

## Low Lactose White Soft Cheese Made with Bioprocessing Treats and Ultrafiltration Technique

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### ABSTRACT

The diversity of products with reduced lactose levels is still limited, despite the worldwide deficiency of the  $\beta$ -galactosidase enzyme. Therefore, the aim of this study was to make low lactose white soft cheese from pasteurized buffalo's milk recombined retentate by applying different bioprocessing treatments, such addition of lactase, or different starters or using UF-technique, compared with that made from recombined retentate as control. Chemical composition and sensory properties as well as curd tension of the resultant cheeses were performed during storage at  $6 \pm 1^\circ\text{C}$  for 21 days. The curd tension values were statistically ( $P \leq 0.001$ ) affected by the UF-technique, adding lactase or starter cultures. A decrease in lactose content in all cheese treatments was detected during the storage period. The highest rate of lactose degradation was observed in cheese treatment that treated with lactase; which showed an improvement in its sensory properties, compared to the control.

**Keywords:** White soft cheese, low lactose cheese, ultrafiltration technique, bioprocessing treats, lactase and recombined retentate.

### INTRODUCTION

White soft cheese is one of the most popular types in Egypt; which is made either by enzymatic and/or acidic coagulation of whole or skim milk and or reconstituted milk powder. Three different processes can be applied in making this cheese on a commercial scale; the traditional method, using of UF-technique and non-traditional process. Recently, one of the white soft cheeses varieties in Egypt is made from concentrated mixture of skim milk powder and vegetable oil (recombined white soft cheese) to simulate retentate used in the UF- processing, because of its industrial and economical importance. This type of cheese is usually characterized with its higher content of lactose, which results in undesirable taste of the resultant cheese, as well as health problems, which lead to motivate bloating, abdominal cramps, nausea, diarrhea and loss of appetite, known as lactose intolerance (Di Stefano and Veneto, 2001, Vasiljevic and Jelen, 2003; Messia, *et al.*, 2007 and Regenhardt *et al.*, 2013).

As with the growing demand for the need of modification in the dairy industry, the modification of lactose level in these products to meet the consumer preferences from one side, and to protect the individuals suffering from the lactose intolerance case, on the other side. Different lactose-hydrolysis techniques are now available for making lactose hydrolyzed milk and lactose-free milk for further utilization of lactose modified dairy products. The available techniques in this case are using bioprocessing treats (such as, specific enzymes and lactose fermenting cultures) and the application of UF-technology (Nguyen *et al.*, 2007; Awad *et al.* 2015, Troise *et al.*, 2016, Moreira *et al.*, 2017, Jelen & Tossavainen, 2003 and Harju *et al.*, 2012). Thus, the objectives of this study is to make low-lactose recombined white soft cheese using different bioprocessing treats, compared to UF-technique and to evaluate their effects on the properties of the resultant white soft cheese during storage.

### MATERIALS AND METHODS

Fresh raw buffalo's milk, recombined retentate, UF-retentate and skim milk powder-low heat treat (imported from European Economic Community, Holland) were obtained from Dairy Processing Pilot Plant, Fac. Agric., Fayoum Univ.; Lactase preparation derived from the fermentation of a selected strain of *Kluyveromyces lactis* (Lactase activity  $> 50000$  ONPGU/g) was obtained from Danisco Co., Denmark. Microbial rennet powder (CHY-MAX, 2280 IMCU/ml) was obtained from Chr. Hansen' Lab., Denmark. Lyophilized strains, of *Lactobacillus rhamnosus* (NRRL-B-442) and *Lactobacillus acidophilus* LA-5 (Hansen Lab., Denmark) were obtained from Nevada Co., Alexandria, Egypt. *Streptococcus salivarius* subsp. *thermophiles* and *Lactobacillus bulgaricus* were obtained from dairy microbiology laboratory, National research center (NRC), Dokki, Giza, Egypt.

For making UF- white soft cheese; UF-retentate was prepared from fresh buffalo's milk using Tec. Sep UF, France, which was fitted with 2s 151 (model Tubular), membrane type: mineral (zirconium oxide), support: carbon, membrane surface area of  $6.8\text{m}^2$ . The unit was operated at  $50^\circ\text{C}$ ; inlet and outlet pressure of 0.36 and 0.06 Mpa, respectively. UF-white soft cheese was made according to Renner and Abd El-Salam (1991), and performed in the dairy Processing Pilot Plant and Dairy Depart., Fac. Agric., Fayoum Univ.

#### Low lactose recombined white soft cheese was made by following the mentioned steps:

- Preparation of recombined retentate: the skim milk powder was reconstituted in permeate at ratio of 7%, mixed with fresh UF- retentate at a ratio of 10:90, respectively (prepared by exterior agent).
- The recombined retentate divided into five equal portions as shown in Fig. (1), and used in preparing of low lactose recombined cheese (Non-traditional Egyptian white soft cheese).

All cheese treatments were finally packaged and stored at  $6 \pm 1^\circ\text{C}$  for 21 days. Samples of the resultant cheeses were taken and analyzed for organoleptic

properties, chemical analysis and curd tension when fresh, and after 7, 14 and 21 days. All experiments and analysis were repeated three times, and the mean values were tabulated.

Chemical and physical analysis of milk, retentate and white soft cheese were carried out by examining the titratable acidity (TA %), total nitrogen (TN %), water soluble nitrogen (WSN %), ash, fat and moisture contents as described in AOAC (2000). The pH values were measured by using laboratory pH meter with a glass electrode Model pH – (Kent EIL 7020). Salt (NaCl

%) was determined by direct titration according to Bradley *et al.* (1992). Lactose content was determined using the method described by Lawrence (1968). Curd tension of cheese samples was measured as described by El-Shabrawy (1973). Organoleptic properties of cheese were evaluated according to El-Shafei *et al.* (2008).

