



RELATIONSHIP BETWEEN OXIDATIVE STABILITY AND ANTIOXIDANT PROPERTIES OF GOAT CREAM BISCUITS SUPPLEMENTED WITH NATURAL ANTIOXIDANT

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Abstract

Fat composition in goat milk is one of the most important components of the nutritional and technological of goat milk. The antioxidant effect of pomegranate peel extract (PPE) was investigated in fat in goat milk (goat cream), as well as their use in the manufacture of biscuits with supplemented ratios 0.5, 1 and 2%. Antioxidant properties such as radical scavenging activity, total phenolic content and total flavonoid content of goat cream and biscuits samples were determined. Supplemented lipid fraction of biscuit formula with PPE was improving the oxidation stability of biscuits samples. The correlation coefficient (R) values range from -0.786 to -0.992, significant negative correlations between oxidative stability and antioxidant properties of goat cream biscuits might generally be considered a result of the antioxidant effects of PPE supplemented as natural antioxidant.

Keywords: Goat cream, Pomegranate peel extract, Cream biscuits, Antioxidant properties, lipid fraction.

Introduction

Goat milk is a valuable food product and a raw material used to produce products of high quality and flavor properties (Chen *et al.*, 2016). On the other hand, the higher importance of goat milk as a rich source of nutrients and functional components (Nurliyani *et al.*, 2015). Fat or lipid content in goat milk it's an important component. Fat in goat milk is more digestible than fat in bovine milk, which may be related to the lower milk fat globule size, higher C8:0–C10:0 contents and a larger ratio of short and medium-chain fatty acids (Bernard *et al.*, 2009). Fatty acid profile characteristics of milk were observed from different dairy mammals: cow, camel, buffalo, yak and goat. Highly unsaturated fatty acid and low short- to medium-chain fatty acid (SMCFA) were observed for camel milk. While, Goat milk had the highest level of C8:0–C12:0–C14:0 milk fatty acid content (Yang *et al.*, 2018). Short-chain and medium-chain fatty acids were determine the higher digestibility and absorption of both these nutrients and have a significant impact on the health properties of goat milk (Milewski *et al.*, 2018).

Goats milk provides nutritional benefits due to its unique fatty acid composition that comprises relatively high amounts of short- and medium-chain fatty acids, which make goats milk easy to digest. A medium-chain fatty acids in goat milk have a unique health benefit limit or inhibits cholesterol deposition and also in gastrointestinal disorders, malabsorption and contributes to normal growth of infants (Shamsudin *et al.*, 2018; Roy and Vadodaria, 2006).

The qualities regarding fats in the composition of goat milk are higher significant in differentiating the special health benefits. These are globule size, and the proportion of medium chain fatty acids. Fat globules size in milk ranged from 1-10 micron in both cow and goat. However, in goat milk the globule size less than 5 microns was 83% when compared to 62% in cow's milk. This smaller size combined with the lack of agglutinin contributes to the higher digestibility of goat milk, and the better tolerance of it for

individuals with certain digestive disorders (Bihaqi and Jalal, 2010; Getaneh *et al.*, 2016).

Pomegranate (*Punica granatum* L.) is a high amount of bioactive compounds and contains a variety of secondary metabolites. In the fruit peel, relatively higher antioxidant activity and polyphenol compounds such as ellagitannins, ellagic acid, punicalic acid, anthocyanins, anthocyanidins, flavonoids and estrogenic flavonols, flavones have been implicated in various pharmacological activities including treatment and prevention of cardiovascular diseases, cancers, hypoglycemic, and so on (Lansky and Newman, 2007 ; Viuda-Martos *et al.*, 2010; Derakhshan *et al.*, 2018). Pomegranate peels contains different sources of phytochemical compounds such as testosterone, tannic acids, α -estradiol, estrone, estriol, pelargonidin 3-glucoside, cyanidin3,5-diglucoside, cyanidin 3-glucoside, delphinidin 3-glucoside and pelargonidin 3,5diglucoside (Mehrizi *et al.*, 2017).

