

PROPERTIES OF FUNCTIONAL SOFT CHEESE MADE BY USING BLENDS OF ARTICHOKE (*Cynara cardunculus* L.) INSTEAD OF CHYMOSIN AS COAGULANT

Metry, Wedad A.

Dairy Sci. Dept., Fac. Agric., Fayoum Univ., Egypt
wedadazab@yahoo.com E-mail

ABSTRACT

This study was designed to investigate the effect of adding different levels of aqueous artichoke extract (AAE) to cheese retentate either as a rennet substitute or functional food on the properties of soft cheese during storage at $5 \pm 1^\circ \text{C}$ / 4 weeks. AAE was added at ratios 0.0, 0.5, 1.0, 1.5 and 2 ml / 100 gm retentate which represents 0.0, 25, 50, 75 and 100 % replacement of chymosin, respectively. Resultant cheeses were analyzed when fresh, 2 and 4 weeks for some chemical, microbiological, rheological and organoleptic properties of cheese during storage, and phenol content and coagulation time of retentate were also measured. No significant differences in the protein and fat contents of cheese samples were detected, but the total solids were slightly higher for control than other treatments. Both titratable acidity and water soluble nitrogen and syneresis of all samples were increased during storage period. Electrophoresis patterns illustrated that, artichoke aspartic proteinase exhibited a lower degree of protein degradation than the calf rennet. Cheese samples containing AAE had higher concentrations of total phenol and total carbohydrate content than the control. No coliform was detected in the cheeses and total viable counts of microorganisms increased throughout storage periods. The average sensory property scores of all cheese samples were very close. All treatments had very good texture, over all acceptability, and as expected, storage time had a negative effect on total sensory scores and microbiological quality of the examined cheeses

Keywords: Artichoke extract, phenol content, electrophoresis patterns, microbiological and organoleptic properties .

INTRODUCTION

Functional foods offer great potential to improve health and/or help in preventing certain diseases when taken as a part of a balanced diet and healthy lifestyle. Therefore, research on different aspects of functional food and its economical and nutritional benefits have been the focus of research for several years all over the world. The research opportunities in nutrition to explore the relationship between functional food and / or food components and improved state of health and well-being, or reduction of diseases, present the greatest challenge to scientists now and in the future. The communication of health benefits to consumers is also of critical importance so that they have the knowledge to make informed choices about the foods they eat and enjoy. The main aim of "functional foods" is to introduce beneficial compounds into the human through daily dietary intake. Therefore, searching for new functional healthy dairy products is needed. Recently, different functional dairy products are currently proposed, such as fermented milks (Sanchez *et al.*, 2009 and Vijayalakshmi *et al.*, 2010), ice creams (El-Nagar *et al.*, 2002 and Di Criscio *et al.*, 2010), soft cheese (Elewa, *et al.*,

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2009 and Delgado *et al.*, 2010) and processed cheese (Awad and Salama, 2010).

Addition of natural sources of antioxidants is an emerging trend for the development of functional dairy products. These ingredients could play a role in reducing the risk of some degenerative diseases (Drewnoski and Gomez-Carneros, 2000 and Talalay and Fahey 2001).

Artichoke (*Cynara Cardunculus L*) has a high content of a fructosane called inulin (Frutos *et al.*, 2008) .The effects of inulin include management of constipation, stimulating calcium absorption from food, modulating lipid metabolism, and preventing cancer (McBain and Macfarlane, 2001 and Rao, 2001). Inulin is legally considered a fiber because it acts as a soluble fiber, being digested almost totally in the colon, not in the small intestine (McBain and Macfarlane, 2001). Also, artichoke extract, maintains healthy bile metabolism, antioxidant activity, blood flow in the liver, and detoxification.