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  $P \leq 0.001$ .

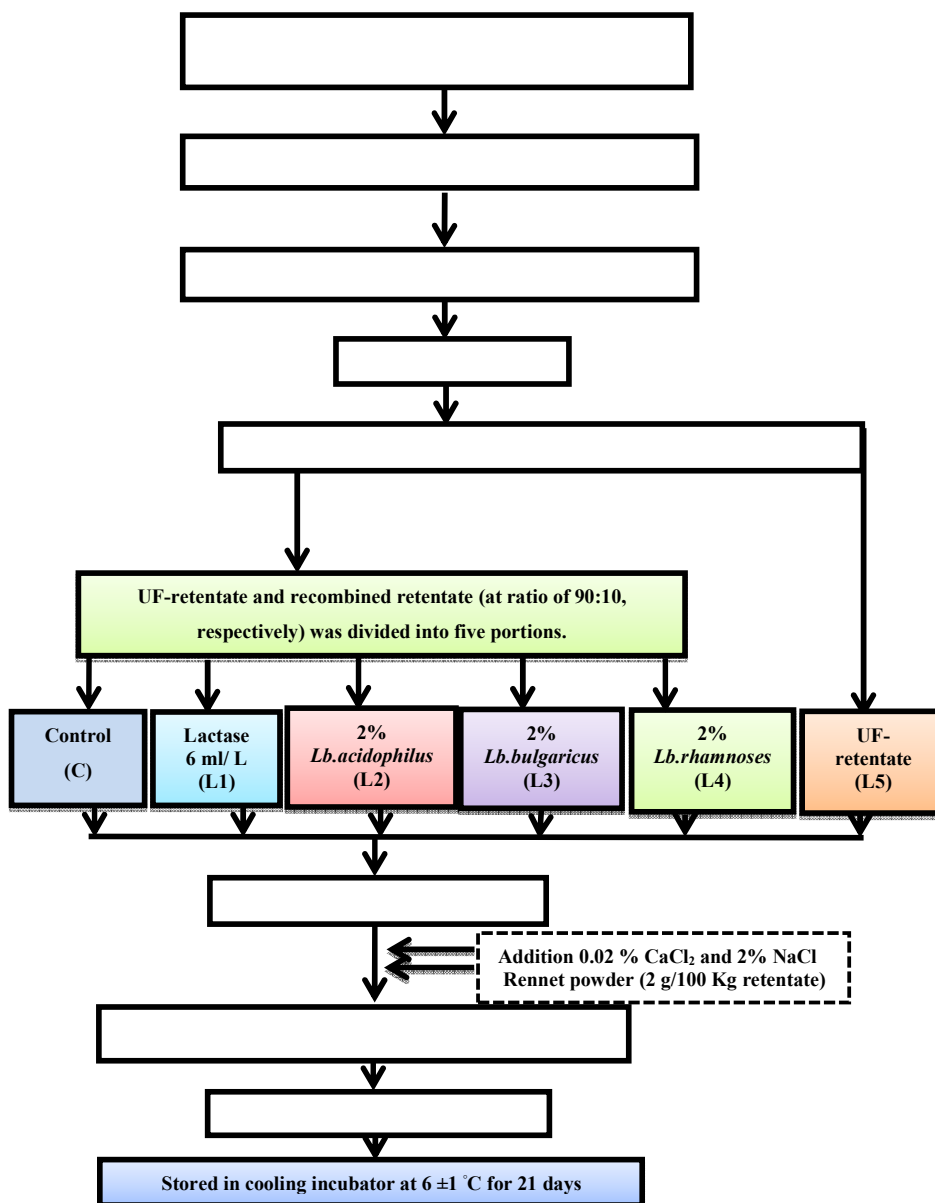


Fig. 1. Manufacturing steps of low lactose white soft cheese from recombined and ultrafiltrated retentates.

## RESULTS AND DISCUSSION

The effects of adding lactase, mixtures of different starter cultures (*Lb. acidophilus* (LA-5) + *Str. Thermophilus*; *Lb. bulgaricus* + *Str. thermophilus* or *Lb. rhamnosus* (NRRL-B-442) + *Str. thermophilus*) or using UF- technique upon the lactose content of UF- and recombined white soft cheese treatments during the storage period are summarized in Fig. (2). The results show that there were significant differences ( $P \leq 0.001$ ) between treatments and during storage at  $6 \pm 1^\circ\text{C}$  for 21 days. All cheese treatments exhibited lower lactose values, compared with the control. Lactose content in fresh white soft cheese samples were, 1.99, 2.11, 2.55, 2.89, 2.99 and 5.50 % in treatments; L<sub>5</sub>, L<sub>1</sub>, L<sub>2</sub>, L<sub>4</sub>, L<sub>3</sub> and C, respectively. Gradual decrease in lactose content was noticed as the storage period progressed to reach; 0.62, 0.68, 0.95, 0.97, 1.21 and 3.35% in treatments L<sub>1</sub>, L<sub>2</sub>, L<sub>4</sub>, L<sub>3</sub>, L<sub>5</sub> and C treatments, respectively at the end of storage period. It could also be noticed that there was slight differences among fresh recombined cheese treatments (L<sub>1</sub>, L<sub>2</sub>, L<sub>3</sub> and L<sub>4</sub>), but the significant differences ( $P \leq 0.001$ ) were detected during the storage time. The decrease in the lactose content could be attributed to the activity of lactase (L<sub>1</sub>) and starter cultures (L<sub>2</sub>, L<sub>3</sub> and L<sub>4</sub> treatments) being occurred during storage. These results agree with those stated by Abdou *et al.* (1984), Dawood *et al.* (1985) and Taher *et al.* (2013). It could also be observed that the rate of hydrolysis in all treatments increased during the storage period (Fig. 3). The difference in the rate of lactose hydrolysis between treatments depends on the treat type to the retentate. The rate of lactose hydrolysis in resultant cheese samples at 7<sup>th</sup> day of storage could be arranged in descending order as follows: L<sub>2</sub> > L<sub>1</sub> > L<sub>4</sub> > L<sub>3</sub> > C > L<sub>5</sub>. The treatment L<sub>2</sub> (contain *Lb. acidophilus* (LA-5) + *Str. thermophilus*) was the highest rate of lactose degradation, followed by L<sub>1</sub> (contain lactase), compared with other treatments and control, because the enzyme hydrolyzed the lactose. This finding came in agreement with that obtained by Kosikowski (1979) and Heyman (2006).