Pomegranate (*Punica granatum* L.) peel, a by-product of juice processing industries was reported to contain a series of bioactive compounds, fibers and minerals for a wide range of dietary requirements (Mirdehghan and Rahemi, 2007). The waste fraction of *Punica granatum* L. showed high levels of total phenolic concentration (160.70 μ g of gallic acid equivalent / mg extract) in comparison to seeds and juices in addition to its properties as promising source of tannin, flavonoid, and anthocyanin (Orak *et al.*, 2012), who demonstrated that the peel extracts include approximately 5.9-fold higher total phenol than juice extracts and seed extract includes 2.1-fold more total phenol than juice extracts. While the data of Total flavonoid (TFC) and DPPH scavenging activity showed that the peel extracts included approximately 12.4-fold higher than juice extracts, and seed extract include 13.4-fold more TF than juice extracts and peel extracts was found 23.4-fold higher than juice extracts and, in seed extract, 2.15-fold higher activity than juice extracts, respectively. Considering that peels are not consumed, rich

source of bioactive compounds is in these non-edible parts could be utilized for different purposes in the food industry such as development or enrichment of food products. (Mansour *et al.*, 2013). The aim of this research is to take advantage of the health and nutritional benefits of goat milk cream in the field of food industries and preserve it from oxidation by using pomegranate peel extract as a natural antioxidant with a study of the relationship between oxidative stability and antioxidant activity when used in making creamy biscuits.

Materials and Methods

Materials

Pomegranate fruits were obtained from the local market of Sharkia, Egypt. Then pomegranate peels were removed carefully with a knife. Peels were washed thoroughly with distilled water. The pomegranate peel samples were dried at room temperature, dried peels were ground to a fine powder, then the powder stored in plastic bags in a refrigerator until use.

Preparation of pomegranate peel extract (PPE)

The pomegranate peels (100 g) were extracted by distilled water (1000 ml) in an ultrasonic water bath; extract was made at 40 kHz frequency, during extraction samples were refluxed for one hour. The extract filtered and the residue was again refluxed for an additional 1hr. All the extracts were pooled and centrifuged. The supernatant obtained was concentrated by rotary evaporator under vacuum at 45°C to obtain the cured extract. The extract was stored in a refrigerator freezer (-18 °C) until used for further analysis.

High Performance Liquid Chromatography (HPLC) analysis of phenolic compounds in pomegranate peel extract

Phenolic compounds in peel extract were identified by HPLC was estimated using the method proposed by Safdar *et al.* (2017). Chromatographic analysis was carried out using Agilent 1260 series (Agilent Technologies/Hewlett Packard, Waldbronn, Germany). The analysis was achieved on Column C 18: Shodex C18 (250mm x 4.6 mm). The mobile phase consisted of a linear gradient with a combination of solvent A (acetonitrile) and solvent B (distilled water/acetic acid, 99:1). The following gradient program was used for the separation of phenolic acids: 20% A (5 min), 80% A (10 min), 20% A (5 min). The analyses were conducted at a flow rate of 1 mL/min with the UV detector set at 280 nm for phenolic acids and a sample injection volume of 10 mL. The analytes were identified by comparing the retention times and spike samples with polyphenol standards and subsequent quantification of phenolic compounds were determined.

Production of cream biscuits

The formula of basic biscuit cream was as follows: wheat flour, 100 g; ghee (goat's cream was obtained from goat milk by milk separator), 41.03 g; lecithin, 0.54 g; sugar, 50.74 g; milk powder, 7.13 g (Manley, 2000) with slightly modified. The shortening was agitated intensively by hand-mixer, so that it became soft. Then the melted shortening was added with other ingredients and mixed thoroughly again. The product was smooth without any grittiness. Cream biscuits were prepared in the two treatments. The first treatment as control samples was prepared without addition a natural antioxidant (PPE). The secondary treatment was

prepared by adding PPE at 3 different levels: 0.5%, 1%, and 2% (lipid weighs basis).

Antioxidant properties of goat's cream and cream biscuits

Radical Scavenging Activity (RSA/DPPH)

The free radical scavenging activity of the extracts, based on the scavenging activity of the stable 1,1-diphenyl-2-picrylhydrazyl (DPPH) free radical, was determined by the method described by Huang *et al.* (2005). A final concentration of DPPH solution was prepared by dissolving in methanol (0.15 mM) in methanol. DPPH solution (3.9 ml) was mixed with sample solution (0.1 ml). The mixture was kept in the dark at ambient temperature. The absorbance of the mixtures was recorded at 515 nm for exactly 30 min. Blank was made from 3.9 ml of DPPH and 0.1 ml methanol and measured absorbance at t=0. The scavenging of DPPH was calculated according to the following equation (Liyana-Pathirana and Shahidi, 2007):

$$\% \text{ DPPH scavenging} = (\text{Abs } t=0 - \text{Abs } t=30) / \text{Abs } t=0 \times 100$$

where

$$\text{Abs}(t=0) = (\text{absorbance of DPPH radical} + \text{methanol}) \text{ at } t = 0 \text{ min}$$

$$\text{Abs}(t=30) = (\text{absorbance of DPPH radical} + \text{phenolic extracts}) \text{ at } t = 30 \text{ min.}$$

