



Food and Dairy Research

<http://www.journals.zu.edu.eg/journalDisplay.aspx?JournalId=1&queryType=Master>



USING POMEGRANATE PEEL EXTRACTS AS NATURAL ANTIOXIDANT IN CREAM CHEESE MANUFACTURED FROM GOAT'S MILK

Samah M.S. El-Shafei^{1*}, E. M.M. Abdeen¹ and Safaa S. Abozed²

1. Anim. and Poult. Breed. Dept., Des. Res. Cent., Cairo, Egypt

2. Food Sci. and Technol. Dept., Nat. Res. Cent., Dokki, Giza, Egypt

Received: 23/10/2017 ; Accepted: 21/11/2017

ABSTRACT: In this study, cream cheese was prepared from goat's milk supplemented with different concentration of pomegranate peel extracts (PPE) (0.5, 1 and 2%) as natural antioxidant. Experimental cheeses evaluated for antioxidant activity RSA/DPPH, total phenolic compound (TPC) and total flavonoid compound (TFC), oxidative stability, microbiological and organoleptic properties during storage periods at 4±1°C for 45 days. Chemical composition was determined for fresh cheese. The obtained results showed that a significant ($P \leq 0.05$) increase observed in DPPH, TPC and TFC in cheese containing PPE3 (goat's cream cheese containing 2% PPE) recorded high values. Stored goat's cream cheese has significant ($P \leq 0.05$) decrease in total bacterial count, proteolytic, lipolytic bacteria and yeast/mould counts than the control cheese. Coliforms were not detected throughout the storage period. Organoleptic results showed that concentration of pomegranate peel extracts up to 1.0% recorded high points than the control. Pomegranate peel extracts could be used as natural preservative to improve acceptability and the oxidative stability of goat's cream cheese.

Key words: Pomegranate peel extracts, goat's cream cheese, antioxidant activity, chemical, microbiological and organoleptic properties.

INTRODUCTION

Goat's milk and its products always preferred for their nutritional and therapeutic value in human nutrition (Alferez *et al.*, 2001; Diaz-Castro *et al.*, 2012; Mukdsi *et al.*, 2013) The consumption of goat's dairy products has increased worldwide with a consequent increase in the demand for goat's milk, which is encouraged dairy production in many countries (Queiroga *et al.*, 2013).

Goat's milk has higher totally free fatty acids which give the dairy products a typical goaty flavours. (Chilliard *et al.* 2003; Collins *et al.*, 2003).

Cream cheese is a white soft cheese manufactured from full fat milk enriched with additional cream. According to United States, the Food and Drug Administration (FDA)

regulations cream cheese must has at least 33% fat in dry matter (Phadungath, 2005). It used as an ingredient in many foods such as crackers, many types of biscuit, savoury snacks, cheese cakes, cheese sauces, spreads, desserts and salads. Also, it's consumed as daily breakfast food (Tokusoglu, 2013).

Lipid oxidation is a main factor affecting the standard of manufactured dairy products, especially during long of storage periods. Lipid oxidation resulting in production of free radicals, inducing the synthesis of hydroperoxides which, consequently, produce volatile carbonyl compounds off- flavours (Kristensen and Skibsted, 1999). This decrease the organoleptic properties of foods especially the raw and oily or fatty products. So, these products are not preferred to consumers (Orhan *et al.*, 2003). Also, lipid oxidation caused early aging, carcinogenesis, inflammation and cardiovascular

* Corresponding author: Tel. : +201007672990
E-mail address: samahelshafei@yahoo.com

diseases (Siddhuraju and Beeker, 2003). Recently there are growing trend towards natural additives to controlled oxidative degradation of lipid, improve acceptability and nutritional value of food products (Fasseas, *et al.*, 2007 ; Camo, *et al.*, 2008).

Antioxidants are the compounds that when added to food products, especially foods rich in fat can prolong the shelf life by retarding the process of lipid peroxidation, which is one of the major reasons for deterioration of food products during manufacturing and storage (Madhavi *et al.*, 1995). The activity of antioxidants and their mechanism of action is dictated by the structural features of the molecules involved, the system in which they are present as well as manufacturing and storage conditions. For antioxidant-fortified foods, physicochemical, microbial, sensory quality and antioxidant activity are important quality parameters, and new functional products should be detected by these parameters (Tokusoglu, 2009).

Natural sources of antioxidants have fewer side effects than artificial antioxidants to the human body (Alenisan *et al.*, 2017). So, it's used in widespread in foods. Fruits, vegetables, legumes, and nuts contain significant antioxidant contents that offer great potential as protective foods. This feature is influential effect for fruits and vegetables can be attributed to the antioxidant effect of the polyphenolic compounds. Some of secondary products of fruit and vegetable are rich in antioxidants. Secondary products can be used to produce many healthy foods (Shahidi, 2015).

Pomegranate (*Punica granatum* L.) has been used as a medicinal and nutritional fruit due mainly to its antioxidant, antitumor, antihepatotoxic, antilipoperoxidation and antibacterial properties (Cam *et al.*, 2009; Vidhan *et al.*, 2010; Wenjuan *et al.*, 2012). Pomegranate peels are by-products of the food industry. Crude extracts and purified fractions from pomegranate peels could provide health benefits to humans and may be employed in food preservation and pharmaceutical purposes (Shiban *et al.*, 2012). The phenolic compounds of pomegranate peels are decade time higher than that found in the pulp (Li *et al.*, 2006). Considering that peels and seeds are not

consumed, the high-handed of bioactive compounds presented in these non-edible everywhere could be used for substitute purposes in the food industry such as enrichment or development of new products (Miguel *et al.*, 2010). Utilization of pomegranate peels as a reservoir of valuable therapeutic agents, food preservatives, supplements, stabilizers, probiotics and quality enhancement agents seems to be a pragmatic approach in the prevention of some chronic maladies (Akhtar *et al.*, 2015)

The objectives of this research were to investigate the effects of various concentrations of pomegranate peel extracts as natural antioxidants on the physicochemical, microbiological, sensory characteristics, oxidative stability and antioxidant activity of goat's cream cheese and their shelf life during storage at $4\pm 1^{\circ}\text{C}$ for 45 days.

MATERIALS AND METHODS

Materials

Fresh whole goat's milk (12.8% total solid, 3.9% fat, 3.72% protein, 0.78% ash, 0.17% acidity and pH value 6.64) was obtained from the herds of Desert Research Center, Ministry of Agric., Cairo, Egypt. Freeze dried starter cultures containing: *Streptococcus thermophilus* and *Lactobacillus delbrueckii* ssp *bulgaricus* (1:1) were obtained from Chr. Hansen's Lab., Copenhagen, Denmark. Rennet, Hannilase @ TL 2300 granulaste NB microbial rennet was obtained from Chr. Hansen's Lab., Copenhagen, Denmark. A commercial pure salt fine grade and calcium chloride were obtained from El-Naser Company and El-Gomhoria Co., Cairo Egypt respectively. Fresh pomegranate fruits (*Punica granatum* L.) were obtained from the local market, Zagazig city, Sharkia Governorate, Egypt. Goat's cream (40% fat) was obtained by milk separator.

Experimental

Preparation of pomegranate peel extracts (PPE)

Pomegranate fruits were washed then peels were separated. The peels (100 g) were refluxed in distilled water (1000 ml) for 1 hr., with ultrasonic water bath, extracts were made at 40

kHz frequency heated bath temperatures as a 40°C Ultrasonic duration of 30 min. percentage of power settings, 80% (Altemimi *et al.*, 2016). The extracts were cooled and filtered through cheese cloth and the residue was again refluxed for an additional hour. Then all the extracts were pooled and centrifuged at 12 100 g for 20 min. The supernatant obtained was concentrated in a rotary evaporator under vacuum at 45°C to obtain the cured extract. The extract was stored at 4°C until used for further all analyses.