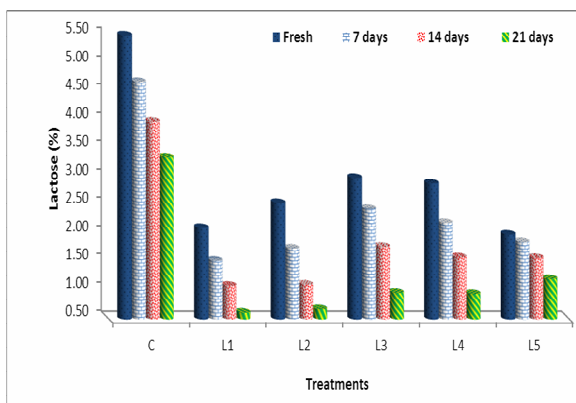


Fig. 2. Lactose content for low lactose white soft cheese treatments and control during storage at  $6 \pm 1^\circ\text{C}$ .

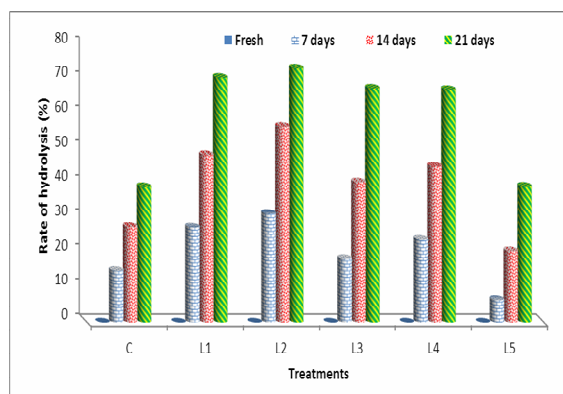


Fig. 3. Rate of lactose hydrolysis for low lactose white soft cheese treatments and control during storage at  $6 \pm 1^\circ\text{C}$ .

Results illustrated in Fig. (4), show the changes in titratable acidity (TA %) of the control and low-lactose white soft cheese treatments during storage at  $6 \pm 1^\circ\text{C}$  for 21 days. The statistical analysis of the obtained results indicated that there were significant differences ( $P \leq 0.001$ ) in TA% between treatments and during storage. The high levels of TA% were recorded in the recombined white soft cheese samples containing starter culture (L<sub>2</sub>, L<sub>3</sub> and L<sub>4</sub>), followed by that containing lactase (L<sub>1</sub>). This increase could be due to their relatively higher moisture content (Table 1) and, consequently to the high rate of lactose hydrolysis as shown in Fig. (3), which stimulated the growth of starter organisms as well as lactase, compared with L<sub>5</sub> and control cheese. These results are in accordance with those reported by Taher *et al.* (2013). Use of mixed probiotic cultures enhanced acid development as recorded by Mehanna *et al.* (2002). Titratable acidity (TA%) were dramatically higher in all cheese treatments than that detected in the control. The results showed that the order of increasing the TA % in fresh soft cheese samples was as follows: 0.22, 0.25, 0.26, 0.32, 0.33 and 0.37 % in L<sub>5</sub>, C, L<sub>1</sub>, L<sub>4</sub>, L<sub>3</sub> and L<sub>2</sub> cheeses, respectively. The corresponding values of TA after 21 days of storage were, 0.36, 0.35, 0.49, 0.65, 0.70 and 0.80 % in the same order. The TA% of all white soft cheese treatments increased gradually during storage period, which came in harmony with Mehaia (2002 and 2006). This difference appears to be due to the high buffering capacity occurring in cheeses made by the UF-process (SriLaorkul *et al.*, 1989).

Data presented in Fig. (5) summarize the changes in pH values between treatments and during storage period. The obtained data indicated that there is a significant difference ( $P \leq 0.001$ ) between the control cheese and the treatments with starter culture or lactase. This could be related to the original ratio of lactose in the retentate. The decrease in the pH was more obvious when starter culture was added before incubation. Such decrease in pH values of cheese is attributed to lactose degradation, and development of lactic acid throughout the storage period. The pH values took an opposite trend of TA%. By prolonging the storage period, the pH values decreased in all cheese treatments, and the

highest decrease was noticed in the treatments containing starter of *Lb. rhamnosus*, *Lb. bulgaricus* or *Lb. acidophilus*, which agree with the findings of Dabiza (2008); Ayad. (2009) and Abd-Elhamid (2017)

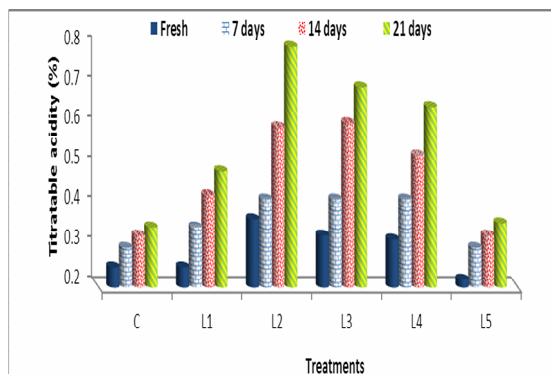


Fig. 4. Titratable acidity (%) of low lactose white soft cheese treatments and control during storage at 6 ± 1°C.