The nutritional benefits of artichokes include high levels of potassium, an excellent source of fiber and vitamin C, and a good source of folate and magnesium. Thus, in addition to the lipid lowering and antioxidant properties of artichoke and an increase in endothelial nitric-oxide synthase (eNOS) gene transcription may also contribute to its beneficial cardiovascular diseases (Li *et al.*, 2004). Meanwhile, flowers of artichoke have been used since ancient times as a source of milk –clotting enzymes. The initial scientific investigations into the cheese making properties of this plant coagulant were conducted by Vieira de Sa and Barbosa (1972). Flowers of the Artichoke plant contain two proteinases capable of causing coagulation of milk (Sousa, 1993 and Sidrach *et al.*, 2005). These enzymes are termed cardosin A and cardosin B; both enzymes split the Phe105–Met106 bond of k-casein. Kinetic parameters of cardosin A were similar to those obtained by chymosin , and Cardosin B is more proteolytic than cardosin A (Macedo *et al.*, 1993 and Verissimo *et al.*, 1995). Traditionally fresh aqueous extracts of the flowers are used as a curd coagulant preparation for production of several cheese varieties (Sousa and Malcata, 2002 and Mahony *et al.*, 2003).

Tallaga cheese is one of the white soft cheeses which are well known in Egypt and other countries. Ultrafiltration (UF) technique process was used successfully in its production in the laboratory pilot plant (Farahat *et al.*, 2008; Elewa *et al.* , 2009 and Kebary *et al.*, 2009) and ,on the industrial scale by the modern dairy factories , which is now accepted by the consumers.

This study was conducted to develop functional dairy products with antioxidant activities to combat the risk of degenerative diseases. The main objectives of this study involved: (1) blending chymosin and artichoke extract in varying proportions for use as coagulant preparations and (2) to formulate functional white soft cheese and choose the optimal proportion of artichoke to be used in cheese making. (3) Assess the acceptability, chemicals and microbiological properties of functional soft cheese during storage at $5 \pm 1^{\circ} \text{C}$ for 4 weeks.

MATERIALS AND METHODS

- Fresh raw buffaloes' milk was obtained from private farms at Fayoum Governorate.
- Calf rennet (Chymosin) powder was obtained from Chr. Hansen's Lab. Denmark.
- Artichoke (*Cynara Cardunculus* L) was obtained from the local market.

The crude extract of the artichoke was obtained from the heart and choke (outer and inner) part of artichoke, which were separated, cut off, extracted by blending in distilled water (1:1) using the blender at room temperature for 5 min and filtered through cloth cheese.

Experimental cheeses were made in the pilot plant of the Dairy Sci. Dept., Fac. Agric. Fayoum Univ. Fresh buffaloes' milk was pasteurized (73° C/15 sec.) before and after homogenized (at about 100 bar) and ultrafiltered at 55 ° C until containing about 37 % total solids , cooled to 40 ± 1° C , 0.02 % calcium chloride and 3% sodium chloride were added . Retentate was divided into five equal portions and manufactured as follows:

- 1- The first one was served as a control without addition AAE, and chymosin was added at ratio of 5 g / 100 kg retentate.
- 2- Aqueous artichoke extract (AAE) was added to the rest four portions of retentate (T₁ , T₂ , T₃ and T₄) at ratios 0.5 , 1 , 1.5 and 2 ml / 100 ml retentate, respectively, which represents 25 , 50 , 75 and 100 % replacement of chymosin. The retentate mixture filled in polyethylene containers (about 100 g), incubated at 40 ± 1 ° C to complete coagulation (within 40 min for all treatments) and stored at 5 ± 1° C for 4 weeks .

The suitable ratios of AAE were determined according to the initial experiments on UF- white soft cheese fortified with AAE, which based on the determination of coagulation time of retentate (40 min.) and sensory evaluation of resultant cheese. Finally, the resultant cheese samples were analyzed when fresh, after 2 and 4 weeks of storage at 5 ± 1° C. The experiments were replicated three times and all analyses were performed in duplicate.

Fat, total nitrogen, titratable acidity, total carbohydrates and ash contents were determined as described in AOAC (2007). Water soluble nitrogen was measured using Kjeldahl method according to Kuchroo and Fox (1982). Proteolytic patterns of cheese proteins were determined by sodium dodecyl sulfate polyacrylamide gel electrophoresis (SDS- PAGE) according to the method of Laemmli (1970) and modified by Studier (1973), The obtained SDS- PAGE patterns were identified as described by Basch *et al.* (1985). The method of Wua and Ng (2008) was used in determining the total phenols content in cheese samples using Folin – Ciocalten reagent and Gallic acid as standard solution. The total phenols content in cheese samples was calculated from the standard curve, and expressed as tannic acid equivalent in (TAE) mg/100g sample.