Total phenolic content (TPC)

Total phenolic content was determined according to the method of Chiremba *et al.* (2009). To measure the total phenolic content about 2 g of the each sample were homogenized and extracted in acidified methanol (1% conc. HCl in methanol, v/v). Centrifuged extracts were reacted with Folin Ciocalteu phenol reagent and sodium carbonate (20%, w/v) the mixture was allowed to stand for 2 h. Then the absorbance at 760 nm was determined. Gallic acid was used as standard, the data were expressed as mg gallic acid equivalents (GAE)/ g dry weight.

Total flavonoid content (TFC)

The flavonoids content was estimated by the method of Chang *et al.* (2002) using rutin as a reference compound. The extracts (0.5 ml) were mixed with 1.5 ml of 95% ethanol, followed by 0.1 ml of 10% aluminum chloride, 0.1 ml of 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 a UNICO UV/VIS-2100A spectrophotometer (Dayton, USA). The flavonoid content was calculated using a standard calibration of rutin solution and expressed as micrograms of rutin equivalent (RE) per gram of sample.

Chemical composition of cream biscuits

Moisture, fat, ash, crude fiber and protein of samples were determined according to A.O.A.C. (2005). All analyses were carried out in triplicates and the average was expressed. Total carbohydrates content was calculated by difference.

Physical measurements of cream biscuits

For the determination of diameter (width), thickness and spread factor methods of A.A.C.C. (2000) were followed. Diameter (W) of biscuits was measured by laying six biscuits edge-to-edge with the help of a scale. The same

set of biscuits was rotated 90° and the diameter was remeasured. Average values of biscuits were reported in millimeter. Thickness (T) of biscuits was measured by stacking six biscuits on top of one another and taking the average in millimeter. The spread ratio was calculated by dividing diameter (W) by thickness (T).

Color intensity measurements of cream biscuits

Using a Hunter colorimeter (Hunter Associates Laboratory Inc., Reston, USA), color intensity was measured and expressed as the L*, a* and b* values, where L* represents lightness of color, a* represents red (positive value), and green color (negative value), while b* defines the proportion of yellow (positive value) or blue color (negative value). The above-mentioned analysis was carried out in 3 replicates (Morales and Jiménez-Pérez, 2001). The chroma (C) represents color saturation or purity was calculated from $C = (a^2 + b^2)^{1/2}$ and total color intensity $(a^2 + b^2 + L^2)^{1/2}$.

Oxidative stability of cream biscuits

The lipids of cream biscuits were extracted by soxhlat apparatus. The solvent was removed by evaporation under vacuum condition onto the rotary evaporator, after that separation of lipid fraction. Stability of the biscuits lipids fraction was followed periodically after 0, 15, 30, and 60 days storage by determining the peroxide value (PV) according to AOAC (2005) methods.

Sensory evaluation of cream biscuits

Biscuit samples were analyzed for sensory characteristics according Baljeet *et al.* (2010). Sensory quality characteristics were evaluated by a panel of 10 semi-trained members using a 9-point Hedonic scale. The biscuits were evaluated for their taste, color, flavor, texture, appearance, and overall acceptability.

Statistical analysis

The data obtained in this study were expressed as the mean of triplicate determinations. Statistical comparisons were made with Duncan's test which were analyses with SPSS (SPSS for Windows, Version Rel. 18., SPSS Inc.). P values <0.05 were considered to be significant.

Results and Discussion

Phenolic compound in pomegranate peel extract (PPE)

The previous results presented in Table (1) Fig (1) confirmed that pomegranate peel extract exhibited the highest amount of total phenolic acids., HPLC analysis was carried to identify major phenolic compounds in pomegranate peel extract. Nine phenolic compounds (gallic acid, ellagic acid, chlorogenic acid, syringic acid, naringenin acid, coffeic acid, caffeine, propyl gallate and cinnamic Acid) were found pomegranate peel extract. PPE had the highest contents of Gallic acid, Ellagic acid and chlorogenic acid, which were, 7764.06, 2799.67, 2135.87 µg/g respectively.