The moisture content of low- lactose white soft cheese samples and control throughout its storage period are presented in Table (1). There is a significant difference (P≤ 0.001) in moisture content within samples of cheese treatments. The moisture content characterized with slight decrease during the storage period to 21 days at 6±1°C. Similar results were obtained by Awad *et al.* (2015) and Abd-Elhamid (2017). White soft cheese made by UF-technique (L<sub>5</sub>)

contained the lowest moisture content, either when fresh or throughout storage period, compared with the other treatments and control. These results are in agreement with El-Din *et al.* (2010). Furthermore, it was noticed that the recombined white soft cheese produced in the absence of additives (control) recorded the highest moisture content, compared with the cheese treatments containing lactase (L<sub>1</sub>) or 2 % starter culture (L<sub>2</sub>, L<sub>3</sub> and L<sub>4</sub>). This might be due to the development of higher acidity, which coincided with the findings of Kebary *et al.* (2015).

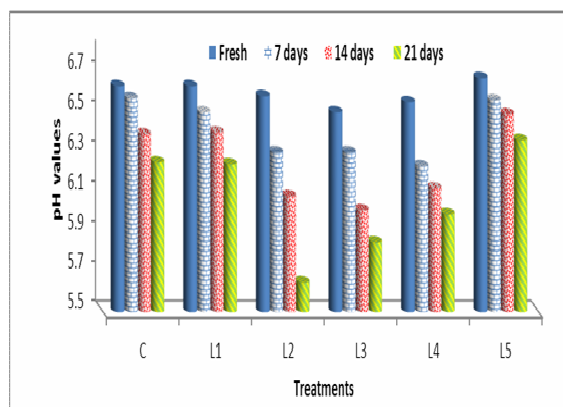


Fig. 5. pH values of low lactose white soft cheese treatments and control during storage at 6 ± 1°C.

Table 1. Changes occurred in the moisture, salt and salt / moisture (%) of low lactose white soft cheese treatments and control during storage at 6 ± 1°C.

Properties	Storage period (days)	Treatments *					
		C	L <sub>1</sub>	L <sub>2</sub>	L <sub>3</sub>	L <sub>4</sub>	L <sub>5</sub>
Moisture (%)	Fresh	71.83 <sup>a</sup>	71.81 <sup>a</sup>	71.58 <sup>abcd</sup>	71.72 <sup>ab</sup>	71.65 <sup>abc</sup>	68.99 <sup>n</sup>
	7	71.68 <sup>ab</sup>	71.65 <sup>abc</sup>	71.43 <sup>bcdef</sup>	71.48 <sup>bcde</sup>	71.55 <sup>abcd</sup>	68.85 <sup>n</sup>
	14	71.58 <sup>abcd</sup>	71.44 <sup>bcdef</sup>	71.32 <sup>defgh</sup>	71.10 <sup>hi</sup>	71.35 <sup>cdefg</sup>	68.76 <sup>n</sup>
	21	71.21 <sup>efgh</sup>	71.15 <sup>ghij</sup>	70.91 <sup>i</sup>	70.55 <sup>l</sup>	70.25 <sup>m</sup>	68.19 <sup>o</sup>
	±SE			0.07			
Salt (%)	Fresh	2.10 <sup>ghi</sup>	2.05 <sup>hi</sup>	2.09 <sup>ghi</sup>	2.04 <sup>hi</sup>	2.08 <sup>ghi</sup>	1.82 <sup>k</sup>
	7	2.27 <sup>de</sup>	2.25 <sup>e</sup>	2.25 <sup>e</sup>	2.23 <sup>ef</sup>	2.20 <sup>ef</sup>	1.91 <sup>jk</sup>
	14	2.41 <sup>bc</sup>	2.30 <sup>cde</sup>	2.30 <sup>cde</sup>	2.49 <sup>ab</sup>	2.39 <sup>bcd</sup>	1.98 <sup>ij</sup>
	21	2.43 <sup>ab</sup>	2.41 <sup>bc</sup>	2.47 <sup>ab</sup>	2.55 <sup>a</sup>	2.48 <sup>ab</sup>	2.05 <sup>hi</sup>
	SE±			0.039			
Salt/Moisture (%)	Fresh	2.92	2.85	2.96	2.83	3.11	2.64
	7	3.17	3.14	3.22	3.12	3.21	2.76
	14	3.37	3.36	3.37	3.49	3.35	2.88
	21	3.41	3.39	3.48	3.61	3.53	3.01

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

C: Recombined white soft cheese made without additions (Control).

L1: Recombined white soft cheese made with Lactase 6 m/ L retentate.