Mineral contents were estimated in ash according to AOAC (2000) using atomic absorption spectrophotometer (ZEISS, AAS 5, Germany) to measure Iron, calcium and magnesium contents, while potassium was

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determined using a flame photometer (JENWAY, PFP7, 7837, UK) whereas, phosphorus content was determined using spectrophotometer according to the method described by Morrison (1964).

Samples were measured for firmness at $15 \pm 1^\circ \text{C}$ by penetrometer (PNR 10 with microprocessor controls, SUR, Berlin). The standard rod weight was 50 gm. The test was performed as follows: the penetrometer cone was adjusted to touch the surface of cheese samples, the cone was released to penetrate into the samples for 5 sec. and penetration depth was recorded in units of 1.0 millimeter (mm). Penetration depth was recorded in triplicate at 3 different spots in each sample. The average of these penetration depths was taken as penetration value (firmness)

The syneresis was calculated by using the flowing Equation:

Syneresis (%) = $(ww/wc) \times 100$. Where *ww* (g) is the weight of whey released from each cheese at the different times of storage and *wc* (g) is the weight of cheese in the same package (Souza and Saad, 2009).

Total viable counts were enumerated on nutrient agar (plates were incubated at 35°C / 48 h), coliform counts on MacConky agar, yeasts and moulds on potato dextrose agar as described in Oxoid (1990).

The resultant cheese samples were organoleptically scored when fresh and during storage period by 15 trained panelists from the staff at the Dairy Sci. Dept.; Food Sci. Dept. and Microbiol. Dept., Fac. Agric., Fayoum Univ. A score card was used as mentioned by Pappase *et al.* (1996) for evaluation of flavor (50 points), body and texture (40), color and appearance (10).

The general linear model was used to determine the effects of artichoke extract on the properties of resultant UF- functional white soft cheese. The SPSS system (1999) software version 9 was used to carry out the statistical analysis. Statistical significance for differences was determined at the 5 % probability level. Duncan's (1955) multiple comparison procedure was used to compare between the means.

RESULTS AND DISCUSSION

There were no significant differences ($P > 0.05$) in the composition (protein, fat, and salt contents) between the control and other treatments either when fresh or during the storage period of functional soft cheese. The total proteins, fat, and salt contents showed increased gradually as the storage period progressed. It was concluded that this increase might be due to the decrease in the moisture content of resultant soft cheese from all treatments during storage. These results are in agreement with those of Elewa *et al.* (2009). Likewise, the control had less moisture content than other treatments, while T4 recorded the highest moisture content, probably due to the higher moisture content of AAE (91.74 %) than retentate (58.59%). The main values of moisture content of fresh soft cheese from different treatments and control ranged from 58.61 to 59.81 %, while their fat and fat/dry matter contents ranged from 22.60 to 23.11 and 54.83 to 56.23, respectively. While, total protein and salt contents ranged from 10.39 to 11.17% and 3.07 to 3.12%, respectively. At the end of storage period, the main values of moisture, fat and fat / dry matter contents in cheese from all

treatments ranged between 57.92 to 59.33 %, 22.83 to 23.95 and 56.13 to 56.68 %, respectively. While protein and salt contents at 4 weeks of storage reached to 10.85 to 11.97 % and 3.13 – 3.20 %, respectively.

Soft cheese samples containing 100 % AAE had higher ash content than other treatments and control, while the lowest ash content found in the control. Ash content in fresh cheese treatments were 3.21, 3.23, 3.48, 3.62 and 3.87% in control, T₁, T₂, T₃ and T₄, respectively and it gradually increased to reach 3.29, 3.31, 3.53, 3.69 and 3.90%, respectively at the end of storage. Data presented in Fig. (1) illustrate the changes in titratable acidity (TA) and water soluble nitrogen (WSN) of different cheese treatments during storage at 5 ± 1° C for 4 weeks. Addition of AAE had no significant effect on the TA of fresh cheese samples at all AAE ratios used, while the WSN and WSN / TN of cheese slightly decreased with increasing the ratio of AAE added. TA, WSN and WSN / TN of all cheese samples were significantly increased during storage. The results indicated that T₄ was higher, TA than other cheese samples after days 28 of storage, this might be due to increase in total carbohydrate in the resultant cheese, which had effect on the activity and growth of cheese microflora, while their WSN was lower than other treatments. Whereas, Vieira and Barbosa (1972) observed that cheese made with cardoon had a softer texture, less bitter taste and a higher degree of proteolysis compared to the cheese made with animal rennet.