Table 1 : Major phenolic compounds (µg/g) identified in the pomegranate peel extract by HPLC.

Phenolic compounds	Gallic acid	chlorogenic acid	caffeine	Coffeic acid	Syringic acid	Ellagic acid	Naringenin	Propyl Gallate	Cinnamic acid
Conc. (µg/g)	7764.06	2135.87	22.6	89.51	264.45	2799.67	134.01	22.35	13.75

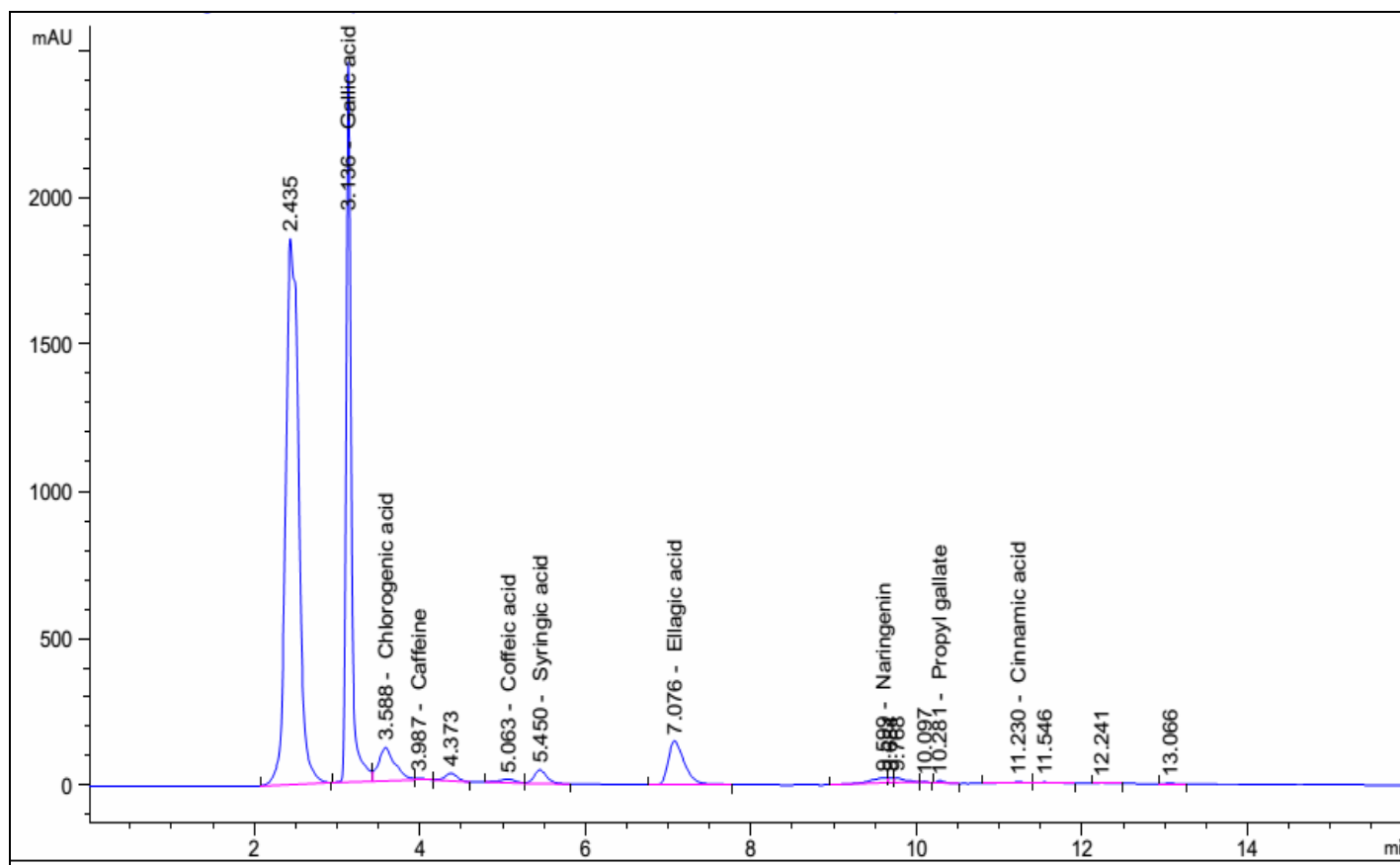


Fig. 1 : HPLC chromatograms of phenolic compounds in pomegranate peel extract

Antioxidant properties of goat's cream and cream biscuits

The antioxidant properties of all samples goat cream and biscuits were analyzed using the RSA/DPPH, TPC and TFC tests, the results of antioxidant properties abbreviated in Table 2 and Fig. 2.

