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THE USE OF ARTICHOKE (*Cynara Scolymus, L*) EXTRACTS FOR THE PRODUCTION OF TALLAGA CHEESE

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ABSTRACT

Aqueous extract of globe artichoke (*Cynara scolymus*, L.) or artichoke flowers were used to produce Tallaga cheese and the chemical, rheological and organoleptic properties of the cheese throughout 21 days of storage were compared with cheese made using calf rennet. Cheese manufactured with artichoke extract exhibited higher levels of acidity, moisture and total nitrogen contents, but lower pH values. Cheese yield was slightly higher in the case of using vegetable enzymes. However, cheese manufactured with artichoke extract contained significantly ($p < 0.05$) higher levels of soluble nitrogen (SN), soluble nitrogen coefficient (SN/ TN %) and free fatty acid (FFA) than cheese manufactured with calf rennet. Urea- PAGE showed pronounced differences in protein degradation between cheese made with calf rennet and cheese made with vegetable rennet throughout storage period. The electrophoretic pattern showed that artichoke flower extract more proteolytic on α_{s1}- and β- caseins than globe artichoke extract or calf rennet. Compared with cheeses made with calf rennet, cheese made with artichoke flower extract caused greater hydrolysis with resultant softer cheese texture and good flavour. Whereas, the most acceptable cheese were cheese made with globe artichoke extract. The obtained cheese had favorable pronounced flavour, received good sensory ratings all over storage period, and quite similar to cheese made with calf rennet.

Keywords: Tallaga cheese, Vegetable coagulants; Artichoke; *Cynara scolymus*, L.

INTRODUCTION

Milk – clotting enzymes are the primary active agents in the manufacture of cheeses. Calf rennet was the first, and the most widely used for cheese making which extracted from the abdomasa of young ruminants (Fox, 1987). The worldwide increase in cheese production, along with the reduce supply of calf rennet, has led to an increase in the demand for alternatives sources of milk coagulants use as rennet substitutes (Lopes *et al*., 1998 & Cavalcanti *et al*., 2004). Increasing attention has been directed toward natural rennet extracted from plants (Tavaria *et al.*, 2001*)*. Plant proteinases are interesting because they are natural products when can easily extracted by aqueous infusion and due to the continuous growth of the vegetarian market (Chazarra *et al.*, 2007*)*. The use of these plant proteinases as milk coagulants play an important part in the local agricultural economy. Although several plant proteinases are able to coagulate milk, unfortunately, most of the plant rennet obtained has been found to be inappropriate for cheese production due its excessively proteolytic character, which lowers the final yield of cheese and produces bitter flavours (Lo Piero, 2002). An exception to this general rule is represented by the aqueous extracts of *Cynara cardunculus* flowers.

Aqueous extracts of the flowers *Cynara cardunculus* have proven successful substitutes for animal rennet and have accordingly been used for ages in the manufacture of goats and ewes milk cheeses in several rural areas of Portugal (Macedo *et al*., 1993_a; Silva *et al*., 2002 and Roseiro *et al*., 2003). The extracts of the flowers of two other *Cynara* species, *C. humilis* and *C. scolymus*, have also been claimed to be effective as rennet (Silva & Malcata, 2000 and Chazarra *et al*., 2007).

Cardosins are aspartic proteinases from the flowers of *Cynara cardunculus* L. (Verissimo *et al*., 1996). Aspartic proteinase was found to induce milk coagulation through cleavage of the Phe_{105} – Met_{106} bond in bovine κ- casein (Faro *et al*., 1992; Macedo *et al*., 1993_b). Cardosins from *Cynara cardunculus* L. have also been named cyprosins or cynarases (Cordeiro *et a*l., 1998; white *et al*., 1999).