Production of goat's cream cheese

Goat's cream cheese was produced according to the method of (Kosikowski and Mistry, 1997) with some modifications. Goat's milk was standardized to (3.9% fat). The milk was pasteurized at 65°C for 30 min and cooled to 42–43°C, then inoculated with (2%) starter culture (*Lactobacillus delbrueckii* ssp *bulgaricus* and *Streptococcus thermophilus* 1:1), calcium chloride 0.02%, salt 1.5%, rennet (0.75ml / kg) were added to the cheese milk then incubated at 42°C until pH reached 4.6. The curd was gently cut into cubes, placed in sterilized cheese cloth, and allowed to drain at 15°C for 6 hr. The cheese curd was stored at 4 ± 1°C, until the homogenization stage. The cheese curd was blended with cream (450 g cream / kg cheese cured). The mixture was divided into 4 portions. The first portions serve as control. PPE was added to the other 3 portions. The final concentrations PPE1, PPE2, PPE3, were 0.5, 1 and 2% in cheese respectively. All treatments were packaged in individual plastic cups and stored at 4 ± 1°C for 45 days. Three replicates were carried out from each treatment. The cheese was analyzed when fresh and after 15, 30 and 45 days for microbiological, antioxidant activity, oxidative stability, physicochemical and organoleptic properties.

Analytical Methods

Chemical composition

Fresh goat's cream cheese samples were analyzed for moisture, fat, protein, acidity as lactic acid (%) and pH values according to AOAC (2000). Salt content was analyzed as described by Bradley *et al.* (1992). Total volatile fatty acids content were determined according to the method described by Kosikowski (1978).

Determination of Antioxidant Activity

Preparation of goat's cream cheese samples with PPE extracts

The extraction procedure of cheese samples was carried out according to the protocol described by Shaiban *et al.* (2006) with some modifications. About 2 g of the cheese sample were homogenized and extracted with 20 ml of 80% methanol containing 1% HCl for 30 minutes. Each sample was re-extracted three times. The resulting mixture was centrifuged at 5000 rpm for 15 minutes. The collected supernatant was stored at 2°C for further used to evaluate the antioxidant activity and total phenolic contents of the cheese samples.

Determination of total phenolic contents (TPC)

The concentration of total phenolic content in PPE and cheese samples was determined by Folin-Ciocalteus procedure (Singleton and Rossi, 1965) and expressed as mg/g of cheese as catechins equivalent (CE). Cheese extract (0.3 ml) was mixed with 0.2 N Folin-Ciocalteus reagent (1.5 ml). After 5 min, 1.2 ml of 0.7N Na₂CO₃ solution were added. The mixture was incubated at room temperature for 2 hours and then the absorbance was measured at 765 nm, using an UV-VIS-1200A spectrophotometer (Dayto, USA) against a blank sample as reference.

Determination of total flavonoid content (TFC)

Flavonoid contents of PPE and cheese samples were assayed using the aluminum chloride colorimetric method (Chang *et al.*, 2002). The appropriate dilution of cheese extracts (0.5 ml) were mixed with 1.5 ml 95% ethanol, followed by 0.1 ml 10% aluminum chloride, 0.1 ml 1 M potassium acetate and 2.8 ml of distilled water. After incubation at room temperature for 30 min, the absorbance of the reaction mixture was measured at 415 nm with an UNICO UV/VIS-2100A spectrophotometer (Dayton, USA). The flavonoid contents were calculated using a standard calibration of rutin solution and expressed as micrograms of rutin equivalent (RE) per gram of sample.

Determination of scavenging activity DPPH

The scavenging of DPPH was determined according to the method of (Brand-Williams *et al.*, 1995) which was modified by (Re *et al.*, 1999). A stock solution of DPPH was prepared by dissolving sample in 0.1 mM methanol. DPPH (1 ml) and methanol (1.5 ml) were added to the supernatant (0.5 ml) obtained after centrifugation. Control was prepared by adding DPPH (1.5 ml) to methanol (1.5 ml). The antioxidant activity was determined for cheese extracts after 30 min by reading the absorbance at 517 nm. Blank contained deionized water. Scavenging activity (%) was calculated using the following equation.

$$\text{Scavenging activity (\%)} = \frac{Aa - [(Ab - Ac) \times 100 / Aa]}{Aa} \times 100$$

Aa → Absorbance of DPPH solution without sample

Ab → Absorbance of mixture containing sample and DPPH

Ac → Absorbance of blank solution without DPPH

The experiments were conducted in triplicate and the mean values were used.

Oxidative stability analysis

The oxidative stability (peroxide and acid values) of goat's cream cheese supplemented with PPE was analyzed according to AOAC (2000). The experimental cheese samples were dried at 40°C for 12 hr., in hot air oven, ground and mixed with n-hexane as a solvent for extraction of fat. The solvent was evaporated in hot air oven and then the extracted fats were analyzed.

Colour analyses

Colour analyses were carried out using Hunter colorimeter which standardized using black and white reference plate before measurement. Sample 10 g cheese were placed in glass cup and covered with black metal cover to prevent light interferes with the reading colour parameters, where L* value corresponds to lightness (0 dark to 100 light), a* value corresponds to red/green (- green /+red) and b* value corresponds to yellow/blue (-yellow/+ blue).

Microbiological examination

Goat's cream cheese samples were microbiologically tested for the count of total aerobic bacterial, coliform bacterial, moulds and yeast, proteolytic bacterial and lipolytic bacterial counts according to international Dairy Federation IDF (1991) and American Public Health Association APHA (2004).

Organoleptic evaluation

The organoleptic evaluation of goat's cream cheese samples was done by 10 experienced food panelists of Animal and Poultry Breeding Department, Desert Research Centre according to the method described by Scott (1981).

Statistical Analysis

Experimental data was analyzed using analysis of variance (ANOVA) and significant differences among means from a triplicate analysis at (P<0.05) were analyzed by Duncan's multiple range test (DMRT) using the (SPSS, 2012) software.

RESULTS AND DISCUSSION

Chemical analysis

The results in Table 1 show that PPE had 55.4% total solid, 0.76% acidity, pH 3.4, 287.54% total phenolic mg/ml extract, 73.75 (mg/ml) total flavonoids and DPPH 98.63% / DPPH. (Abd-Allah *et al.*, 2017) reported that Pomegranate peel extracted with 100 ml of aqueous (80, 70 and 50%) ethanol, showed antioxidant activity as measured by DPPH.

Chemical Composition of Goat's Cream Cheese

Chemical compositions of fresh goat's cream cheese was affected by addition of different concentration of pomegranate peel extracts (PPE). The results in Table 2 show that, the experimental cheese recorded a gradual significant increase in moisture, protein and acidity contents with the increasing the concentration of (PPE) compared with the control (P ≤0.05). The maximum values were recorded for PPE3 followed by PPE2, PPE1. However control samples recorded the lowest values. Significant decreased in fat, salt and pH values with the increase of the concentration of

Table 1. Chemical composition and antioxidant activity of pomegranate peel extracts (PPE)

Parameter (%)	Pomegranate peel extracts (PPE)
Total solid	55.4±4.2
Acidity (as lactic acid) (%)	0.76±0.02
pH value	3.4±0.14
Total phenolic content mg/ml extract	287.54±7.62
Total flavonoid content mg/ml extract	73.75±1.03
RSA/DPPH	98.63±0.223

Table 2. Chemical composition of fresh goat's cream cheese supplemented with different concentration of pomegranate peel extracts (PPE)

Parameter (%)	Treatment			
	Control	PPE1	PPE2	PPE3
Moisture	57.92±0.16 ^d	58.69±0.03 ^c	59.23±0.08 ^b	59.99±0.04 ^a
Protein	8.69±0.05 ^c	8.78±0.13 ^{ab}	8.83±0.07 ^{ab}	8.91±0.07 ^a
Fat/ DM	67.59±0.018 ^d	67.41±0.04 ^{bc}	67.36±0.16 ^{ab}	67.23±0.05 ^b
Salt/DM	3.56±0.23 ^a	3.51±0.09 ^a	3.51±0.06 ^a	3.50±0.06 ^a
Acidity as lactic acid (%)	0.28±0.08	0.30±0.16	0.32±0.04	0.36±0.13
pH values	4.83±0.18 ^a	4.85±0.01 ^a	4.81±0.04 ^a	4.79±0.08 ^a
TVFA (ml0.1 NaoH/100g)	22.50±0.06 ^a	21.78±0.03 ^{ab}	20.12±0.03 ^c	19.97±0.07 ^d

Means with different letters within the same row different significantly at $P < 0.05$

Control: goat's cream cheese without pomegranate peel extract. PPE1: goat's cream cheese +0.5% pomegranate peel extract. PPE2: goat's cream cheese + 1.0% pomegranate peel extract. PPE3: goat's cream cheese + 2% pomegranate peel extract.