The influence of supplementation of PPE to goat cream at different levels of antioxidant properties is depicted in Fig. 2. The antioxidant activity was determined by RSA/DPPH inhibition assay and the results are expressed in % inhibition. The radical scavenging activity of the goat cream increased steadily with continuous increase in PPE supplementation. The DPPH radical stabilizing activity of the goat cream supplemented with 0.5-2% PPE was 63.33 to 78.66 %, significantly superior to the control goat cream (28.33%). The possible reason for the increase in antioxidant activity might be contributory of antioxidant compounds by PPE supplemented during goat cream preparation. The findings of this study indicated that there were significant increases in total phenolic content for the control and supplemented goat cream samples by PPE (Fig. 2). The TPC it was increased from 23.66 to 31.55, 40.40 and 45.500 mg (GAE)/g of sample for control goat cream and with the addition of 0.5%, 1% and 2% of PPE, respectively. Maximum total flavonoid content was found to be increased from 52.96 μg (RE)/g of control goat cream to 179.72 μg (RE)/g for goat cream containing 2% PPE. Supplement of goat cream with various levels of PPE significantly ($P \leq 0.05$) increased contents of antioxidant properties by different antioxidant measured.

Antioxidant properties of biscuits were presented in Table 2. Data obtained from the study revealed an attractive antioxidant activity for pomegranate peel. The supplemented PPE in biscuit cream led to significant differences ($P \leq 0.05$) among the samples in DPPH, TPC and TFC. The antioxidant activity of biscuits supplemented with (0.5, 1 and 2%) PPE was assayed using the DPPH radical scavenging activity. The high antioxidant activity was 38.66 % of supplemented 2% of PPE treatment. The percentage of DPPH radical scavenging activity in biscuits samples were (27.33 and 35.33%) for supplemented (0.5 and 1%) of PPE, respectively., when the control sample was 21.00 %. The data indicate that the ability to scavenge free radicals was increased with the increasing supplemented percentage of PPE compared with control

samples. The results agree with Paul and Bhattacharyya, (2015) when they used pomegranate peel as a natural source of antioxidant in cookies, they observed the radical scavenging activity in cookies enriched with pomegranate peels was significantly improved, probably as a result of a presented of less polar phytochemicals.

The influence of different levels of PPE of the total phenolic content of biscuits samples was shown in the same table. TPC increased with increasing PPE concentration. It increased from 18.39 mg/g for control biscuit samples to 25.00, 31.12 and 38.81 mg/g for supplemented biscuits at levels 0.5, 1 and 2% PPE, respectively. These increased levels of TPC might have helped to improve the antioxidant properties and shelf life of biscuits samples. Similar results were obtained by Tharshini *et al.* (2018) who reported that the higher polyphenol content showed after adding pomegranate peel powder to bread product. Flavonoid the more common group of phenolic compounds that was found in all plant parts. The TFC content of biscuits supplemented at 2% was much higher than those prepared from 0.5 and 1% levels added. There was a prominent increment in TFC by 58.67, 60.64 and 67.611 μg /g with supplement by 0.5, 1 and 2% respectively. The rise in TFC levels was due to the addition of PPE at varying concentration of goat cream. Generally, PPE as a food industry by-product is recommended to be used as food additives to gain health benefits and technological quality.