Cynarases have been isolated from artichoke (Verissimo *et al*., 1998). Sidrach *et al*., (2005) detected high proteinase activity in the stigma of artichoke. The artichoke was used as a food and medicine by the ancient Egyptians, Greeks and Romans. Globe artichoke (*Cynara scolymus* L.) is a perennial plant of the compositae family. In Egypt globe artichoke is becoming one of the most important vegetable crops grown for local consumption and export to European countries (Salamah, 1997). In Egypt, the plantation of globe artichoke is concentrated in Alexandria, El- Giza and El- Behira regions. Chazarra *et al*., (2007) indicated the possibility of the use of artichoke rennet in the cheese manufacture. Several varieties of soft cheese are produced in Egypt. One of these varieties is the

cold stored soft cheese (Tallaga). Tallaga cheese has a spreadable mellow soft body with a pleasant creamy taste (Hofi *et al*., 1979). Tallaga cheese is Egyptian unripened soft cheese, usually made from heated milk with adding low concentration of salt and stored in the refrigerator until consumption within two weeks (Mehanna and Rashed, 1990 and Shehata *et al*., 1995).

The objective of this study was to investigate the applicability of using aqueous enzyme extracted from artichoke (*Cynara scolymus*, L.) for the production of Tallaga cheese, and to asses the effect of this vegetable coagulant on the chemical, rheological and organoleptic properties of Tallaga cheese.

MATERIALS AND METHODS

MATERIALS

Fresh raw buffaloe's milk (5.5 % fat) was obtained from a private farm in Ismailia governorate. Table salt (NaCl dry coarse, El- Nasr Co., Alex.). Calcium chloride (pure) was obtained from El- Nasr Pharmaceutical chemicals, liquid calf rennet 1N (Mifad, Misr food additives (25: 50 ml / 100 L milk). Globe artichoke (*Cynara scolumus*, L.) were obtained from local market. Artichoke flowers (which not harvested from the plant, the bud will blossom into, blue – violet flower, which is not edible) were obtained from a farm in El- Behira region (Egypt). The stigmas and styles of globe artichoke (the mass of inedible fuzzy part, or choke in the center of the bud) and of artichoke flowers(blue violet – part of the flower) were removed and left to dry (by air) in the laboratory by leaving them in a dark dry place. The styles and stigma were stored in this form prior to extraction. The crude extract was prepared by grinding the styles of artichoke (*Cynara scolymus*, L.) in a mortar and pestle for 1 min, suspending in distilled water (20 ml) and stirring for 10 min at room temperature, and then filtering through a fine piece of cloth. All chemicals used were of the recognized analytical grade.

EXPERIMENTAL PROCEDURES

Fresh buffaloe's milk was standardized to 5 % fat, heated at 72° C/ 15 sec, then cooled to 37º C, calcium chloride and sodium chloride were added at the rate of 0.02 % and 4 % (w/ w) respectively. Five batches of Tallaga cheeses were then manufactured on the same day. The milk was divided to five equal portions and renneted as follows: First portion was renneted with calf rennet and served as control, and the other four portions renneted with different amounts of vegetable rennet extracts of *Cynara scolymus*, L. using the enzyme extracts prepared as above as coagulant. The second portion (T2) was renneted using 1 g of crude styles and stigma of Globe artichoke per liter of milk (1g/ L milk), third portion (T3) was renneted using 2 g of styles of globe artichoke per liter of milk (2g/ Lmilk). Fourth portion (T4) was renneted using 0.5 g of crude styles of artichoke flowers per liter of milk (0.5g/ L milk), while the fifth portion (T5) was renneted using 1 g of crude styles of artichoke flowers per liter of milk (1g/ L milk). Tallaga cheese was made from each portion by the conventional method of making Domiati cheese (Fahmi and Sharara, 1950). The resultant Tallaga cheese was packed in plastic cups filled with boiled whey from the respective treatment and stored in refrigerator (7 ± 2° C) for 3 weeks. The whole experiment was repeated in triplicates and each analysis in duplicate and average results were tabulated.

METHODS OF ANALYSIS

COMPOSITIONAL ANALYSIS

Cheese sample were analyzed chemically when fresh and after 7, 14 and 21 days of storage. Titratable acidity and moisture content were determined according to AOAC (1990); soluble nitrogen (SN), total nitrogen (TN) by micro Kjeldahl method, and fat content by Gerber butyrometer according to Ling (1963). The pH value was measured by using (Jenway digital pH meter , Jenway Limited, England). The yield of fresh cheese was calculated as percentage of cheese weight to cheese milk. Total volatile fatty acids (TVFA) were estimated by the direct distillation method according to Koiskowski (1978), results were expressed as ml N/ 10 acid per 100 gm cheese.

