج زياده العدد الكلى للميكروبات الحية وأعداد الـ Lactobacilli و الـ Streptococci فى عينات الجبن القريش خلال فترة التخزين لجميع معاملات الجبن الناتج وكانت المعاملة الأعلى فى أعداد الـ Lactobacilli و الـ Streptococci هى المضاف لها خليط من كل من البادئات المنتجه للسكريات العديدة والشرش المجفف.