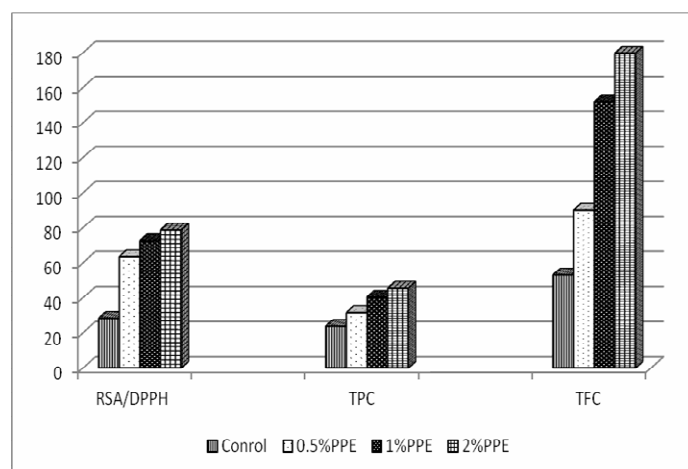


Fig. 2 : The antioxidant properties of goat cream supplemented with (PPE) as natural antioxidant

Table 2 : The antioxidant properties radical scavenging activity, total phenolic and total flavonoid contents of goat cream biscuits

TFC μg (RE)/g	TPC mg(GAE)/g	RSA /DPPH %	Cream biscuits samples
41.99 ^c	18.39 ^d	21.00 ^d	Control
58.67 ^b	25.00 ^c	27.33 ^c	0.5%
60.64 ^b	31.12 ^b	35.33 ^b	1%
67.61 ^a	38.81 ^a	38.66 ^a	2%

Results are mean, n =3; Values within a column with different superscript letters are significantly ($p < 0.05$) different. RSA/DPPH- Radical scavenging activity%; TPC- Total phenolic content as mg of gallic acid equivalent/g; TFC- Total flavonoid content as rutin equivalent/g.

Chemical composition of cream biscuits

The proximate chemical composition of biscuits with supplemented (0.5, 1 and 2%) of pomegranate peel extract as a natural antioxidant was presented in Table 3. The samples of biscuits with supplemented (0.5, 1 and 2%) of PPE led to increase the percentage of ash and crude fiber. The ash content of biscuit supplemented with PPE did not increase considerably, but there was a maximum increase of 2.55 % in

biscuit cream supplemented with 2% PPE. The crude fiber of biscuit cream supplemented with PPE by 0.5, 1 and 2% increased by 1.51, 1.63, and 2.82 % respectively. The increase in ash and crude fiber content might be mainly due to the addition of PPE in varying composition. Our results are in agreement with the findings of Sayed-Ahmed (2014) who mentioned that the significant increases of ash and fiber content were observed in the different levels of pomegranate

peel powder supplemented bread compared with the control bread sample. A negligible reduction in fat contents of supplemented biscuits, increasing supplemented ratios was not statistically significant on percentage of fat. Addition of PPE increased the moisture content of biscuits in comparison

with control samples. The moisture, ash, fat, protein, crude fiber and carbohydrates of 2% PPE supplemented were 4.97, 2.55, 18.72, 6.32, 2.82 and 64.60 respectively compared with control sample Table 3.

Table 3 : The chemical composition of goat cream biscuits

carbohydrate*	Crude fiber	Protein	Fat	Ash	Moisture	Cream biscuits samples
66.30 ^a	0.92 ^c	6.65 ^a	19.83 ^a	1.51 ^b	4.76 ^d	Control
64.30 ^b	1.51 ^b	6.04 ^b	19.15 ^a	2.25 ^a	6.71 ^a	0.5%
64.92 ^a	1.63 ^b	6.60 ^a	18.72 ^a	2.49 ^a	5.61 ^b	1%
64.60 ^b	2.82 ^a	6.32 ^{ab}	18.72 ^a	2.55 ^a	4.97 ^c	2%

*Percentage of carbohydrate was calculated by difference. Results are mean, n =3; Values within a column with different superscript letters are significantly (p < 0.05) different.

Physical measurements of cream biscuits

Table (4) presents the results of physical properties such as diameter, thickness and spread factor for biscuits samples. The data revealed that there were slightly significant differences in all samples and control biscuit. The mean values diameter of control biscuit was 59.85 mm, whereas that of supplemented biscuits varied from 60.50 to 66.30 mm for PPE at 0.5-2% levels. A statistical analysis by ANOVA revealed that there were significant differences in all samples and control of diameter except supplemented level 0.5% of

PPE treatment. On the other hand, the mean values thickness of control biscuit was 6.91 mm and three other supplemented levels, it ranged from 6.77 to 7.61 mm. There were no significant differences in all samples and control of spread factor were reached to 8.65, 8.92, 8.79 and 8.70 at control samples, 0.5%, 1%, 2% PPE, respectively. Generally, the data concluded that the supplemented biscuits with 2% of the PPE improved all studied the physical properties in all the biscuit samples compared control.