PPE in all experimental cheese ($P \leq 0.05$). Similar results were obtained by Schulz-Collins and Senge (2004) and Phadungath (2005). Also, the total volatile fatty acids (TVFA) of goat's cream cheese affected by the concentration of pomegranate peel extracts. PPE3 recorded lowest value followed by PPE2, PPE1 and control. This may be due to masked the characteristic flavours and taste of goat's milk and improve the taste aroma.

Antioxidant Activity of Goat's Cream Cheese Supplemented with PPE

Results in Table 3 show that the radical scavenging activity (RSA/DPPH) (%) of pomegranate peel extracts of experimental

cheese had significantly ($P \leq 0.05$) increased with the increase of PPE concentration than control. PPE3 recorded high level of radical scavenging activity. It was (95.82 ± 0.24) while control samples recorded the lowest activity (31.07 ± 0.08). On the other hand, gradually decreased in activity was noticed after 15 days during storage period. These results are in harmony with Amarowicz *et al.* (2004).

Table 4 shows that the total phenolic and total flavonoid compounds in experimental cheese were highly significantly ($P \leq 0.05$) increased than control. Also, PPE3 recorded high level of both TPC and TFC. It were 62.84 ± 0.5 and 297.05 ± 0.5 , respectively. The results

Table 3. The radical scavenging activity (%) RSA/DPPH of goat's cream cheese supplemented with different concentration of pomegranate peel extracts (PPE) during storage period at refrigerator (4±1°C) for 45 days

Parameter (%)	Storage period (day)	Treatment			
		Control	PPE1	PPE2	PPE3
Radical scavenging activity	Fresh	31.07±0.08 ^d	88.05±0.14 ^c	91.28±0.07 ^b	95.82±0.24 ^a
	15	29.19±0.12 ^d	85.16±0.07 ^c	89.64±0.16 ^b	90.95±0.014 ^a
	30	26.37±0.18 ^d	80.27±0.21 ^c	85.43±0.09 ^b	88.51±0.05 ^a
	45	24.93±0.09 ^d	77.68±0.13 ^c	79.62±0.10 ^b	82.63±0.07 ^a

Means with different letters within the same row different significantly at P < 0.05

Table 4. Total phenolic and total flavonoid of goat's cream cheese supplemented with different concentration of pomegranate peel extracts (PPE) during storage period at refrigerator (4±1°C) for 45 days

Parameter	Storage period (day)	Treatment			
		Control	PPE1	PPE2	PPE3
Total phenolic (mg catechins/g)	Fresh	20.48±0.04 ^d	51.12±0.11 ^c	56.97±0.09 ^b	62.84±0.5 ^a
	15	16.09±0.1 ^d	41.11±0.08 ^c	46.45±0.1 ^b	51.56±0.07 ^a
	30	10.45±0.5 ^d	36.07±0.08 ^c	39.07±0.15 ^b	41.73±0.07 ^a
	45	9.12±0.12 ^d	24.3±0.10 ^c	27.89±0.09 ^b	34.74±0.10 ^a
Total flavonoid (µg rutin/g)	0	54.35±0.08 ^d	171.2±0.07 ^c	178.9±0.18 ^b	297.05±0.5 ^a
	15	40.9±0.1 ^d	113.18±0.09 ^c	121.35±0.7 ^b	191.36±0.27 ^a
	30	29±0.09 ^d	109.17±0.07 ^c	144.95±0.19 ^b	155.5±0.45 ^a
	45	24.34±0.09 ^d	101.18±0.08 ^c	113.3±0.34 ^b	151.82±0.8 ^a

Means with different letters within the same row different significantly at P < 0.05.

were confirmed by Ashoush and Gadallah (2011) and Ashoush *et al.* (2013). Clear decrease in TPC and TFC showed in all cheese samples after 15 days of storage period. It could be concluded that PPE can be used as industrial by-products of fruits as a natural preservation retarder to reduce oxidation and extend the shelf life of goat's cream cheese.

Oxidative Stability of Goat's Cream Cheese Supplemented with PPE

Table 5 shows that goat's cream cheese supplemented with the different concentrations of PPE had significant (P < 0.05) higher acid value with the increase of concentration of PPE

than control in fresh and after 15 days. Slightly increase was noticed during storage. This may be attributed to the fat hydrolysis and liberation of free fatty acids, which cause gradual increase in rancidity during storage period. The acid value of control cheese ranged from (0.51±0.03 to 1.07±0.03 mg KOH/g of fat) during the storage period. PPE3 recorded lowest acid value followed by PPE2 and PPE1 when fresh and during the storage period. From previous results, acid value decreased with the increase of PPE which containing phenolic compounds act as antioxidant and this improved cheese properties. These results agree with previous investigators (Yemis *et al.*, 2008 ; Gutiérrez-Larrazar *et al.*, 2012).

Table 5. The changes in the acid value and peroxide value of goat's cream cheese supplemented with different concentration of pomegranate peel extracts (PPE) during storage period at refrigerator (4±1°C) for 45 days

Parameter	Storage period (day)	Treatment			
		Control	PPE1	PPE2	PPE3
Acid value (mg KOH/g fat)	Fresh	0.51±0.03 ^a	0.46±0.07 ^{ab}	0.44±0.05 ^b	0.42±0.14 ^b
	15	0.73±0.05 ^a	0.67±0.03 ^b	0.59±0.04 ^c	0.55±0.02 ^d
	30	0.94±0.01 ^a	0.93±0.04 ^{ab}	0.86±0.03 ^{bc}	0.81±0.05 ^d
	45	1.07±0.03 ^a	0.98±0.03 ^b	0.92±0.06 ^{bc}	0.84±0.08 ^d
Peroxide value (meq/kg fat)	Fresh	2.28±0.06 ^a	2.17±0.03 ^a	2.04±0.01 ^a	2.01±0.05 ^a
	15	2.64±0.02 ^a	2.56±0.07 ^b	2.43±0.06 ^c	2.29±0.06 ^d
	30	3.24±0.09 ^a	2.68±0.06 ^b	2.59±0.08 ^c	2.34±0.04 ^d
	45	3.76±0.08 ^a	2.97±0.09 ^b	2.75±0.07 ^c	2.69±0.07 ^d

Means with different letters within the same row different significantly at $P < 0.05$

Table 5 shows that the goat's cream cheese fortified with PPE had lower peroxide values ($P \leq 0.05$) compared with the control when fresh. Peroxide value of PPE1 ranged from (2.17±0.03 to 2.97±0.09 meq/kg fat) followed by PPE2 (2.04±0.01 to 2.75±0.07 meq/kg fat) and PPE3 samples (2.01±0.05 to 2.69±0.07 meq/kg fat) after 45 days. The obtained results revealed that the peroxide value decreased with the increase of the concentration of PPE in cheese due to the phenols compounds and antioxidants activity which improved and extend shelf life of goat's cream cheese. This results are in agreement with Han *et al.* (2011a,b) and El-Shourbagy and El-Zahar (2014).

Physicochemical Analysis of Goat's Cream Cheese Supplemented with PPE

Fig. 1 illustrate the changes in acidity and pH values in goat's cream cheese containing different concentration of PPE, significant ($P < 0.05$) increase acidity with the increase of concentration of PPE when fresh and during storage period up to 45 days. The range of acidity was 0.71 ± 0.12 to 1.35 ± 0.18 , on the contrary the pH values showed significantly ($P < 0.05$) decrease in all cheese samples compared with control when fresh and during storage period which may be due to the acidic and phenolic compounds present in pomegranate

peel extract (Naveena *et al.*, 2008a,b) and Devatkal *et al.* (2010). The pH values range from 4.88 ± 0.26 to 4.31 ± 0.19 .