CHEESE FIRMNESS

Firmness of Tallaga cheese was determined using Brabender Structograph model D4100 (Brabender, OHG, Duishburg, Germany) with spindle No: 449650 and force 1000 Cmg. The heights of resultant curve express the firmness. These measurements were replicated three times for each samples.

GEL ELECTROPHORESIS (UREA – PAGE)

Urea – Page was performed by the method of Andrews (1983). The gels were stained by the method of Blakesly and Boezi (1977). Cheese samples (0.1g) were dissolved in 1 ml samples buffer and (11 µl) were applied to the gel. Electrophoresis in polyacrylamide (12.5% separation, 4.2% stacking) gels was performed in a Double - Slab Vertical Cooling Gel System (JVD- 80) Shelton Scientific Mfg., Inc. USA.

SENSORY EVALUATION

Organoleptic properties of cheese samples were evaluated according to the method of Pappas *et al*., (1996) when fresh, 7, 14 and 21 days of cold storage (7ºC ± 2). Cheese were assessed by means of six panelists from the staff of the Dairy Department, with maximum score points (50 points) for flavour, body and texture (40 points) and appearance (10 points)

STATISTICAL ANALYSIS

All data were analyzed by ANOVA using the general models procedure of Costat (1998) under windows software version 6.311. Differences among means were tested for significance at ($p < 0.05$). The data presented in tables, are the mean of 3 experiments.

RESULTS AND DISCUSSION

CHEMICAL COMPOSITION OF CHEESE

As shown in Table (1), Tallaga cheese made with extracts of artichoke (*Cynara scolymus* L.) flowers (T5 and T4) had a significant ($p < 0.05$) higher moisture content comparing to control and other cheese treatments. The

moisture content of cheese from all treatments decreased significantly ($p< 0.05$) as storage period progressed. Similar results were obtained by El- Kholy (2005) and Al-Jasser and Al- Dogan (2009).

Concerning the fat content of cheese no remarkable differences were found between different cheese treatments. The fat content of all Tallaga cheese treatments increasing significantly ($p< 0.05$) as storage period progressed which might be due to the reduction of moisture content throughout the storage period (Ezzat 1990 and Kebary *et al*., 1996). Fat content based on dry matter calculation had slight differences, with the level slightly higher in T5 and T4 than control and other cheese treatments, and increased pronouncedly ($p < 0.05$) in all cheese treatments during storage period. These results agreed with those reported for Domiati cheese by Al-Jasser & Al- Dogan(2009). The observed increase in fat content (DM) during storage period could be due to the whey syneresis (Al- Jasser and Al- Dogan, 2009).

It could be observed from Table (1) that there were a significant differences ($p< 0.05$) among all cheese treatments in total nitrogen contents (TN). Cheese made with globe artichoke extract (T2) had the highest TN content followed by (T3), then cheeses made with artichoke flower extract (T4 and T5) respectively. However, The total nitrogen content of control cheese (made with calf rennet) was at par with cheese made with globe artichoke extract (T2) , while was significantly different ($p< 0.05$) from other treatments. The total nitrogen (TN %) content of all cheeses decreased significantly ($p< 0.05$) throughout storage period, which might be due to the degradation of proteins into soluble nitrogen (SN) and subsequenty the loss of some water soluble nitrogen from the degraded proteins. These results were in agreement with those reported for Domiati cheese by Badawi and Kebary (1996) and for Tallaga cheese by El- Kholy (2005). With regard to titratable acidity, the data presented in Table (1) showed that cheese made with globe artichoke extract (T2) had the lowest titratable acidity (acidity %) than the the control, while cheese made with artichoke flower extract (T5) had the highest titratable acidity, followed by (T4). This might be due to the higher proteolytic activity of artichoke flower proteases. Whereas, cheese made with 2g/ L of globe artichoke extract (T3) exhibited intermediate titratable acidity and significantly ($p< 0.05$) different compared with control and other cheese treatments. There were a significant ($p< 0.05$) differences in titratable acidity between control and all cheese treatments. The acidity of cheese was progressively increased during storage either the control or cheese made with artichoke extracts as coagulants, these results in agreement with Abdel Kader (2003) and Al- Jasser and Al-Dogan (2009). The pH value of control Tallaga cheese and cheese made with artichoke extracts as coagulant followed opposite trends to those of titratable acidity (Table 1). Tallaga cheese made with extract of globe artichoke (T2) had pH value (6.22) significantly ($p< 0.05$) higher comparing to control and other cheese treatments suggesting lower proteolytic activity. While cheese made with artichoke flower extract (T5) had the lowest pH (5.96) value. The pH values of all cheese treatments decreased significantly ($p< 0.05$) as storage period advanced.