Table 4 : The physical properties of goat cream biscuits.

Spread factor (D/T)	Thickness (mm)	Diameter (mm)	Cream biscuits samples
8.65 ^a	6.91 ^{bc}	59.85 ^c	Control
8.92 ^a	6.77 ^c	60.50 ^c	0.5%
8.79 ^a	7.17 ^b	63.03 ^b	1%
8.70 ^a	7.61 ^a	66.30 ^a	2%

Results are mean, n =3; Values within a column with different superscript letters are significantly (p < 0.05) different.

Color intensity measurements of cream biscuits

The color determined by measuring L*, a* and b* values represents lightness, redness and yellowness respectively, of biscuits samples are outlined in Table (5). The control biscuits illustrated highest L* values which reduced steadily with increasing PPE levels. The a* and b* values indicating increased redness and yellowness with the increasing incorporation of PPE in the fat formula of biscuits. The decline in whiteness while a rise in redness may be attributed to increase in pigments and antioxidant compound in the concentrated pomegranate extract. The chroma

parameter represents the color saturation of biscuits, i.e. indicates the intensity or purity of a color relative to white (Batista *et al.*, 2016). The biscuits with PPE had a more saturated color. Hue angle gives a numerical estimate of the color of the biscuits. The hue sequence on a CIELAB diagram is defined with red-purple (0°), yellow (90°), bluish-green (180°) and blue (270°) (McGuire, 1992). As for hue angle°, the values ranged from 80.42° to 81.21°. Increase in hue angle values was observed according to the increase of PPE concentration, with the biscuits becoming more redness/yellowness.

Table 5 : The color parameters of goat cream biscuits

Hue angle	Chroma	b*	a*	L*	Cream biscuits samples
80.98 ^{ab}	20.32 ^d	20.07 ^c	3.18 ^c	75.25 ^a	Control
80.58 ^{ab}	20.96 ^c	20.68 ^c	3.43 ^c	70.20 ^b	0.5%
81.21 ^a	24.90 ^b	24.61 ^b	3.80 ^b	67.35 ^c	1%
80.42 ^b	25.24 ^a	24.89 ^a	4.20 ^a	65.68 ^c	2%

Results are mean, n =3; Values within a column with different superscript letters are significantly (p < 0.05) different. L*: lightness; a*: redness; b*: yellowness.

Oxidative stability of cream biscuits

The PV method is probably the mostly used one and measures concentration of peroxides formed from fatty acids oxidation. Because of the unstable of peroxides PV is an approximate indicator of state of oxidation but particularly in the early stage of oxidation it serves as a good tool for the

measurement of degree of oxidation (Mildner-Szkudlarz *et al.*, 2009). The peroxide value (PV) taste was performed to determine lipid peroxidation of biscuits at zero time and after 15, 30 and 60 days (Fig 3). Results showed that significant decreases were found in PV means value for biscuits with increased the supplemented PPE levels in fresh and during storage periods. Lipid peroxidation of biscuit samples of 2%

supplemented at storage periods 0, 15, 30 and 60 days were found 0.68, 0.97, 1.28 and 1.60 O₂ meq/kgoil respectively. The mean values of PV after 60 days of the biscuits samples supplemented at 0.5, 1 and 2% PPE were reached 2.59, 2.25 and 1.60 O₂ meq/kgoil as compared to the control 5.47 O₂ meq/kgoil. The results concluded that the supplemented lipid fraction of biscuit formulation with PPE was improving the oxidation stability of biscuit products. Table 6 shows the correlation coefficient (R) of the oxidative stability and antioxidant properties. The values revealed that the significant negative correlations (R values ranged from -0.786 to -0.992) were observed between peroxide value during different storage periods and antioxidant properties, indicating the significant contribution of antioxidant activity for PPE to enhanced oxidation stability for biscuits samples. The lower means of peroxide values indicates the delay in oxidation of lipid fraction in biscuits, and thus the delay in the deterioration of the biscuits samples, due to the natural antioxidant supplemented PPE.