Colour Changes of Goat's Cream Cheese Supplemented with PPE

Colour changes of goat's cream cheese supplemented with different concentrations of pomegranate peel extracts during storage up to 45 days are shown in Table 6. PPE1, PPE2 and PPE3 presented lower L^* values ($P < 0.05$) than control in fresh and during storage period. This may be related to the addition of different concentration of pomegranate peel extracts which effected in lighting in cheese sample, in colour evaluation, the L^* parameter indicates lightness and reflect light on a scale ranging from 0 to 100. These results are in agreement with Sheehan *et al.* (2009) and Queiroga *et al.* (2013).

Significantly higher a^* values ($P < 0.05$) were found in PPE3 followed by PPE2 and PPE1 than the control in fresh and during storage period. The higher a^* values (green component) in goat dairy may be attributed to their fatty acids profiles also, goat have the ability to convert β -carotene into vitamin A. These results agree with Park (2006), Lucas *et al.* (2008) and Sheehan *et al.* (2009). The b^* values

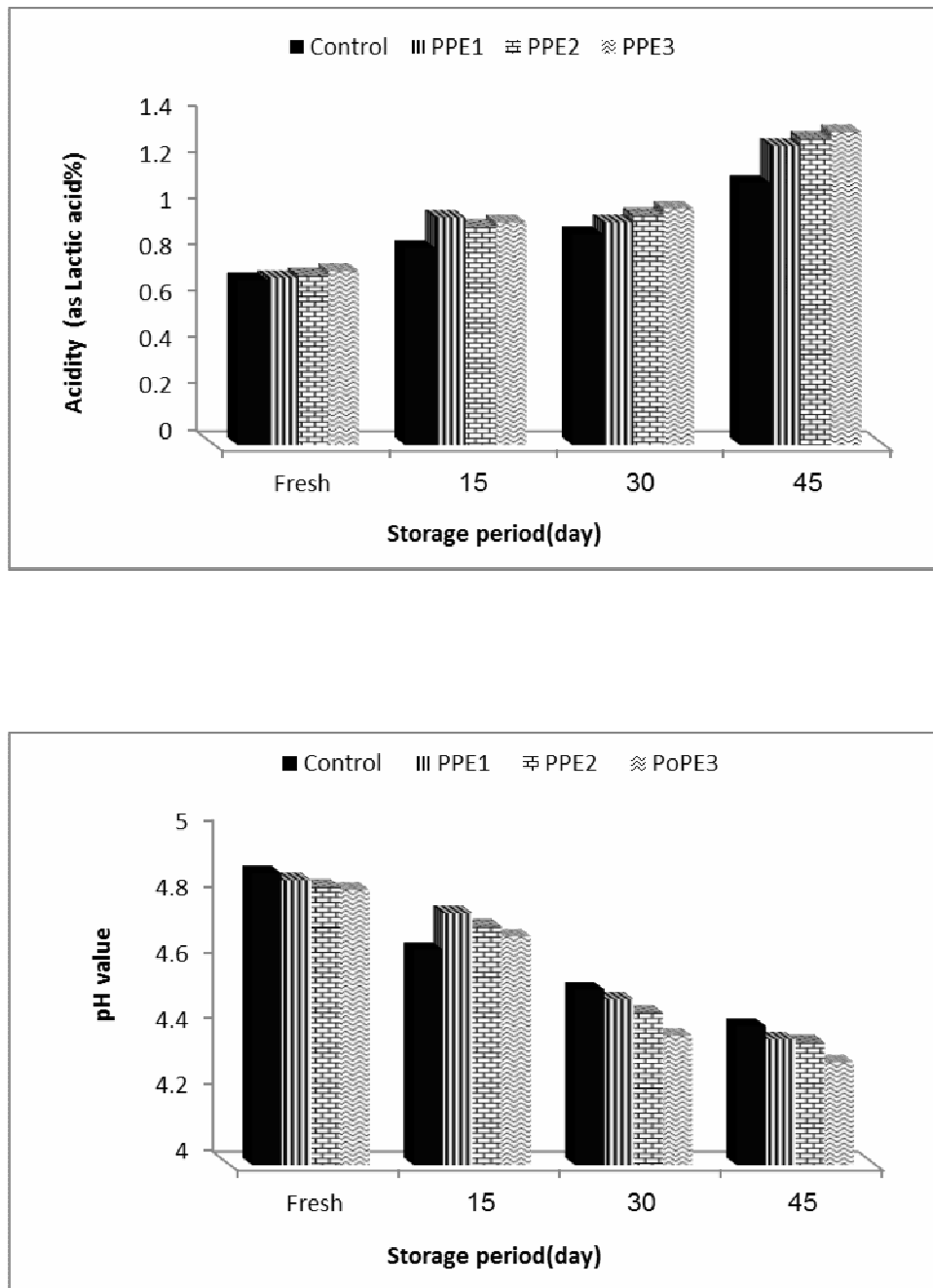


Fig. 1. The changes in the acidity (%) and pH value of goat's cream cheese supplemented with different concentration of pomegranate peel extracts (PPE) during storage period at refrigerator ($4\pm 1^{\circ}\text{C}$) for 45 days

Table 6. Colour changes of goat's cream cheese supplemented with different concentration of pomegranate peel extracts (PPE) during storage period at refrigerator (4±1°C) for 45 days

Variables	Storage period (day)	Treatment			
		Control	PPE1	PPE2	PPE3
L*	Fresh	86.39±0.13 ^a	77.99±0.08 ^b	76.84±0.17 ^c	74.22±0.03 ^d
	15	87.92±0.10 ^a	78.47±0.07 ^b	77.47±0.13 ^c	75.82±0.28 ^d
	30	89.42±0.14 ^a	78.97±0.21 ^b	78.07±0.02 ^b	77.62±0.10 ^{bc}
	45	72.49±0.02	38.45±0.18	53.93±0.27	69.82±0.04
a*	Fresh	-3.37±0.26 ^d	-3.04±0.16 ^c	-2.74±0.08 ^b	-0.97±0.24 ^a
	15	-1.43±0.12 ^d	-1.32±0.11 ^c	-1.21±0.03 ^b	-0.66±0.18 ^a
	30	-1.35±0.23 ^b	-1.28±0.04 ^b	-1.11±0.14 ^b	-0.22±0.13 ^a
	45	-1.14±0.08 ^d	-1.12±0.24 ^{bc}	-1.01±0.19 ^b	-0.38±0.05 ^a
b*	Fresh	9.62±0.06 ^c	9.96±0.17 ^b	10.27±0.16 ^a	8.62±0.15 ^d
	15	10.81±0.18 ^b	10.86±0.06 ^b	11.2±0.03 ^a	6.93±0.27
	30	12.83±0.03 ^c	13.02±0.18 ^b	13.23±0.06 ^a	9.94±0.19 ^d
	45	15.20±0.14 ^c	15.51±0.03 ^b	15.84±0.31 ^a	14.88±0.08 ^d

Means with different letters within the same row different significantly at $P < 0.05$.

(yellow component) were found to be higher ($P < 0.05$) in PPE2 followed by PPE1 and control in fresh and during storage period. The increase in b* values may be related to the addition of pomegranate peel extracts, which decrease the luminosity. The examined samples presented high yellow component (b*) values, with predominance of the green component (a*) rather than the luminosity (L*), suggesting that the yellow-green mostly contributed to the colour characteristics of the goat's cream cheese with pomegranate peel extracts.

Microbiological Examination of Goat's Cream Cheese Supplemented with PPE

Microbiological properties of goat's cream cheese supplemented with different concentration of pomegranate peel extracts are shown in Figs. 2, 3, 4 and 5. The results showed significant ($P \leq 0.05$) increasing in total bacterial counts during storage period in control while other treatments had lowest counts with the increase of extracts concentration. Total bacterial counts of the samples were ranged from 5.30 ± 0.07 to 8.19 ± 0.04 log cfu/g. Total bacterial counts of (PPE3) had the lowest

proteolytic and lipolytic bacterial counts increased during 30 days then decreased at the end of storage period for 45 days compared the counts with the control samples and also decreased with increasing the concentration of pomegranate peel extracts. Coliform bacteria were not detected in any cheese samples this indicate the good sanitary conditions during preparation the cheese. Similar results were reported by Singh *et al.* (2015) and Bhat *et al.* (2015). Yeast and mould counts of the samples were affected by increasing pomegranate peel extract concentrations. Yeast and mould counts were not detected at the first 15 days of storage period which may be due to the antifungal properties of the pomegranate peel extracts. These results agree with Devatkal *et al.* (2010) and Bukhari *et al.* (2012). Yeast and mould counts in the samples were ranged from 3.00 ± 0.38 to 4.53 ± 0.56 log cfu/g.