L2: Recombined white soft cheese made with 2 % *Lb. acidophilus* (LA-5) +*Str. thermophilus* (1:1)

L3: Recombined white soft cheese made with 2 % *Lb. bulgaricus* +*Str. thermophilus*. (1:1)

L4: Recombined white soft cheese made with 2 % *Lb. rhamnosus* (NRRL-B-442) +*Str. thermophilus*. (1:1)

L5: White soft cheese made using UF-technique. SE: Standard error

Results in the same Table illustrate the changes in salt and salt/moisture content of white soft cheese samples during storage period. Statistically significant difference (P ≤ 0.001) in the salt content between recombined soft cheese treatments and UF- soft cheese

was detected. The lowest content of salt and salt/moisture was noticed in soft cheese made using UF-technique (L<sub>5</sub>), either when fresh or during storage period, while, the recombined soft cheese treatments containing lactase or starter and control samples were

almost similar in salt and salt/moisture contents. It could be found that the salt and salt/moisture contents in all of the examined soft cheese gradually increased as the storage period advanced, that might be due to the decrease in the moisture content in the cheese samples. An inverse relationship between the moisture and salt content was established. Similar trends were obtained by Fayed *et al.* (2014) and Kebary *et al.* (2015). Fat, fat/dry matter (F/DM %) and ash contents of low-lactose soft cheese and control during storage period are shown in Table (2). The fat content of fresh white soft cheese made from UF-retentate (L<sub>5</sub>) was higher than that made without addition (C), where the fat content was 13.98 and 10.25 %, respectively. In all cheese treatments fat, F/DM and ash contents increased during storage period as a result of the decrease moisture content. Fat and F/DM (%) in L<sub>5</sub> treatment was the highest, where it was 14.50 and 45.58 %, respectively at 21 days of storage,

while the lowest fat and F/DM (%) was found in the recombined white soft cheese (C); where it was 11.00 and 38.21 %, respectively at 21 days of storage. These results are in agreement with those reported by Taher *et al.* (2013) and Kebary *et al.* (2015). The ash content ranged from 2.58 to 2.84% in the fresh cheese samples and increased during storage period to reach 2.74 to 3.26% after 21 days. White soft cheese made by UF-technique (L<sub>5</sub>) was of the lowest ash content, compared with the recombined soft cheese treatments, either when fresh or during storage. This could be due to manufacturing process by UF-technique, which led to more loss of soluble salts in permeate, comparing with the recombined soft cheese treatments being made by using UF-retentate, skim milk powder and permeate. These results confirm those reported by Limsawat and Pruksasri (2010).

**Table 2. Fat, fat/ dry matter and ash content of low lactose white soft cheese treatments and control during storage at 6 ±1 °C**

Properties	Storage period (days)	Treatments*					
		C	L <sub>1</sub>	L <sub>2</sub>	L <sub>3</sub>	L <sub>4</sub>	L <sub>5</sub>
Fat (%)	Fresh	10.25 <sup>g</sup>	10.75 <sup>ef</sup>	10.43 <sup>fg</sup>	10.30 <sup>g</sup>	10.45 <sup>fg</sup>	13.98 <sup>b</sup>
	7	10.51 <sup>fg</sup>	11.00 <sup>de</sup>	10.50 <sup>fg</sup>	10.40 <sup>fg</sup>	10.75 <sup>ef</sup>	14.05 <sup>a</sup>
	14	10.75 <sup>ef</sup>	11.25 <sup>cd</sup>	11.00 <sup>de</sup>	10.75 <sup>ef</sup>	11.10 <sup>cde</sup>	14.20 <sup>a</sup>
	21	11.00 <sup>de</sup>	11.50 <sup>c</sup>	11.15 <sup>cde</sup>	11.08 <sup>de</sup>	11.35 <sup>cd</sup>	14.50 <sup>a</sup>
	SE±	0.127					
Fat/dry matter (%)	Fresh	36.39	38.14	36.70	36.42	36.86	45.08
	7	37.12	40.22	38.08	37.27	39.02	45.10
	14	37.83	40.82	39.16	38.01	39.17	45.45
	21	38.21	40.81	39.74	38.96	39.48	45.58
	SE±	0.027					
Ash (%)	Fresh	2.81 <sup>defgh</sup>	2.79 <sup>defgh</sup>	2.80 <sup>defgh</sup>	2.82 <sup>defgh</sup>	2.84 <sup>defgh</sup>	2.58 <sup>h</sup>
	7	2.92 <sup>bcdefg</sup>	2.88 <sup>bcdefg</sup>	2.94 <sup>bcdefg</sup>	2.95 <sup>abcdef</sup>	2.95 <sup>abcdef</sup>	2.63 <sup>gh</sup>
	14	3.04 <sup>abcde</sup>	3.02 <sup>abcde</sup>	3.05 <sup>abcde</sup>	3.08 <sup>abcd</sup>	3.07 <sup>abcde</sup>	2.69 <sup>fgh</sup>
	21	3.21 <sup>ab</sup>	3.18 <sup>abc</sup>	3.26 <sup>a</sup>	3.23 <sup>abc</sup>	3.22 <sup>ab</sup>	2.74 <sup>efgh</sup>
	SE±	0.027					