Table (1): Chemical composition of Tallaga cheese made using artichoke extracts as coagulants during storage at 7± 2˚C

Treatments	Moisture (%)					Fat (%)				
	Storage period (weeks)					Storage period (weeks)				
	Fresh	1	2	3	Mean	Fresh	1	2	3	Mean**
Control	61.38	60.38	59.15	58.12	59.75^{D}	17.10	18.20	19.40	19.90	18.65^{B}
T2	61.20	60.20	59.20	58.12	59.68^{E}	17.30	18.30	19.40	19.90	18.72^{A}
T3	61.40	60.38	59.22	58.30	59.82^{C}	17.20	18.20	19.40	19.90	18.67^{AB}
T4	62.41	61.44	60.10	59.17	60.78^{B}	17.20	18.20	19.40	19.90	18.67^{AB}
T5	62.46	61.49	60.22	59.22	60.84^{A}	17.20	18.20	19.40	19.90	18.67^{AB}
Mean**	61.77^{a}	60.78^{b}	59.57^{c}	58.58^{d}		17.20^{d}	18.22^{c}	19.40^{b}	19.90^{a}	
	F/ DM*					*TN (%)				
	Storage period (weeks)					Storage period (weeks)				
	Fresh	1	2	3	Mean**	Fresh	1	2	3	Mean**
Control	44.27	45.93	47.49	47.51	46.30^{C}	2.57	2.55	2.50	2.46	2.52^{A}
T2	44.58	45.97	47.54	47.51	46.40^{BC}	2.63	2.54	2.49	2.44	2.52^{A}
T3	44.55	45.93	47.57	47.72	46.44^{B}	2.60	2.52	2.46	2.42	2.50^{B}
T4	45.75	47.19	48.62	48.73	47.57^{A}	2.60	2.52	2.44	2.40	2.49^{B}
T5	45.81	47.26	48.76	48.79	47.65^{A}	2.60	2.50	2.38	2.35	2.45^{C}
Mean**	44.99^{c}	46.46^{b}	47.99^{a}	48.05^{a}		2.60^{a}	2.52^{b}	2.45^{c}	2.41^{d}	
	Acidity (%)					pH				
	Storage period (weeks)					Storage period (weeks)				
	Fresh	1	2	3	Mean**	Fresh	1	2	3	Mean**
Control	0.27	0.32	0.36	0.45	0.35^{D}	6.54	6.35	5.97	5.90	6.19^{B}
T2	0.27	0.32	0.36	0.41	0.34^{E}	6.53	6.46	6.01	5.89	6.22^{A}
T3	0.32	0.38	0.41	0.45	0.39^{C}	6.49	6.04	5.96	5.86	6.08^{C}
T4	0.32	0.41	0.45	0.49	0.41^{B}	6.44	6.01	5.90	5.83	6.04^{D}
T5	0.34	0.45	0.52	0.60	0.48^{A}	6.42	5.95	5.79	5.70	5.96^{E}
Mean**	0.30^{d}	0.38^{c}	0.42^{b}	0.48^{a}		6.48^{a}	6.16^{b}	5.92^{c}	5.83^{d}	

*F / DM : fat on dry matter *TN : total nitrogen , *a, b, c & d and A, B, C, D & E: means with the same letters among treatments and storage period respectively are not significantly different ($p< 0.05$)

Control: Cheese renneted using calf rennet
T2: Cheese renneted using (1g /L milk) styles and stigmas of globe artichoke.
T3: Cheese renneted using (2g /L milk) styles and stigmas of globe artichoke
T4: Cheese renneted using (0. 5g /L milk) styles and stigmas of artichoke flower.
T5: Cheese renneted using (1g /L milk) styles and stigmas of artichoke flower.