Results in Fig. (2) showed that total carbohydrates and total carbohydrates / dry matter were influenced by the increase of added AAE. Minor differences could be observed in the total carbohydrates between fresh cheese samples, which slightly increased with increasing the concentration of AAE added.

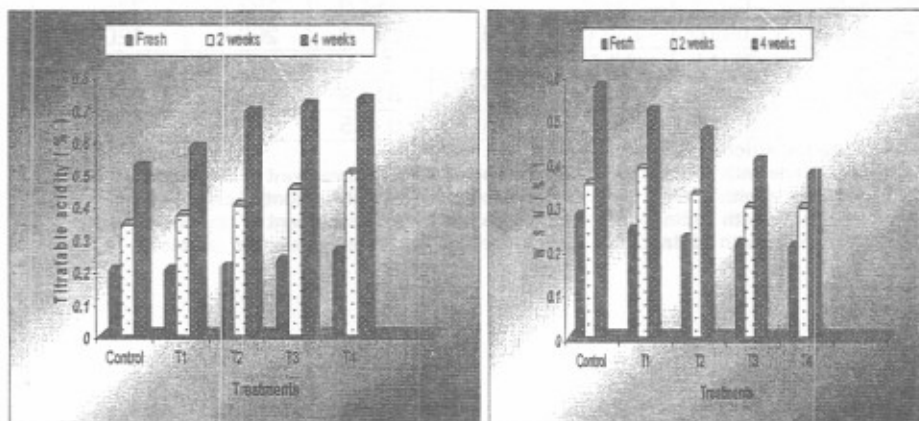


Fig. 1: Titratable acidity (TA) and water soluble nitrogen (WSN) of functional soft cheese as affected by using different levels of AAE when fresh and during storage at 5 ± 1° C for 4 weeks.

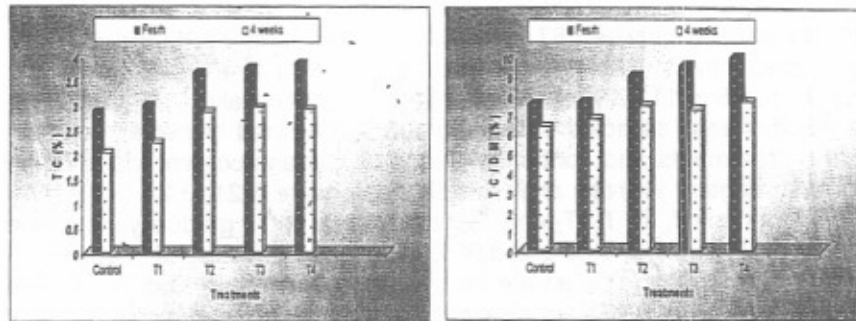


Fig.2: Total carbohydrates (TC) and total carbohydrates / dry matter (TC/DM) of functional soft cheese as affected by using different levels of AAE when fresh and during storage at $5 \pm 1^{\circ} \text{C}$ for 4 weeks.

Minerals and total phenols content of different cheese treatments are presented in Table (1) and Fig. (3). Minerals and total phenols content of cheese samples slightly increased by increasing the added artichoke extract (0.5, 1.0, 1.5 and 2 ml / 100 g retentate) and T_4 had the highest total minerals and phenol content. However, there were no significant differences ($P > 0.05$) in minerals and total phenols contents in all cheese treatments during storage period. This might be attributed to the high content of minerals (Table 1) and total phenols (814 mg / 100 g AAE) in AAE.

Table (1): Minerals contents of functional soft cheese made with AAE at different concentrations.