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

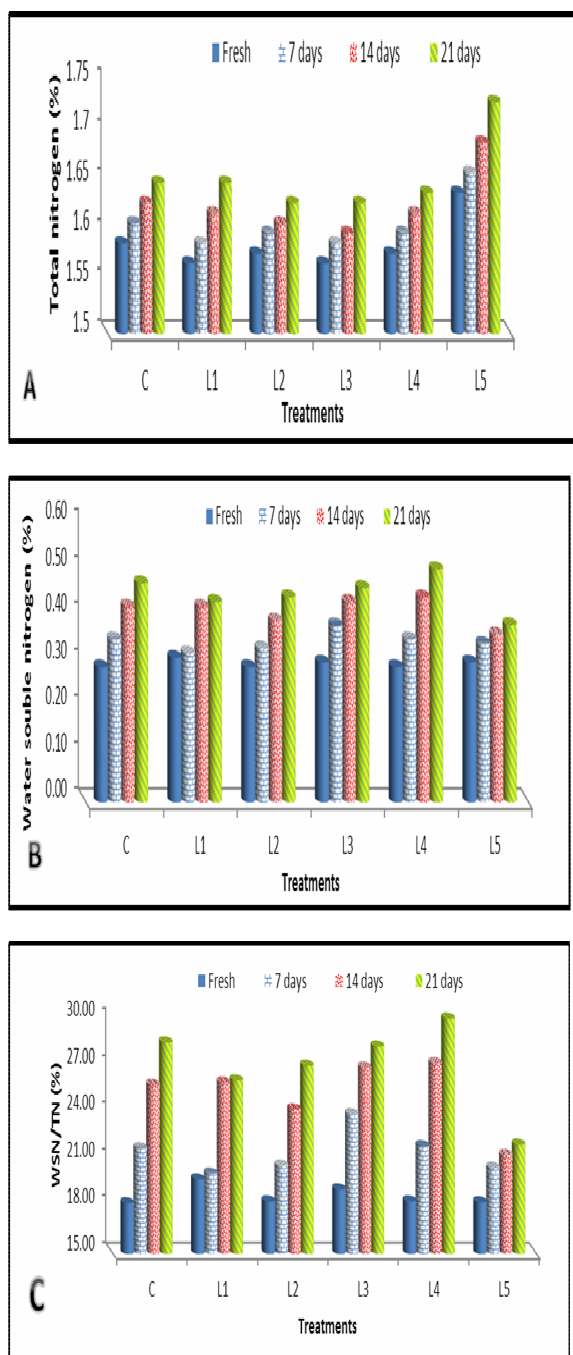
\* See table (1)

SE: Standard error.

Results in Fig. (6) illustrate the total nitrogen (TN %), water soluble nitrogen (WSN %) and water soluble nitrogen/ total nitrogen (WSN/TN %) contents of different low lactose white soft cheese treatments and control during storage period. TN, WSN and WSN/TN contents in all the experimented white soft cheese gradually increased with the progress of the storage period. This increase was due to the decrease of the moisture content during storages. Similar trends were obtained by Kebary *et al.* (2015). In general, the TN (%) did not differ significantly in all fresh treatments, while significant differences (P≤ 0.001) were found during storage period. The rate of accumulation of WSN increased in all cheese treatments as the storage period proceeded. This might be attributed to the rate of proteolysis throughout the storage period. Similar trends were mentioned by Mehaia (2002); Taher *et al.* (2013); and Dimitreli *et al.* (2017). Positive correlation could also be observed between WSN content and the different methods used to reduce lactose in the resultant white soft cheese (using UF, adding the starter or lactase). Addition of the starter led to an increase in

WSN in cheese treatments; L<sub>4</sub>, L<sub>2</sub> and L<sub>3</sub>, comparing with C and L<sub>5</sub> treatments. This increase could be due to the activity of proteinases and peptidases released from *Lb. rhamnosus* (L<sub>4</sub>), which resulted in higher level of proteolysis in the cheese. These results are in agreement with those obtained by (Kebary *et al.* 2015). Slightly less WSN/ TN ratio was also observed L<sub>5</sub> than that in the other treatments. These results confirm those reported by Mehaia (2002 and 2006). Strong proteolytic activity of lactobacilli may explain the high WSN/ TN ratio of these treatments (Abd Alla *et al.*, 2008).

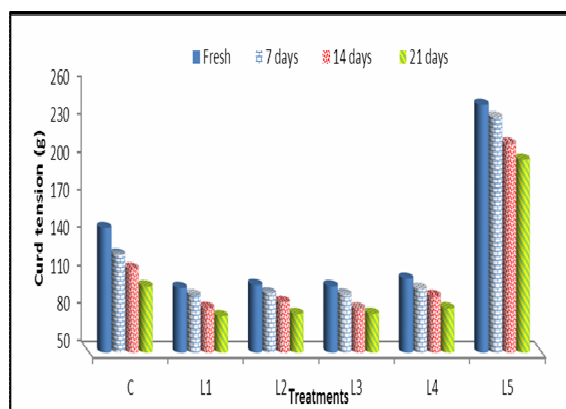
As with the curd tension (CT) of low-lactose white soft cheese treatments, it is obvious from Fig. (7), that the CT of white soft cheese sample manufactured using UF-technique (L<sub>5</sub>) was higher than that made from recombined retentate. Furthermore, the addition of lactase or starter culture resulted significantly in a decrease (P≤0.001) for CT values, compared with control sample.



**Fig. 6. Changes occurred in: (A) total nitrogen (%); (B) Water soluble nitrogen (%) and (C) Water soluble nitrogen/ total nitrogen (%) of low lactose white soft cheese treatments and control during storage at  $6 \pm 1^\circ\text{C}$ .**

The CT value was 148.7 g for fresh control cheese sample; while it slightly decreased with using lactase or starter cultures reaching 101.16, 102.53, 103.49 and 108.63 g for treatments L<sub>1</sub>, L<sub>3</sub>, L<sub>2</sub> and L<sub>4</sub>, respectively. These results are in agreement with that given by Hassanien *et al.* (2014). Likewise, the obtained results revealed that there were significant differences ( $P \leq 0.001$ ) between treatments during storage period. Curd tension of all cheese treatment and control

significantly ( $P \leq 0.001$ ) decreased as storage period proceeded. This finding is similar to that reported by Badawi and Kebary (1998).