Table (2): Effect of using artichoke extracts as coagulant on soluble nitrogen, soluble nitrogen coefficient and total volatile fatty acids of Tallaga cheese during storage at 7± 2˚C

Treatments	Parameter	Storage period (weeks)				Mean**
		Fresh	1	2	3	
Control	**Soluble nitrogen (SN%)**	0.26	0.37	0.44	0.53	0.40^{D}
T2		0.27	0.37	0.43	0.49	0.38^{E}
T3		0.28	0.40	0.46	0.54	0.41^{C}
T4		0.35	0.48	0.56	0.60	0.49^{B}
T5		0.35	0.48	0.56	0.64	0.50^{A}
Mean **		0.30^{d}	0.42^{c}	0.49^{b}	0.55^{a}	
Control	**SN/TN (%)**	9.85	14.88	17.88	20.66	15.80^{D}
T2		9.88	14.39	17.19	20.05	15.37^{E}
T3		10.50	15.68	18.69	21.48	16.58^{C}
T4		13.46	18.82	22.76	24.86	19.97^{B}
T5		13.46	18.82	22.98	25.77	20.25^{A}
Mean**		11.43^{d}	16.50^{c}	19.90^{b}	22.56^{a}	
Control	**TVFA***	2.90	3.70	5.62	6.82	4.76^{D}
T2		3.30	4.12	5.91	7.30	5.16^{B}
T3		3.30	4.12	5.81	7.00	5.06^{C}
T4		3.90	4.52	6.21	7.50	5.53^{A}
T5		3.90	4.52	6.21	7.50	5.53^{A}
Mean**		3.47^{d}	4.19^{c}	5.95^{b}	7.23^{a}	

See Table 1 for treatments designation
*TVFA: total volatile fatty acids expressed as ml NaOH 0.1N/ 100g cheese
** a, b, c & d and A, B, C, D & E: means with the same letters among treatments and storage period respectively are not significantly different ($p < 0.05$)

As shown in table (2) artichoke extracts affected significantly ($p< 0.05$) the soluble nitrogen content (SN %) and soluble nitrogen coefficient (SN/ TN%) of Tallaga cheese. Although, Tallaga cheese made with extract of globe artichoke (T2) showed the lowest soluble nitrogen content and soluble nitrogen coefficient, cheeses made with artichoke flower extract as coagulant (T5) contained the highest soluble nitrogen content and soluble nitrogen coefficient. The SN contents increased significantly ($p< 0.05$) as storage progressed. A similar result was reported by El- kholy (2005). It could be noticed that cheese made with *Cynara Scolymus* L. flower extract showed higher rate of protein brake down. Similar results were obtained by Verissimo *et al*., 1996 and Al- Jasser and Al- Dogan (2009). The highest values of soluble nitrogen coefficient were recorded with cheese made with artichoke flower extracts (T5 and T4 respectively) either fresh or during storage. Soluble nitrogen coefficient increased significantly ($p< 0.05$) in all cheeses as storage period progressed.

With regard to total volatile fatty acids (TVFA), the data illustrated in Table (2) showed that Tallaga cheese made with artichoke flower extracts had the highest ($p< 0.05$) values of TVFA compared to other treatments. These results could be attributed to the increase in the moisture content and consequently increase of water activity that enhances lipolytic bacteria and lipases activity (Kebary *et al*., 2006). Concerning cheese made with artichoke flower extract as coagulant, no remarkable differences in TVFA can be found between T4 and T5. Generally, it could be noticed that cheese made using *Cynara scolymus*, L. extract showed higher TVFA than control. The TVFA increased significantly ($p< 0.05$) in all cheeses as storage period progressed. Tallaga cheese yield (Table 3) which produce using artichoke flower extract (T4 and T5) as coagulant were significant ($P< 0.05$) compared to control and other cheese treatments. Data given in table (3) indicates that the use of artichoke flower aqueous extract in cheese making increased the yield of the fresh cheese than the control and their corresponding cheese made with globe artichoke aqueous extract which may attributed to increased moisture retention and consequently higher moisture content. These results coincided with these of El-shibiny *et al*., (1973); Al- Jasser- and Al- Dogan (2009). Also, this probably due to the greater proteolytic effect of *Cynara scolymus*, L. flower extract resulting in compounds with greater water holding capacity.