Minerals (mg/100 g)	Treatments					AAE
	Control	T ₁	T ₂	T ₃	T ₄	
Phosphorus	137.3	139.8	156.13	191.0	192.9	245
Potassium	208.02	210.0	233.0	267.0	269.7	320
Calcium	25.11	26.0	30.8	31.3	37.0	40
Magnesium	481.82	480.3	497.7	513.9	522.8	267
Iron	0.035	0.108	0.107	0.485	0.718	1.19

AAE: Aqueous artichoke extract

T₁: cheese made with adding 0.5 % AAE; represent 25 % replacement of chymosin

T₂: cheese made with adding 1.0 % AAE; represent 50 % replacement of chymosin

T₃: cheese made with adding 1.5 % AAE; represent 75 % replacement of chymosin

T₄: cheese made with adding 2.0 % AAE; represent 100 % replacement of chymosin

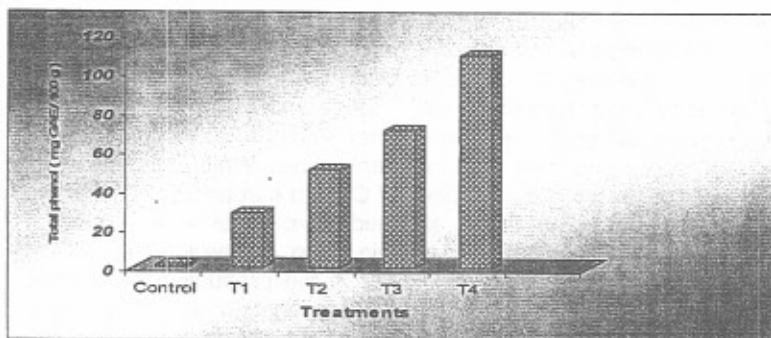


Fig.3: Total phenol contents of functional soft cheese as affected by using different levels of AAE when fresh and during storage at $5 \pm 1^\circ \text{C}$ for 4 weeks.

Results of urea – polyacrylamide gel electrophoresis (PAGE) of fresh and stored white soft cheese manufactured with artichoke and chymosin are shown in Fig. (4).

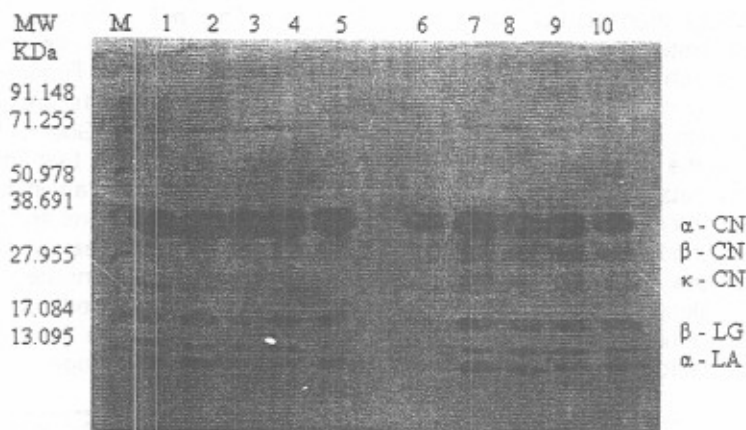


Fig. (4): SDS – PAGE electrophoretograms of soft cheese as affected by using different levels of AAE when fresh and during storage at $5 \pm 1^\circ \text{C}$ for 4 weeks.

Lane M: Molecular weight marker.

Lanes 1 and 6: The control cheese, when fresh and storage at $5 \pm 1^\circ \text{C}$ for 4 weeks.

Lanes 2 and 7: cheese made with 0.5 % AAE; when fresh and storage at $5 \pm 1^\circ \text{C}$ for 4 weeks.

Lanes 3 and 8: cheese made with 1.0 % AAE; when fresh and storage at $5 \pm 1^\circ \text{C}$ for 4 weeks.

Lanes 4 and 9: cheese made with 1.5 % AAE; when fresh and storage at $5 \pm 1^\circ \text{C}$ for 4 weeks.

Lanes 5 and 10: cheese made with 2.0 % AAE; when fresh and storage at $5 \pm 1^\circ \text{C}$ for 4 weeks.