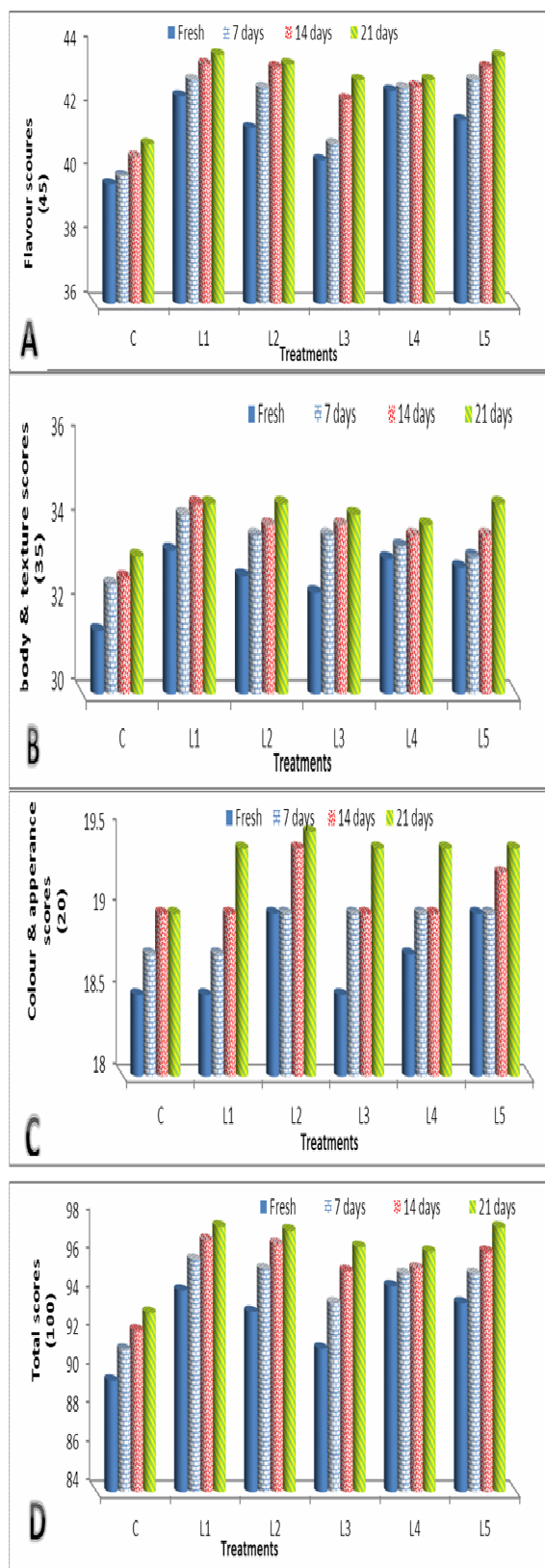


**Fig. 7. Curd tension (g) of low lactose white soft cheese treatments and control during storage at  $6 \pm 1^\circ\text{C}$ .**

The average data for all organoleptic properties of different low lactose white soft cheese treatments and control when fresh and during the storage period are summarized in Fig. (8). The Fresh cheese made by adding *Lb. rhamnoses*+ *Str. thermophilus* (L<sub>4</sub>), gained the maximum total scores (94.62), followed by L<sub>1</sub> (94.40), compared with control cheese sample, which gained the lowest scores when fresh and during the storage period, The total scores was 89.75, 91.35, 92.35 and 93.25 when fresh, and after 7, 14 and 21 days of storage, respectively. On the other hand, the total score point increased in all treatments along storage period, pronounced increase was observed after 21 days of storage in the cheese treatment made by UF-technique L<sub>5</sub> (97.65) and that made with adding lactase, L<sub>1</sub> (97.70).

Concerning flavor scores, there were no a significant difference between white soft cheese treatments. In general the flavour scores of all white soft cheese treatments were increased during storage period. The results showed that flavour scores of fresh UF and recombined soft cheese samples were 39.75, 40.50, 41.50, 41.75, 42.50 and 42.67 for C, L<sub>3</sub>, L<sub>2</sub>, L<sub>5</sub>, L<sub>1</sub> and L<sub>4</sub> cheeses, respectively. The corresponding values of flavor scores after 21 days of storage were, 41.00, 43.00, 43.00, 43.50, 43.75 and 43.80 for C, L<sub>3</sub>, L<sub>4</sub>, L<sub>2</sub>, L<sub>5</sub> and L<sub>1</sub> cheeses, respectively. The flavour of control was the lowest score compared to other treatments. In general, the results indicated that the use of starter cultures or lactase improved the flavour of recombined cheese. This may be due to the high concentration of lactose in the control sample, which gave an undesirable sweet taste compared with other treatments. The obtained data were similar to that reported by Salem *et al.* (1982).

Regarding the body and texture, L<sub>5</sub>, L<sub>1</sub> and L<sub>2</sub> treatments recorded the highest body and texture scores. Moreover, the results of colour and appearance scores stated that, white soft cheese made using UF (L<sub>5</sub>) or recombined soft cheese gave close degrees either when fresh or during storage period for 21 days.