Table (3) reveals TS%, TN%, Fat%, Acidity and pH of whey drained from cheese of different treatments as affected by using artichoke extracts as coagulants. Results cleared that total solids (TS %) obtained from Tallaga cheese whey were significantly ($p< 0.05$) different among

all cheese treatments. Control cheese whey contained the highest ($p< 0.05$) total solids content comparing to the recovered with cheese processed used artichoke extracts as coagulants. The recovered whey with cheese made using 1g /L artichoke flower extract (T5) had the highest ($p< 0.05$) total nitrogen content (TN %) as compared to the control. This could be explained on the basis that some soluble nitrogenous compounds of cheese may go with whey (Al- Jasser and Al- Dogan, 2009). Slight differences ($p< 0.05$) were observed on fat content of whey of Tallaga cheese treatments, whereas, no remarkable ($p< 0.05$) differences were noticed in acidity between the different treatments. With regard to pH values, from Table (3) it could be observed that pH value had an opposite trend to acidity of the corresponding drained whey and that a significant differences ($p< 0.05$) among all treatments except treatments (3, 4 and 5).

Using artichoke extracts as coagulant significantly ($p< 0.05$) decrease the cheese firmness. The firmness data Table (4) illustrates that Tallaga cheese made with artichoke flower extract (T5) was softer and had lower firmness values than control and other cheese treatments. This may be due to that treatment (T5) had the highest moisture content than other cheese treatments. These results confirmed by Fox *et al*., (2000), who reported a direct relationship between moisture and cheese firmness. The firmness of control Tallaga cheese was markedly ($p< 0.05$) higher than that of other cheeses at all storage period. Firmness of treatments (T5, T4, T3) in order decreased at the end of storage period (week 3). This may be due to the enzymatic hydrolysis of the caseins, and the moisture in cheese acts as a plasticizer in the protein matrix, thereby making it less elastic and more susceptible to fracture upon compression (Fox *et al*., 2000). The results in Table (4) showed significant ($p< 0.05$) differences were recorded among all treatments. During cold storage, firmness of tallaga cheese made with *Cynara scolymus* L., as coagulant decreased significantly ($p< 0.05$) with the time starting from week 2 except for control cheese which had an opposite trend. The changes in firmness values of Tallaga cheese during storage could be related to the differences in moisture content, proteolysis and structure and protein network breakdown. There were significant correlation between cheese firmness and either pH values or cheese moisture (Abd El- Aziz *et al*., 2007).

POLYACRYLAMIDE GEL ELECTROPHORESIS

From the electrophoretic patterns (Fig 1) it can be seen that, cheese made with calf rennet, α_{s1}- and β- casein degraded more slowly (Lanes 2, 3 and 4) compared to cheese made using artichoke extracts as coagulant. There are a progressive breakdown of both α_{s1}- and β- casein with time (14 and 21 days) in cheese made using artichoke extracts as coagulant. However, the decrease of the intensity in the α_s- fraction in the cheese coagulated with artichoke flower extracts are more profound (T5 and T4) respectively (Lanes 16, 15,13 and 12) compared to control and other treatments (T2 and T3). Globe artichoke extract (T2) did not undergo extensive protein breakdown (Lanes 5, 6 and 7) as in cheese made using artichoke flower extracts. The β- casein bands weaken in cheese made with artichoke extracts, the intensities of these bands were decreased for (T5) Lane 16 after 21 days of storage more than other treatments (T4 and T3) respectively (Lanes 13 and 10) compared to control (Lane 4) and treatment (T2 Lane 7). These bands nearly disappeared after 21 days of storage (T5 Lane 16). These results indicate the higher degree of proteolysis in the cheese made using artichoke flower extracts as coagulant. Comparison of the electrophoretic patterns of tallaga cheese with calf rennet and with artichoke extracts allows some distinct differences.