A comparison study of the effects of artichoke extract on milk proteins with that from chymosin by gel electrophoresis showed that these coagulants had similar coagulation efficiency, but different reaction rates. Cheese made with AAE exhibited a lower degree of degradation than cheese made using Chymosin. This result is in agreement with Sausa and Malcata (1998), who indicated that the animal rennet acts more intensively, in quantitative terms, on ovine β - , α_{s1} and α_{s2} caseins than the plant rennet. While, Macedo *et al.* (1993) found that the proteolytic coefficient of *Cynara cardunculus* L. has the same effect of magnitude as those obtained from other milk – clotting enzymes, but it has a high affinity on κ -casein. Also, Esteves, *et al.* (2001) suggested that different coagulants may differ in the production of reactive sites in casein, which may influence particle aggregation and mechanical characteristics of gel networks. Results of this study also indicated that the pattern for gel assembly using the artichoke and chymosin was generally similar. Likewise, the results of urea-PAGE analysis of cheese samples were in good agreement with water soluble nitrogen (proteolysis parameter).

The syneresis and firmness of functional soft cheese made using coagulant obtained from artichoke were compared with that produced from chymosin. There were no significant differences ($P > 0.05$) in the syneresis and firmness for all fresh treatments; however, Plant coagulant (T₄) was of lower firmness than control during storage period. This might be due to slightly less proteolytic and casein hydrolysis than chymosin. Meanwhile, the resistance of cheese matrix toward penetration decreased (the firmness weakened) during storage at $5 \pm 1^\circ$ C for 4 weeks. These results are in agreement with those found by Desouky *et al.*, (2002) for UF- Goat soft cheese. On the other hand, Wium and Qvist (1998) mentioned that the firmness of Feta cheese during storage was the result of both an initial increase in firmness due to changes in the physicochemical conditions and a decrease in firmness caused by the break down of α_{s1} and α_{s2} casein by the rennet enzymes. Delgado *et al.* (2010) showed that firmness and consistency decreased along storage period, while adhesiveness increased, also indicated that highly significant correlations were found between textural parameters, residual caseins levels and nitrogen fractions during storage.

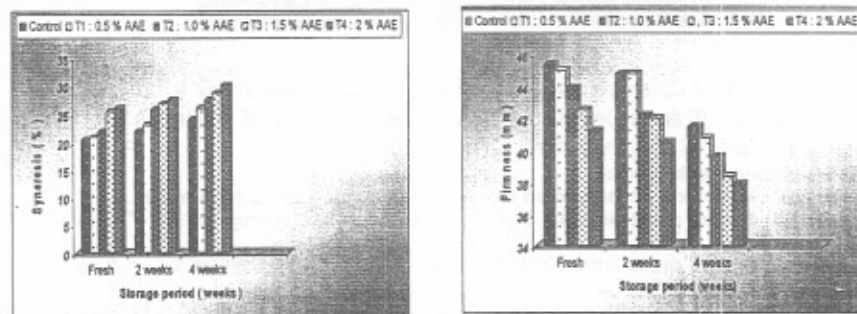


Fig. 5 : Syneresis and firmness of functional soft cheese as affected by using different levels of AAE when fresh and during storage at $5 \pm 1^\circ$ C for 4 weeks.

Results in Fig. (5) illustrated that the lowest syneresis found in the control treatment while the highest was found with T₄ (100 % substitution) followed by 75 % and 50 % then 25 % substitution, this means that control treatment was the firmest while T₄ was the softest, this might be attributed to the moisture in control than T₄ during storage. On the other hand, the syneresis increased during storage. The results of the present study are in agreement with Metry (2004).

All cheese samples were found free from coliform; likewise ,yeast and mould were not found in the fresh and after two weeks of storage in both the control and other treatments. This might be due to several times of heat treatment previously applied on the UF- retentate prior making precheese and the hygienic practices followed during the preparation and storage of cheese. However, yeast and mould began to appear after two weeks of storage and were slightly increased at the end of storage (4 weeks at $5 \pm 1^\circ \text{C}$). As shown in Fig.(6) the log total viable counts (TVC) in the control was less than that in other treatments containing AAE which led to an increase in the log of TVC in the resultant cheeses. Meanwhile, gradual increase was recorded in TVC during storage periods up to four weeks. The two treatments (T₄ and T₅) of products had satisfactory microbiological qualities.