**Fig. 8. Organoleptic scores of low lactose white soft cheese treatments and control during storage at 6 ± 1°C, where: (A) flavour, (B) body & texture, (C) colour and appearance and (D) total scores.**

The obtained results were in harmony with that obtained by Hassan *et al.* (1983) and Dawood *et al.* (1985) and Taher *et al.* (2013). The overall organoleptic properties of all cheese treatments were remained acceptable up to three weeks, but they were deteriorated when the cold storage period was exceeded.

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## تصنيع الجبن الأبيض الطرى منخفض اللاكتوز باستخدام المعاملات الحيوية وتقنية الترشيح الفائق وداد عزب مبرى، منال قطب احمد خضر و فتحية عاشور يس عثمان قسم الألبان- كلية الزراعة - جامعة الفيوم - مصر

تهدف هذه الدراسة إلى إنتاج الجبن الأبيض الطرى منخفض اللاكتوز من المترکز المعاد تركيبه باستخدام المعاملات الحيوية وتقنية الترشيح الفائق وأيضاً تقييم بعض خواص الجبن الناتج خلال فترة التخزين. ولتحقيق هذه الأهداف تم تصنيع الجبن الأبيض الطرى من اللبن الجاموسى المركز بالترشيح الفائق ومن المترکز المعاد تركيبه والذي قسم إلى خمس أجزاء لإعداد المعاملات المختلفة وتصنيعها لجبن أبيض على النحو التالي: الكنترول (C): الجبن المصنع باستخدام مركز معاد تركيبه بدون أى إضافة. المعاملة الأولى  $L_1$ : إضافة لاكتيز بمعدل 6 مل/ لتر (تم تحديد هذه النسبة بناء على نتائج التجارب المبدئية) إلى المترکز المعاد تركيبه. المعاملة الثانية  $L_2$ : إضافة 2% بادئ يتكون من  $Str. thermophilus + Lb. acidophilus$  LA-5. المعاملة الثالثة  $L_3$ : إضافة 2% بادئ يتكون من  $Lb. + Str. thermophilus$ . المعاملة الرابعة  $L_4$ : إضافة 2% بادئ يتكون من  $Str. thermophilus + Lb. bulgaricus$ . المعاملة الخامسة  $L_5$ : الجبن المصنع باستخدام اللبن الجاموسى المركز بالترشيح الفائق بدون إضافات. تم تخزين الجبن الناتج لمدة 21 يوم على درجة حرارة  $16 \pm 1^\circ\text{C}$  تم خلالها إجراء التحليل الكيمياءى وأيضاً قياس الجذب الخثري وعمل التقييم الحسى للجبن الناتج من المعاملات المختلفة خلال فترة التخزين (طازجة، 7، 14 و 21 يوم). ويمكن تلخيص أهم النتائج المتحصل عليها فيما يلى: دلت النتائج على وجود انخفاض فى نسبة اللاكتوز فى كل عينات الجبن الناتج خلال فترة التخزين وكان معدل الإنخفاض أكبر فى المعاملة المضاف لها اللاكتيز والبادئات بالمقارنة بالكنترول. كما وجد أن الـ % للموضوعة فى عينات الجبن الطرية الناتج تزداد تدريجياً مع تقدم فترة التخزين، وكانت الأعلى فى الحموضة والأقل فى قيم الرقم الهيدروجينى المعاملة ( $L_3$ ) المضاف لها بادئ الـ  $Lb. bulgaricus + Str. thermophilus$  بالمقارنة بباقي المعاملات والكنترول. كما سجلت الـ % الرطوبة إنخفاضاً تدريجياً بنسب متفاوتة مع تقدم فترة التخزين، على العكس من ذلك حدث ارتفاع تدريجى فى نسبة الدهن خلال فترة التخزين وكانت المعاملة المصنعة من مركز الترشيح الفائق الأقل فى الرطوبة والأعلى فى نسبة الدهن. كما أوضحت النتائج وجود زيادة فى نسبة الرماد والملح والنيتروجين الكلى والنيتروجين الذائب فى الماء فى كل المعاملات وكانت الأعلى فى نسبة النيتروجين الكلى هى المعاملة المصنعة من مركز الترشيح الفائق ( $L_5$ ) بينما إنخفضت هذه المعاملة فى محتواها من النيتروجين الذائب منسوبا للنيتروجين الكلى. عند قياس الجذب الخثري فى الجبن الطرية الناتجة من المعاملات المختلفة كانت هناك فروق معنوية بينها، ووجد أن أعلى معدل صلابة (أختراق الخثرة) كانت للجبن المصنعة بطريقة الترشيح الفائق ( $L_5$ ) وكانت الأقل فى قيمة اختراق الخثرة هى الجبن المضاف لها اللاكتيز ( $L_1$ ) مقارنة بالكنترول خلال فترة التخزين. عند إجراء تقييم حسى لعينات الجبن الأبيض الطرى وهى طازجة وخلال فترة التخزين وجد أن المعاملة الكنترول حصلت على أقل درجات تحكيم كلية مقارنة بباقي المعاملات. بينما حصلت المعاملة ( $L_1$ ) المضاف لها اللاكتيز وكذلك المعاملة ( $L_2$ ) المضاف لها  $Lb. acidophilus$  LA-5 على أعلى درجات فى التقييم الحسى خلال فترة التخزين. بناء على النتائج السابقة توصي الدراسة بإمكانية تصنيع جبن أبيض طرى من مترکز معاد تركيبه بمحتوى منخفض من اللاكتوز بإضافة اللاكتيز بمعدل 6 مل/ لتر أو 2% بادئ يتكون من الـ  $Str. thermophiles + Lb. acidophilus$  LA-5 أو  $Str. thermophilus + Lb. rhamnoses$  إلى المترکز المعاد تركيبه.