Organoleptic Properties of Goat's Cream Cheese Supplemented with PPE

Organoleptic evaluation of goat's cream cheese when fresh and during storage is presented in Fig 6. The results indicated that,

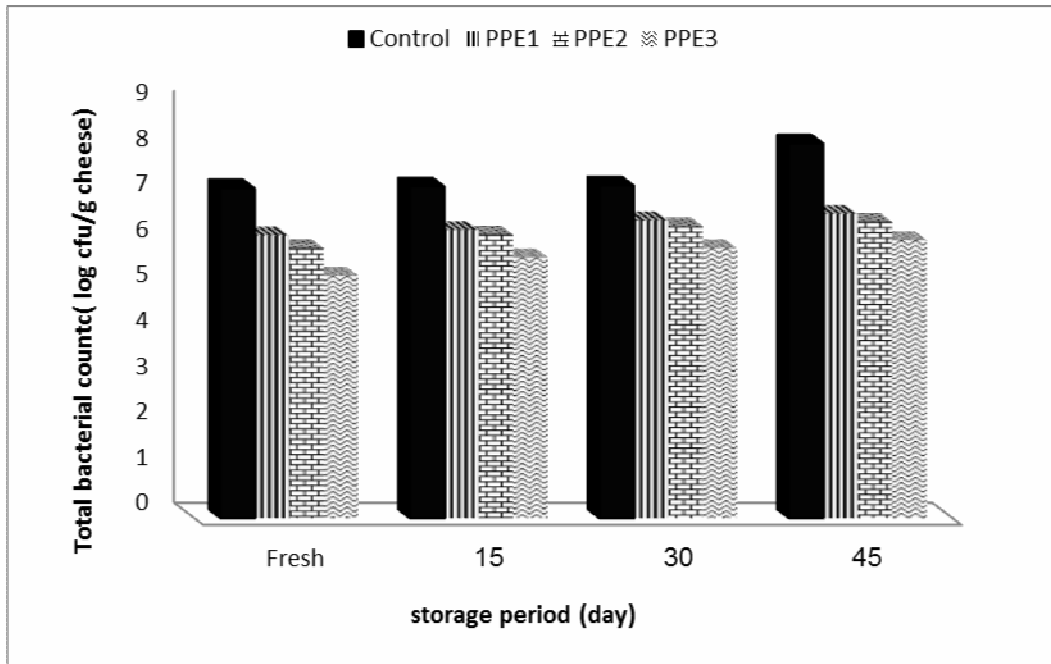


Fig. 2. Total bacterial count of goat's cream cheese supplemented with different concentration of pomegranate peel extracts (PPE) during storage period at refrigerator ($4\pm 1^\circ\text{C}$) for 45 days

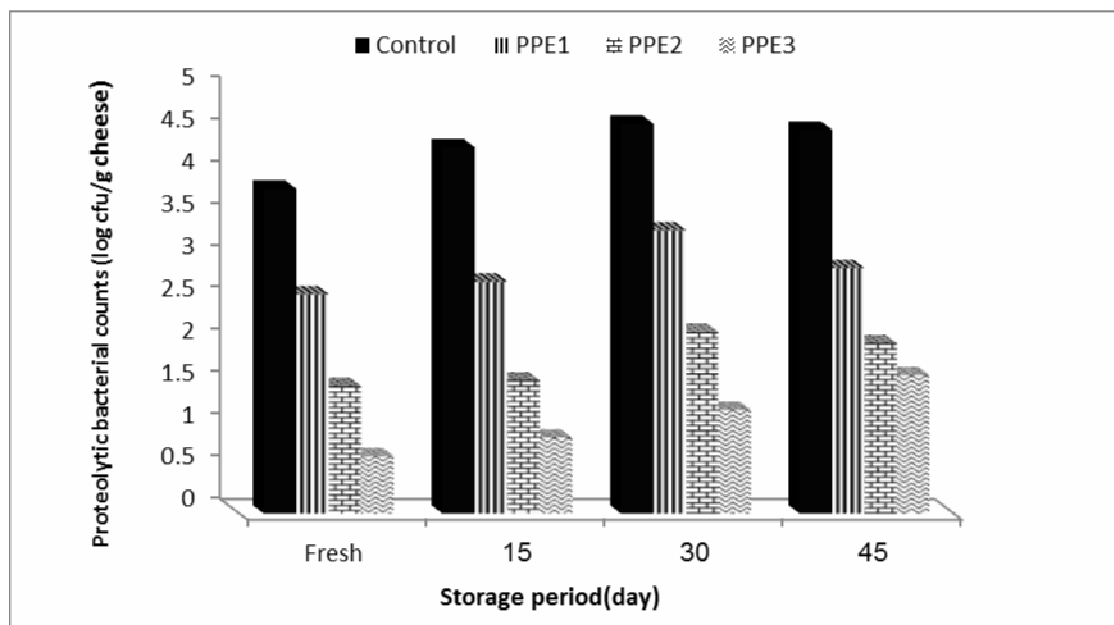


Fig. 3. Proteolytic bacterial count of goat's cream cheese supplemented with different concentration of pomegranate peel extracts (PPE) during storage period at refrigerator ($4\pm 1^\circ\text{C}$) for 45 days

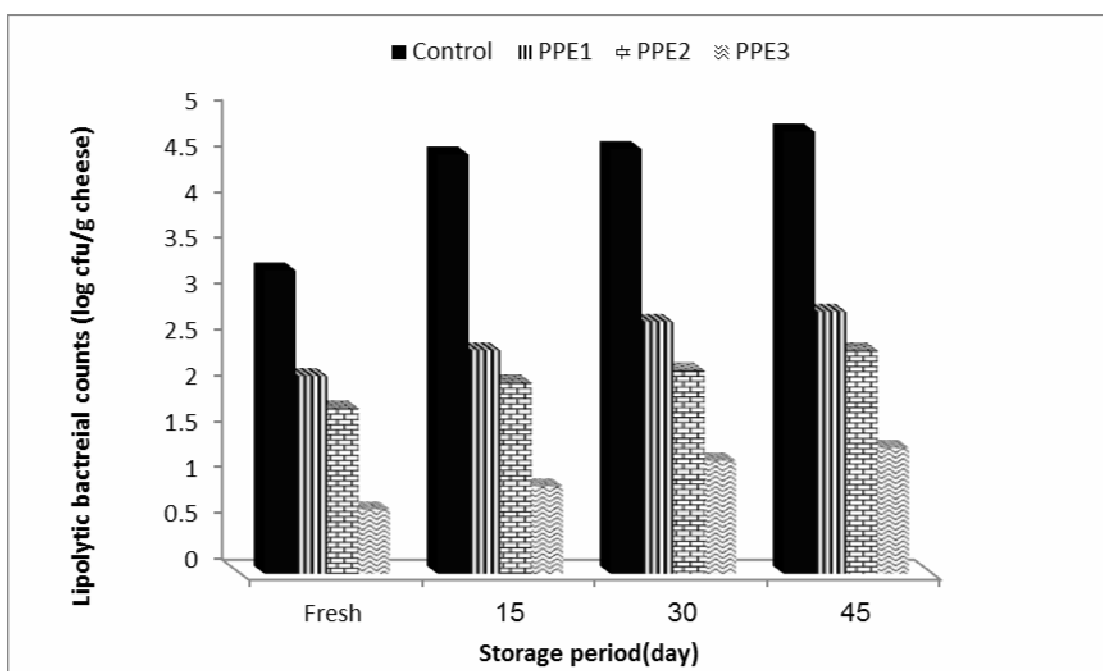


Fig. 4. Lipolytic bacterial count of goat's cream cheese supplemented with different concentration of pomegranate peel extracts (PPE) during storage period at refrigerator ($4\pm 1^\circ\text{C}$) for 45 days