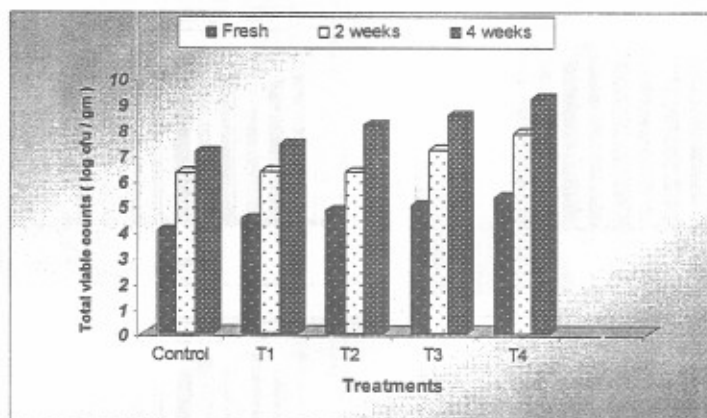


Fig. 6: Changes in total viable counts (log cfu /g) of functional soft cheese as affected by using different levels of AAE when fresh and during storage at $5 \pm 1^\circ \text{C}$ for 4 weeks.

Fig. (7) illustrates the sensory evaluation of functional soft cheese when fresh and during storage at $5 \pm 1^\circ \text{C}$ for 4 weeks. There were no significant differences ($P > 0.05$) in the total scores between the control and all treatments when fresh, but there was a slightly decrease in flavour and consistency scores during storage at $5 \pm 1^\circ \text{C}$ for 4 weeks. The same trend was found by Elewa *et al.* (2009) for white soft cheese. Most panelists preferred T₄ compared to the control, this might be due to lake taste in control sample, and addition of artichoke evidently enhance the flavour as well as

consistency of the resultant cheese. Furthermore, cheeses made with rennet had lower odour and taste scores, somewhat clearer in colour, and grainier, but less creamy than cheeses made with vegetable coagulant.

The two treatments (T₃ and T₄) of products had very good sensory acceptability and gained higher scores than control cheese. Gala'n *et al.* (2008) demonstrated that, the higher proteolytic activity in the breakdown of caseins and the first degradations products in cheeses made with vegetable coagulant led to a softer and creamier texture than in those obtained with calf rennet.

Likewise, Tejada *et al.* (2006) indicated that there were no significant differences between the bitter taste of cheeses made with vegetable coagulant and those made with animal rennet.

It can be concluded that artichoke extract in cheese samples did not result in inferior sensory quality of fresh or stored cheeses. Color scores for cheeses made from the high AAE ratio were significantly lower than control, because the high AAE (T₄) ratios gave light yellowish color for the resultant soft cheese. However, total sensory scores, body and texture scores for cheeses made from the high ratio of AAE were higher than those for cheeses made from the low and medium AAE ratios and control either fresh or during storage at 5 ± 1 °C.

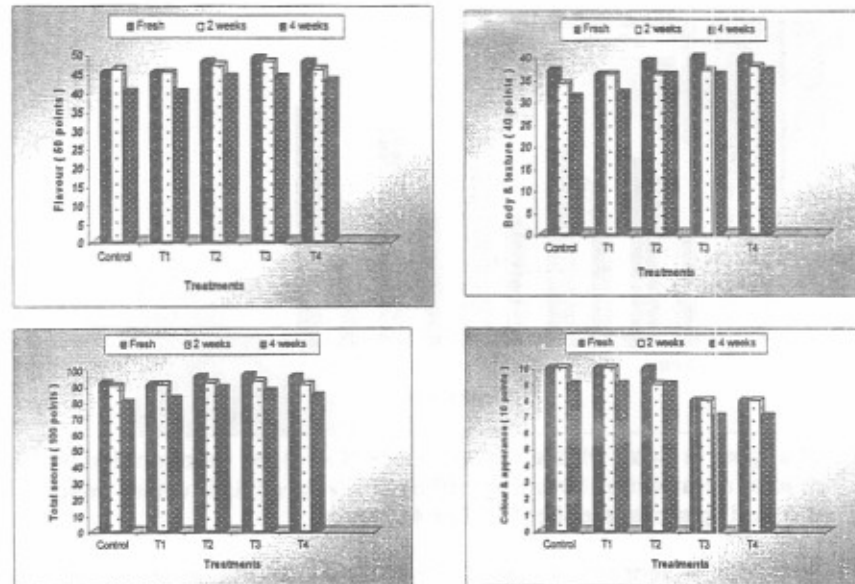


Fig.7: Changes in organoleptic properties of functional soft cheese as affected by using different levels of AAE when fresh and during storage at 5 ± 1 °C for 4 weeks

Conclusion

It is evident from the foregoing study that the artichoke extract can be utilized in the manufacture of soft cheese as a cheap source of coagulation and it can be used as food supplement in nutritional deficiency of the elements, as well as for production of good and new taste cheese. T₄ cheese having good acceptability, many nutritional values and they would buy this type of functional dairy products. Moreover, the resultant functional soft cheese could be stored up to 4 weeks at $5 \pm 1^{\circ}$ C with satisfy organoleptic and microbiological properties.