Table (3): Cheese yield and chemical composition of fresh whey of Tallaga cheese made with artichoke extracts as coagulant

Treatments*	Cheese yield	Chemical composition of fresh cheese whey				
		TS (%)	TN (%)	Fat (%)	pH value	Acidity (%)
Control	29.16^{b}	11.67^{a}	0.12^{b}	0.29^{a}	5.72^{c}	0.17^{a}
T2	29.30^{b}	11.41^{b}	0.13^{a}	0.29^{a}	5.79^{b}	0.16^{ab}
T3	29.36^{b}	11.31^{c}	0.13^{a}	0.20^{b}	5.87^{a}	0.16^{ab}
T4	31.13^{a}	11.28^{d}	0.14^{a}	0.20^{b}	5.87^{a}	0.15^{b}
T5	31.30^{a}	11.23^{e}	0.14^{a}	0.19^{b}	5.87^{a}	0.15^{b}

*See Table (1) for treatments designation
**a, b, c, d and e: means with the same letters among treatments are not significantly different ($p < 0.05$)

Table (4): Effect of using artichoke (*Cynara scolymus*, L.) extracts on the firmness (N) of Tallaga cheese during storage at 7 ± 2˚ C

Treatments*	Storage period (weeks)				Mean**
	Fresh	1	2	3	
Control	2.00	2.05	2.05	2.2	2.06^{A}
T2	2.00	2.00	2.05	2.00	2.01^{B}
T3	2.00	2.20	2.00	1.85	2.01^{B}
T4	2.20	1.85	1.85	1.50	1.85^{C}
T5	1.60	1.60	1.20	1.18	1.39^{D}
Mean**	1.96^{a}	1.93^{b}	1.83^{c}	1.74^{d}	

*See Table 1 for treatments designation
** a, b, c & d and A, B, C & D: means with the same letter among the treatments and storage period respectively are not significantly different ($p <0.05$).

Table (5): Sensory evaluation of Tallaga cheese made with artichoke (*Cynara scolymus L.*) extracts as coagulants during storage at 7 ± 2˚C

Treatments*	Storage period (weeks)				Mean**
	Fresh	1	2	3	
Flavour (50 points)					
Control	46	46	47	46	46.25^{A}
T 2	46	47	47	46	46.50^{A}
T 3	47	47	47	46	46.75^{A}

T 4	47	47	46	45	46.25^{A}
T 5	47	47	46	45	46.25^{A}
Mean**	46.6^{a}	46.8^{a}	46.6^{a}	45.6^{b}	
Body& Texture (40points)					
Control	38	38	38	38	38.00^{A}
T 2	38	38	38	38	38.00^{A}
T 3	38	38	37	37	37.50^{A}
T 4	39	38	35	34	36.50^{B}
T 5	39	36	33	30	34.50^{C}
Mean**	38.4^{a}	37.6^{a}	36.2^{b}	35.4^{b}	
Appearance (10 points).					
Control	9	9	9	8	8.75^{A}
T 2	8	8	9	8	8.25^{AB}
T 3	9	9	9	8	8.75^{A}
T 4	9	8	8	7	8.00^{AB}
T 5	9	8	8	6	7.75^{B}
Mean**	8.8^{a}	8.4^{a}	8.6^{a}	7.4^{b}	
Total acceptance (100 points)					
Control	93	93	94	92	93.00^{A}
T 2	92	93	94	92	92.75^{A}
T 3	94	94	93	91	93.00^{A}
T 4	95	93	89	86	90.75^{B}
T 5	95	91	87	81	88.50^{C}
Mean**	93.8^{a}	92.8^{b}	91.4^{c}	88.4^{d}	

*****See Table (1) for treatments designation
****** a, b, c & d and A, B, & C: means with the same letter among the treatments and storage period respectively are not significantly different ($p<0.05$).