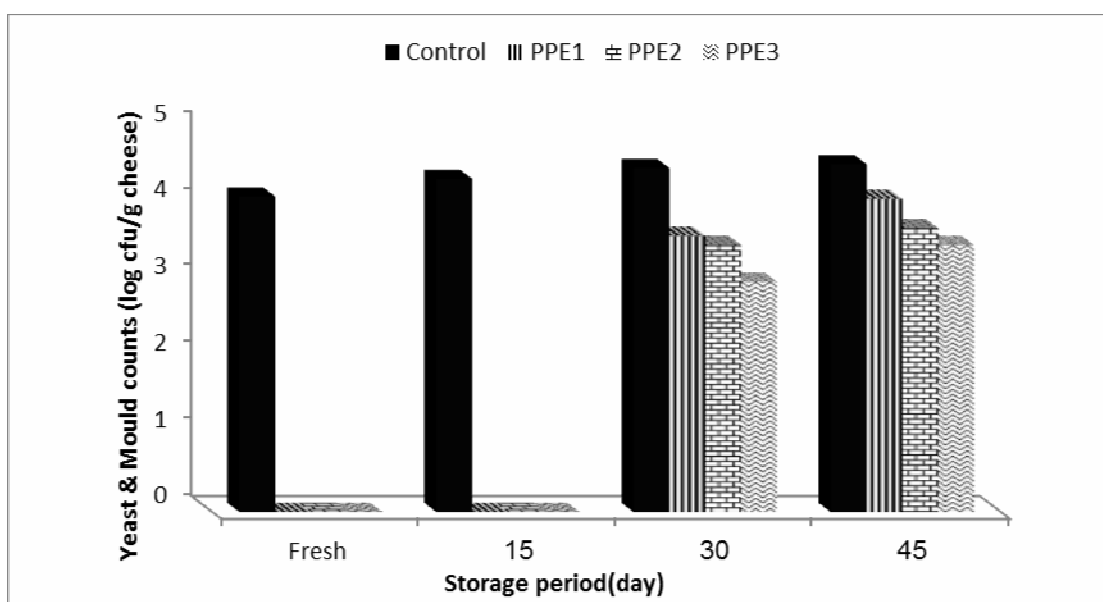


Fig. 5. Yeast and mould counts of goat's cream cheese supplemented with different concentration of pomegranate peel extracts (PPE) during storage period at refrigerator ($4\pm 1^\circ\text{C}$) for 45 days

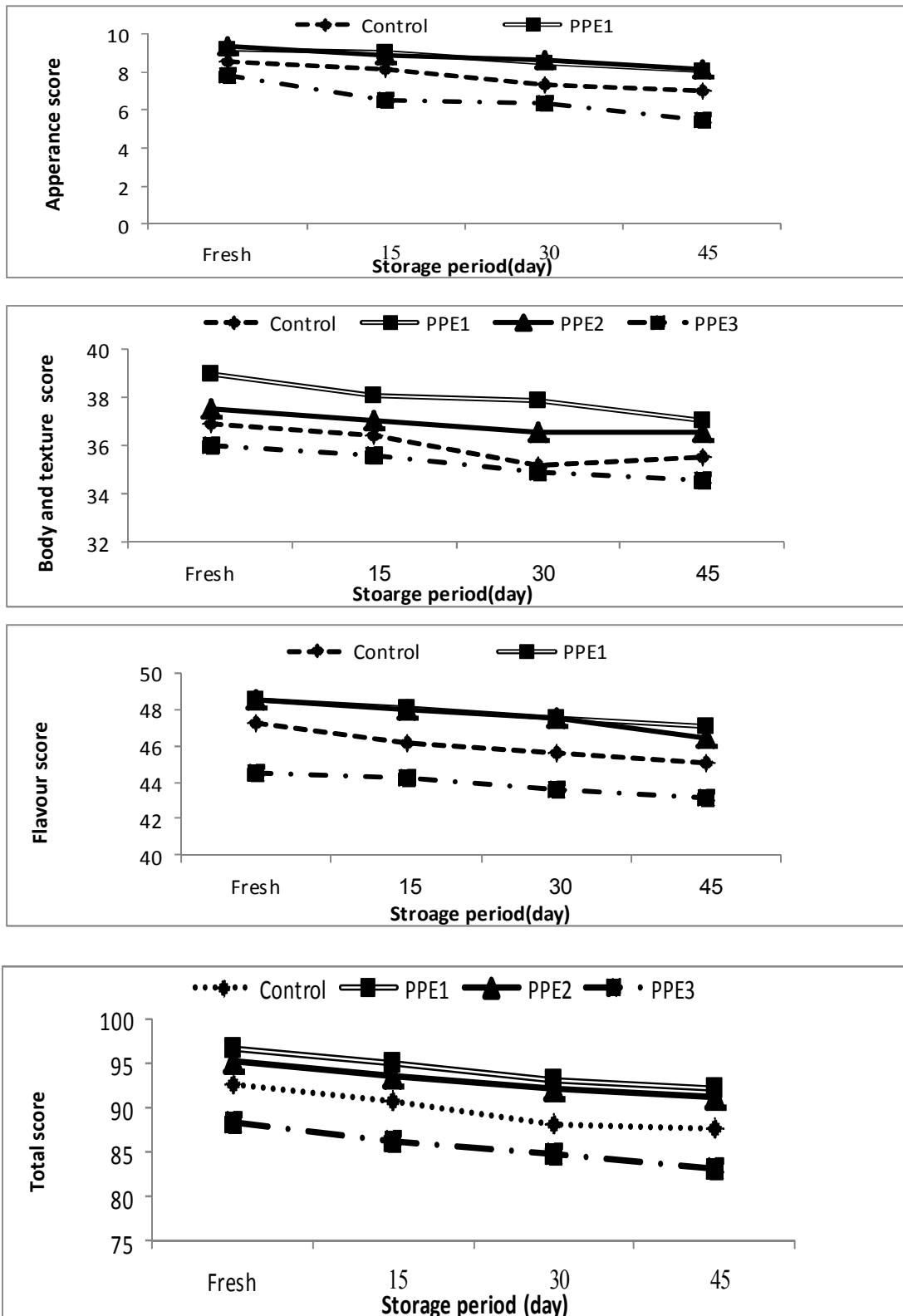


Fig. 6. Sensory properties of goat's cream cheese supplemented with different concentration of pomegranate peel extracts (PPE) during storage period at refrigerator ($4\pm 1^{\circ}\text{C}$) for 45 days

appearance, texture and flavour of goat's cream cheeses were affected by addition of pomegranate peel extracts to cheese. The total score points of control cheeses were 92.65 ± 0.01 , 90.79 ± 0.08 , 88.08 ± 0.16 and 87.64 ± 0.09 for fresh, 15, 30 and 45 days of storage, respectively. While cheese samples (PPE1) were 96.74 ± 0.13 , 95.10 ± 0.03 , 93.10 ± 0.18 and 92.17 ± 0.07 , when fresh and during storage in the same order. It could be noticed that addition of pomegranate peel extracts enhanced the development of cheese flavour, improved the acceptability of goat's cheese and masked goaty flavour than the control which, might be due to the effect of the phenolic compound (Abd El-Aziz *et al.*, 2013; Khalifa and Wahdan, 2015). This improvement was proportional to the concentration of pomegranate peel extracts added. Good flavour and highly acceptable consistency were observed at 45 days for PPE1 and PPE2, respectively. So, the addition of pomegranate peel extracts at a level of 0.5% and 1.0% produced the highest acceptable properties through over the storage period. It gained the highest scores among other treatments and control at the end of the storage period.

Conclusion

This study clearly showed that goat's cream cheese could be made successfully from goat's milk supplemented with different ratio of pomegranate peel extracts as a natural antioxidant which improved the level of resistance of fats to oxidation process and rancidity. The observations indicated that goat's cream cheese with pomegranate peel extract (0.5% and 1.0%) improved the lipid stability and storage quality. Furthermore the goat's cream cheese had good properties during storage period for 45 days.