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خصائص الجبن الطرى الوظيفى المدعم بالخرشوف كبديل للكيموسين

وداد عزب مبرى

قسم علوم وتكنولوجيا الألبان - كلية الزراعة - جامعة الفيوم - الفيوم - مصر

انتشر فى الآونة الأخيرة ما يسمى بالأغذية الوظيفية و التى يفصلها الإنسان كأغذية علاجية . و لذلك يهدف هذا البحث الى استخدام الخرشوف فى تصنيع الجبن الطرى المصنع بطريقة الترشيح الفوقى و ذلك لما له من فعل مجبن للبن و كذلك قيمته الصحية و الغذائية . و قد أظهرت التجارب المبدئية لهذه الدراسة أن الجزء الداخلى (المركز) لنبات الخرشوف له قدرة تجبينية أعلى من الجزء الخارجى الذى يؤكل (التخت) و عند استخدام الجزء الداخلى فقط فى التصنيع أعطى جبن بها مرارة خفيفة بالمقارنة باستخدام الجزء الخارجى و لذلك تم خلط الجزئين مع ماء مقطر بنسبة ١ : ١ ثم الخلط فى الخلاط لمدة ٥ دقائق للحصول على مستخلص مائى استخدم فى تصنيع الجبن الطرى .أضيف المستخلص الى المركز (الناتج من الترشيح الفوقى) بنسبة ٠,٥ ، ١ ، ١,٥ ، ٢ % و التى تمثل نسبة استبدال للكيموسين ٢٥ ، ٥٠ ، ٧٥ ، ١٠٠ % و ذلك بهدف الوصول الى أفضل تركيز يمكن إستخدامه فى التصنيع ، كما قورنت هذه المعاملات بعينة كمنترول (بدون إضافة المستخلص) .وخزنت الجبن الناتجة على ٥ ± ١ °م لمدة ٤ أسابيع و قد درست التغيرات الكيميائية والريولوجية والميكروبيولوجية والحسية للجبن الطازج و خلال فترة التخزين .

و قد أظهرت النتائج بعد تحليلها إحصائيا ما يلى :

لا يوجد أختلاف معنوى فى التركيب الكيميائى للجبن الناتج و لكن أحتوت الجبن المصنعة بإضافة مستخلص الخرشوف على نسبة رطوبة أعلى من الكمنترول .و أظهرت نتائج التحليل الألكتروفوريسيس و كذلك النيتروجين الذائب فى الماء أن معدل تحلل البروتين فى الجبن المصنع باستخدام الكيموسين أكثر من تلك المعاملات المحتوية على مستخلص الخرشوف إضافة المستخلص المائى للخرشوف أدى الى زيادة محتوى الجبن الناتج من الفينولات و الكربوهيدرات الكلية و بعض العناصر المعدنية . جميع العينات كانت خالية من مجموعة القولون و بدء يظهر الفطر و الخمائر بعد الأسبوع الثانى كما أزداد العدد الكلى للميكروبات مع طول فترة التخزين . وبلت نتائج التقييم الحسى على تفضيل المحكمين للجبن المحتوى على ١,٥ ، ٢ % مستخلص الخرشوف و التى أدى الى تحسين القيمة الغذائية والقوام و الطعم بينما أعطى لون يميل الى الأصفر الخفيف . ولذلك يوصى باستخدام مستخلص الخرشوف فى التجبن كبديل رخيص للكيموسين و لرفع القيمة الغذائية للجبن الطرى .

قلم بتحكيم البحث

كلية الزراعة - جامعة المنصورة
كلية الزراعة - جامعة عين شمس

أ.د / طه عبد الحليم نصب
أ.د / جمال الدين احمد مهران