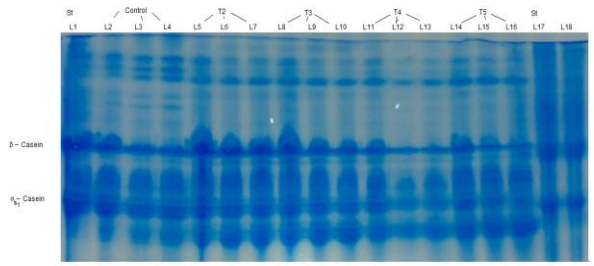

Fig (1): Urea- PAGE of Tallaga cheese made using artichoke extracts as coagulants for fresh, 14 and 21 days Lane (1) sodium caseinate (ST); Lanes (2& 3& 4) control; Lanes (5& 6& 7) T2; Lanes (8& 9& 10) T3; Lanes (11& 12& 13) T4; Lanes (14& 15& 16) T5

Tavaria *et al*., (1997) concluded that the extracts of *Centaurea calcitrapa*, a plant proteases degraded both α_s- and β- caseins more extensively than the commercial rennet. In addition, α_s- caseins were degraded to a higher extent than β- caseins. This observation is in agreement with the literature because β- casein has been claimed to be more resistant to proteolysis than α_s- caseins in cheese manufacture with raw ovine milk and extracts from flowers of *Cynara cardunculus* (Sousa and Malcata, 1997). Pezeshki *et al*., (2011) reported that UF white cheeses produced with Withania coagulants enzyme, the hydrolysis of both α_{s1}- and β- casein occurred more rapidly and intensively with the intact caseins disappeared apparently.

ORGANOLEPTIC EVALUATION

The average scores for sensory evaluation in terms of flavour, body & texture and appearance of Tallaga cheese of the different treatments are illustrated in Table (5). It seems from the data given in Table (5) that all fresh Tallaga cheese had nearly the same scoring point for flavour, body & texture and the general appearance.

The resultant cheese made with aqueous extract of *Cynara scolymus* L. had a pleasant creamy flavour and good body and texture. However, with advance of storage period a pronounced change was observed in cheese texture. Cheese made with artichoke flower extract as coagulant (T4 & T5) was more preferable when cheese was fresh, as well as, during the first week of storage and had a pronounced flavour with smooth, more soft body and acceptable texture compared to control. While, the cheese made with globe artichoke extract (T2 & T3) was more preferable during the second and the third weeks of storage and had sensory scores very close to control cheese. Tallaga cheese made with artichoke flower extract as coagulant (T4 & T5) gained a highest scores for flavour either fresh or after one week of storage and had the lowest scores for body and texture during the second and the third weeks of storage. This could be attributed to the higher rate of proteolysis. Chen *et al*., (2003) and Nazni et.al., (2010) reported that cardoon rennet cheese exhibited softer texture and higher creaminess scores as compared with the calf and microbial rennet cheeses. No significant ($p< 0.05$) differences for flavour were observed among all treatments, while the flavour decreased significantly from days 14 to 21 of cold storage.

Tallaga cheese made with *Cynara scolymus* L. extract as coagulant seemed to be favorite and had a pronounced flavour, this may be contributed to the higher artichoke cheese contents of SN and TVFA which serve as precursors of certain flavour components. This finding agrees with those given by Prados *et al*., (2007). Scores of appearance of cheese from all treatments were quite similar except for treatment (2) which had the lowest scores when fresh and after one week of storage. With the advance of storage, artichoke flower cheese (T5) received the lowest appearance scores (after 3 weeks of storage). Although all cheeses were accepted by panelists, the most acceptable cheese were cheese from treatment (T2) and (T3). The obtained cheese had favorable pronounced flavour, and have overall liking scores quite similar to control cheese all over storage period. The overall liking scores for all cheese treatments decreased significantly ($p< 0.05$) with storage progressed.

CONCLUSIONS

Results of this study showed that Tallaga cheese manufacture using aqueous extract of artichoke (*Cynara scolymus* L.) had similar chemical composition to that made with calf rennet. The use of artichoke flower extracts as coagulant caused greater casein hydrolysis with resultant softer cheese texture and good flavour. Cheese manufacture with globe artichoke extract received good sensory ratings and quite similar to cheese made with calf rennet. This indicates that globe artichoke extract can be

used for making Tallaga cheese suggesting that the extract could be a good substitute for calf rennet and that artichoke flower extract as accelerating ripening.

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