REFERENCES

- Abd El-Aziz, M.E., R.E. El-Gammal, M.M. Abo-srea' and F.I. Youssef (2013). Antioxidant and antimicrobial activity of pomegranate (*Punica granatum* L.) fruit peels extract on some chemical, microbiological and organoleptic properties of yoghurt during storage. *J. Food and Dairy Sci.*, Mansoura Univ., 4 (7): 387 – 400.
- Abd-Allah S.M.A., M.A. Rabie, D.M.M. Mostfa, A.M. Suliman and A.A. El-Badawi (2017). Nutritional evaluation, chemical composition and antioxidant activity of some food processing wastes. *Zag. J. Food and dairy Res.*, 43 (6A): 2115 – 2132.
- Akhtar, S., T. Ismail, D. Fraternali and P. Sestili (2015). Pomegranate peel and peel extracts: Chemistry and food features *Food Chem.*, 174 : 417–425.
- Alenisan, A.M., H.H. Alqattan, L.S. Tolbah and A.B. Shori (2017). Antioxidant properties of dairy products fortified with natural additives: A review. *J. Association of Arab Uni. for Basic and Appl. Sci.*, 5 :1-6.
- Alferez, M.J., M. Barrionuevo, I. Lo'pez-Aliaga, M.R. Sanz Sampelayo, F. Lisbona, J.C. Robles and M.S. Campos (2001). Digestive utilization of goat and cow milk fat in malabsorption syndrome. *J. Dairy Sci.*, 64: 451-461.
- Altemimi, A., D.G. Watson, R. Choudhary, M.R. Dasari and D.A. Lightfoot (2016). Ultrasound assisted extraction of phenolic compounds from peaches and pumpkins. *PLoS ONE* 11(2): e0148758. Doi: 10.1371/j.pone.0148758.
- Amarowicz, R.B., P. Pegg, B.R. Moghaddam and A.W.J. Barl (2004). Free radical scavenging capacity and antioxidant activity of selected plant species from the Canadian prairies. *Food Chem.*, 84 (4): 551-562.
- AOAC (2000). Official Methods of Analysis. 17th Ed., Association of Official Analytical Chemists Gaithersburg, MD, USA.
- APHA (2004). Standard Methods for the Examination of Dairy Products. American Publ. Health Assoc.Inc.17th Ed., Washington D.C20001, USA.
- Ashoush, I.S. and M.G.E. Gadallah (2011). Utilization of mango peels and seed kernels powders as sources of phytochemicals in biscuit. *World J. Dairy and Food Sci.*, 6 (1): 35-42.
- Ashoush, I.S., O.I. El-Batawy and G.A. El-Shourbagy (2013). Antioxidant activity and hepatoprotective effect of pomegranate peel

- and whey powders in rats. *Annals Agric. Sci.*, 58 (1): 27-32.
- Bhat, Z.F., S. Kumar and P. Kumar (2015). Effect of Aloe Vera on the lipid stability and storage quality of chicken nuggets. *Nut. and Food Sci.*, 45 : 20–24.
- Bradley, R.L., J.E. Arnold, J.D.M. Barbano, R.G. Semerad, D.E. Smith and B.K. Vines (1992). Chemical and Physical Method: In Standard Method for the Examination of Dairy Products, 16th Ed., (Ed.) Marshall, RT, American Public Health Ass., (APHA). New York, USA, 433.
- Brand-Williams, W., M.E. Cuvelier and C. Berset (1995). Use of a free radical method to evaluate antioxidant activity. *LWT - Food Sci. and Technol.*, 28 125-30.
- Bukhari, S.A.A., V. Pathak, Z.F. Bhat and S.R. Ahmed (2012). Effect of ambient storage on the quality characteristics of Kaladhi-an acid coagulated milk product. *Ame. J. Food Technol.*, 7 (4): 192–203.
- Cam, M., Y. Hisil and G. Durmaz (2009). Classification of eight pomegranate juices based on antioxidant capacity measured by four methods. *Food Chem.*, 112.
- Camo, J., J.A. Beltrán and P. Roncalés (2008). Extension of the display life of lamb with an antioxidant active packaging. *Meat Sci.*, 80: 1086–1091.
- Chang, C., M. Yang, H. Wen and J. Chern (2002). Estimation of total flavonoid content in propolis by two complementary colorimetric methods. *J. Food Drug Anal.*, 10: 178-182.
- Chilliard, Y., A.A.J. Ferlay, J. Rouel and G. Lamberet (2003). A review of nutritional and physiological factors affecting goat milk lipid synthesis and lipolysis. *J. Dairy Sci.*, 86 (5): 1751-1770.
- Collins, Y.F., P.L.H. McSweeney and M.G. Wilkinson (2003). Lipolysis and free fatty acid catabolism in cheese: A Rev. Current knowledge. *Int. Dairy J.*, 13 (11): 841-866.
- Devatkal, S.K., K. Narsaiah and A. Borah (2010). Anti-oxidant effect of extracts of kinnow rind, pomegranate rind and seed powders in cooked goat meat patties. *Meat Sci.*, 85: 155–159.
- Díaz-Castro, J., L.J. Pérez-Sánchez, M. Ramírez López-Frías, I.T. López Aliaga, M.L. Ojeda and M.S. Campos (2012). Influence of cow or goat milk consumption on antioxidant defiance and lipid peroxidation during chronic iron repletion. *British J. Nut.*, 108 (1): 1-8.
- El-Shourbagy, G.A. and K.M. El-Zahar (2014). Oxidative stability of ghee as affected by natural antioxidants extracted from food processing wastes. *Ann. Agric. Sci.*, 59 (2): 213–220.
- Fasseas, M.K., K.C. Mountzouris, P.A. Tarantilis, M. Polissiou and G. Zervas (2007). Antioxidant activity in meat treated with oregano and sage essential oils. *Food Chem.*, 106 : 1188.
- Gutiérrez-Larraínzar, M., J. Rúa, I. Caro, D. Castro-Arriaga, R. García-Armesto and P. Valle (2012). Evaluation of antimicrobial and antioxidant activities of natural phenolic compounds against foodborne pathogens and spoilage bacteria. *Food Control* 26: 555-563.
- Han, J., M. Britten, D. St-Gelais, C.P. Champagne, P. Fustier and S. Salmieri (2011a). Polyphenolic compounds as functional ingredients in cheese. *Food Chem.*, 124: 1589 – 1594.
- Han, J., M. Britten, D. St-Gelais, C.P. Champagne, P. Fustier, S. Salmieri and M. Lacroix (2011b). Effect of polyphenolic ingredients on physical characteristics of cheese. *Food Res. Int.*, 44: 494–497.
- IDF (1991). International Dairy Federation. Milk and Milk Products: Enumeration of Yeast and Moulds (Colony count technique at 30°C). IDF: 100 B.
- Khalifa, S.A. and K.M. Wahdan (2015). Improving the quality characteristics of white soft cheese using cranberry (*Vaccinium macrocarpon*) fruit extract. *Int. Food Res. J.* 22 (6): 2203-2211.
- Kosikowski, F. and V.V. Mistry (1997). Cheese and Fermented Milk Foods: Procedures and Analysis 3rd Ed. Published by the Author. Cornell Univ. Itacha, N.Y.