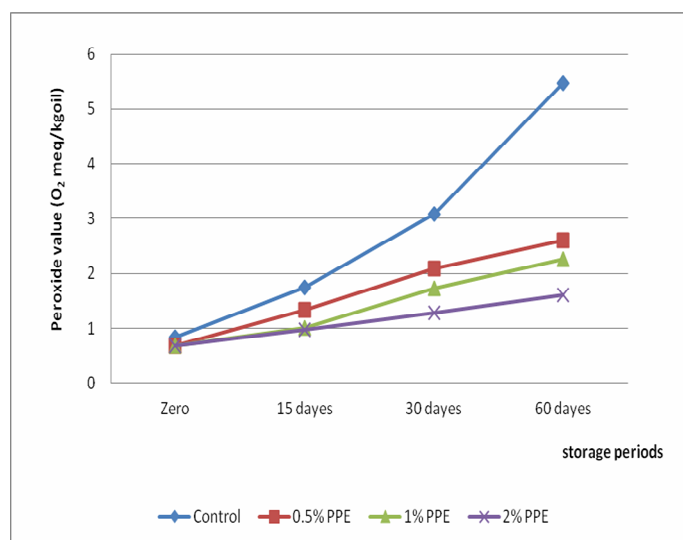


Fig. 3 : Oxidative stability of goat cream biscuits during different storage periods

Table 6 : Correlation coefficients (r) of antioxidant properties radical scavenging activity, total phenolic content, total flavonoid content and oxidative stability for goat cream biscuits.

Oxidative stability	Antioxidant properties		
	DPPH	TPC	TFC
peroxide value at zero time	-0.825	-0.786	-0.947
peroxide value after 15 days	-0.957*	-0.936	-0.954*
peroxide value after 30 days	-0.969*	-0.966*	-0.992**
peroxide value after 60 days	-0.911	-0.894	-0.992**

*. Correlation is significant at the 0.05 level (2-tailed).

**. Correlation is significant at the 0.01 level (2-tailed).

Sensory evaluation of cream biscuit

The sensory scores of the biscuits samples were presented in Table 7. Biscuits prepared from 1% PPE supplemented were rated high in color, texture and overall acceptability with significant difference ($p < 0.05$) as compared to control and different supplemented levels. Mean values of taste for the different biscuits samples ranged from 8.42 to 8.22 for control and 1% PPE supplement, respectively. From the study results, it was also concluded

that there were no significant differences in taste and flavor scores for all samples. The mean values of texture varied from (8.31 to 7.52). Control samples were the least texture scores. While, the control samples were the higher appearance score than all other biscuits samples. Finally, it could be concluded that PPE could be utilized in improving antioxidant properties for biscuit products without affecting on sensory characteristics or consumer acceptability.

Table 7 : Sensory characteristics of biscuits supplemented with antioxidant goat cream (AGC).

Overall acceptability	Appearance	Texture	Flavor	Color	Taste	Cream biscuit samples
7.28 ^b	8.42 ^a	7.52 ^b	8.53 ^a	7.74 ^b	8.42 ^a	Control
7.37 ^b	7.63 ^b	8.22 ^a	8.25 ^a	7.82 ^b	8.48 ^a	0.5%
8.48 ^a	7.74 ^b	8.31 ^a	8.22 ^a	8.53 ^a	8.22 ^a	1%
7.17 ^b	7.82 ^b	7.73 ^b	8.09 ^a	8.42 ^a	8.31 ^a	2%

Results are mean, n =10; Values within a column with

Conclusions

Goat milk has been distinguished as a feasible option for consumers that are delicate to cow milk, there is an expanding interest in goat milk due to an inherent biochemical characteristic that contribute to nutritional quality. Fat composition is one of the most important components of nutritional and technological property in goat milk due to their high health benefits. The natural antioxidant compounds can protect the goat cream reactions during manufacturing or storage of food products with supplemented. The result can conclude it the radical scavenging activity of the goat cream increased steadily with

continuous increase in PPE supplementation. The TPC it was increased from 23.66 to 45.50mg (GAE)/g for control sample and 2% PPE. Maximum total flavonoid content was found 179.72 μ g (RE)/g for goat cream containing 2% PPE. Sensory evaluation of the biscuit cream showed that PPE supplemented seemed to be more accepting of biscuit cream. This study is the potential to provide a goat cream biscuit product with specific beneficial properties for human nutrition. Therefore, PPE supplemented for lipid fraction in cream biscuits recipe could be recommended to be produced as cream biscuits with acceptable sensory attributes as well as enhancing their oxidative stability.

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