- Kosikowski, F.V. (1978). Cheese and Fermented Milk Foods. 2nd Ed. Published by the Author. Cornell Univ. Itacha, NY.
- Kristensen, D. and L.H. Skibsted (1999). Comparison of three methods based on electron spin resonance spectrometry for evaluation of oxidative stability of processed cheese. J. Agric. Food Chem., 47 : 3099 - 3104.
- Li, Y., C. Guo, J. Yang, J. Wei, J. Xu and S. Cheng (2006). Evaluation of antioxidant properties of pomegranate peel extract in comparison with the pomegranate pulp extract. Food Chem., 96: 254–260.
- Lucas, A., E. Rock, C. Agabriel, Y. Chilliard, and J.B. Coulon (2008). Relationships between animal species (cow versus goat) and some nutritional constituents in raw milk farmhouse cheeses. Small Rum. Res., 74: 243-248.
- Madhavi, D.L., S.S. Deshpande and D.K. Salunkhe (1995). Food Antioxidant, Technological, Toxicological and Health Perspectives. Marcel Dekker, New York, 66- (159): 267 - 471.
- Miguel, M.G., M.A. Neves and M.D. Antunes (2010). Pomegranate (*Punica granatum* L.), a medicinal plant with myriad biological properties-A short review. J. Med. Plants Res., 4: 2836–2847.
- Mukdsi, M.C.A., C. Haro, S.N. Gonzalez and R.B. Medina (2013). Functional goat milk cheese with feruloyl esterase activity. J. Functional Foods, 5 (2): 801-809.
- Naveena, B.M., A.R. Sen, R.P. Kingsly, D.B. Singh and N. Kondaiah (2008a). Antioxidant activity of pomegranate rind powder extract in cooked chicken patties. Int. J. Food Sci. and Technol., 43: 1807–1812.
- Naveena, B.M., A.R.S. Sen, S. Vaithyanathan, Y. Babji and N. Kondaiah (2008b). Comparative efficacy of pomegranate juice, pomegranate rind power extract and BHT as antioxidants in cooked chicken patties. Meat Sci., 80: 1304–1308.
- Orhan, I., A. Aydin, A. Colkesen and A.I. Isimer (2003). Free scavenging activities of some edible fruit seeds. Pharmaceutical Biol., 41: 163–165.
- Park, Y.W. (2006). Goat Milk-Chemistry and Nutrition. In YW Park and GFW Haenlein (Eds.), Handbook of Milks of Non-Bovine Mammals. Ames, IO, USA: Blackwell Publishing, 34-58.
- Phadungath, C. (2005). Cream cheese products: A review. Songklanakarin. J. Sci. and Technol., 27: 191-199.
- Queiroga, R.D.C.R.D.E., B.M. Santos, A.M.P. Gomes, M.J. Monteiro, S.M. Teixeira and E.L. Souza (2013). Nutritional, textural and sensory properties of Coalho cheese made of goats' cows' milk and their mixture. LWT-Food Sci. and Technol., 50 (2): 538-544.
- Re, R., N. Pellegrini, A. Proteggente, A. Pannala, M. Yang and C. Rice-Evans (1999). Antioxidant activity applying an improved ABTS radical action decolonization assay. Free Radical Biol. Med., 26: 1231 – 1237.
- Schulz-Collins, D. and B. Senge (2004). acid and acid/rennet-curd cheeses. Part A: Quark, Cream Cheese and Related Varieties. Cheese: Chem. Physics and Microbiol., 6: 301- 328.
- Scott, R. (1981). Cheese Making Practice. Applied Sci. Publisher Ltd. London.
- Shahidi, F. (2015). A volume in Wood head Publishing Series in Food Sci., Technol. and Nut. ISBN: 978-1-78242-089-7.
- Shaiban M., M. Al-Mamary and M. Al-Habori (2006). Total antioxidant activity and total Phenolic contents in Yemeni smoked cheese. J. Nut., 12(1): 87-92.
- Sheehan, J.J., M.A. Drake and P.L.H McSweeney (2009). Effect of partial or total substitution of bovine for caprine milk on the compositional, volatile, non-volatile and sensory characteristics of semi-hard cheeses. Int. Dairy J., 19: 498-509.
- Shiban, M.S., M.M. Al Otaibi and N.S. Al-Zoreky (2012). Antioxidant activity of pomegranate (*Punica granatum* L.) fruit peels. Food Nut. Sci., 3: 991–996.

- Siddhuraju, P. and K. Beeker (2003). Antioxidant properties of various solvent extract of total phenolic constituents from three different agro climatic origins of Drum stick tree (*Moringa oleifera* Lam.) leaves. *J. Agric. and Food Chem.*, 51: 2144.
- Singh, P.K., S. Kumar, Z.F. Bhat and P. Kumar (2015). Effect of sorghum bicolor and clove oil on the quality characteristics and storage quality of aerobically pack-aged chevron cutlets. *Nut. and Food Sci.*, 45(1): 48–52.
- Singleton, V.L. and J.A. Rossi (1965). Colorimetry of total phenolics with phosphomolybdic-phosphotungstic acid reagents *Ame. J. Enol. and Vit.*, 16: 144–158.
- SPSS (2012). Statistical Package for Social Science, Release 11.5, SPSS INC, Chicago. USA.
- Tokusoglu, O. (2009) Eritme Peynirinin Lutein Antioksidanöncü Zenginleşmesi (Bolum 2) [The Lutein antioxidant enhancing of processed cheese (Chapter 2)]. In Peynir Dair (Regarding Cheese), Aras N, ed. _Istanbul: Metro Kultur Yayınları, 37–47.
- Tokusoglu, O. (2013). The physicochemical, microbiological, organoleptic properties and antioxidant activities of functional cream cheeses fortified with lutein *Int. J. Dairy Technol.*, 66: 4.
- Vidhan, J., A.D. Marderosian and R.P. John (2010). Anthocyanins and polyphenol oxidase from dried arils of pomegranate (*Punica granatum* L.). *J. Food Chem.*, 118: 11-16.
- Wenjuan, Q., P.B. Andrew, P. Zhongli and Ma Haile (2012). Quantitative determination of major polyphenol constituents. *J. Food Chem.*, 132: 1585-1591.
- Yemis, O., E. Bakkalbasi and N. Artik (2008). Antioxidant activities of grape (*Vitis vinifera*) seed extracts obtained from different varieties grown in Turkey. *Int. J. Food Sci. Technol.*, 43: 154–159.

استخدام مستخلص قشور الرمان كمضادات أكسدة طبيعية للجبن الكريمي المصنع من لبن الماعز

سماح محمد سعيد الشافعي^١ – السيد محمد محمد عابدين^١ – صفاء سيد ابوزيد^٢

١- قسم تربية الحيوان والدواجن – شعبة الإنتاج الحيواني والدواجن – مركز بحوث الصحراء – القاهرة- مصر
٢- قسم تكنولوجيا الأغذية – المركز القومي للبحوث - الدقى – الجيزة- مصر

في هذه الدراسة تم تجهيز جبن كريمي من لبن الماعز مضاف إليه مستخلص قشور الرمان بنسب (صفر ، ٠,٥ ، ١ و ٢%) كمصدر طبيعي لمضادات الأكسدة، تم تقييم النشاط المضاد للأكسدة – المركبات الفينولية والفلافونويد وثبات الأكسدة لجبن التجربة والخواص الميكروبيولوجية والحسية خلال فترة التخزين على درجة حرارة ٤م لمدة ٤٥ يوم، تم تقدير التركيب الكيميائي للجن الطازج، من النتائج المتحصل عليها لوحظ حدوث زيادة معنوية في نشاط مضادات الأكسدة والمركبات الفينولية والمركبات الفلافونودية حيث سجلت المعاملة المحتوية على مستخلص قشور رمان بنسبة ٢% أعلى تقييم للنشاط مضادات الأكسدة، وقد وجد انخفاض في أعداد البكتريا الكلية والبكتريا المحللة للدهن وللبروتين والفطريات والخمائر في جبن التجربة بالمقارنة بمعاملة الكنترول ولم يتم الكشف عن وجود بكتريا القولون في جبن الماعز الكريمي خلال فترات التخزين، أوضحت نتائج التحكيم الحسى أن استخدام مستخلص قشور الرمان بنسبة ٠,٥ و ١ % على التوالي سجلوا أعلى القيم الحسية وبالتالي وبصوره عامه يمكن القول أن مستخلص قشور الرمان يمكن استخدامه كمادة حافظة طبيعيه تحسن من قابلية و ثبات الأكسدة وجودة التخزين لجبن الماعز الكريمي.

المحكمون :

- ١- أ.د. إيهاب عيسوي عبدالباقي
٢- أ.د. محمد مجدي زكي العباسي
أستاذ تكنولوجيا الأغذية – معهد تكنولوجيا الأغذية.
أستاذ الألبان المتفرغ – كلية الزراعة – جامعة الزقازيق.