The Effect of Pomegranate and Red Grapes Fruits By-products as Antioxidants on Storage Stability and Quality of Chicken Thigh Mince

Abou-El Naga, F.M.M., Shaltout, O.E., El-Difrawy, E.A. and Abou El-Yazeed, A.M.
Food Science Dept. Faculty of Agriculture (Saba Basha)

ABSTRACT: The objective of this study was to investigate the effect of two concentration of pomegranate fruit by-product powders (rind "PR" and seeds "PS") and red grapes by-product (seeds "GS" and skin "Gk") at 2 and 4%, as antioxidants when incorporated to chicken thigh mince and frozen stored at –18°C for 3 months. The proximate chemical composition of raw chicken thighs, pomegranate and red grapes by-products as well as the total phenolics of the later were determined. The pH, peroxide values (PVs), 2-Thiobarbaturic acid reactive substances (TBARS), cooking loss and sensory attributes were monitored monthly for 3 months of storage at –18°C. Results indicated that total phenolics of pomegranate rind powder (PR) exceeded that of PS being 118 mg/mL and 7.4 mg/mL as tannic acid equivalent, respectively. Total phenolics of GS powder was twice that of GK being 4.3 and 2.1, mg/ mL gallic acid, respectively. Results showed that 4%. PR and 2% GS and GK added to chicken thigh mince exhibited significant lower pH values ($P<0.05$) at the end of the frozen storage period. The PVs of added 2 and 4% PR and 2% GS and GK significantly ($P<0.05$) lowered PV of chicken mince than other treatments and control at the end of the storage period. TBARS at all levels of added pomegranate rind and seeds were significantly lower ($P<0.05$) than that of the control with no significant differences between them. The TBARS of added 2% GK, 4% GS and 2% GS were significantly lower than other treatments and the control at the end of the storage period. Data of cooking loss (CL%) showed that 4% PR and 4% GS exhibited the lowest cooking loss values. The organoleptic evaluation indicated that the addition of PS powder at 2 and 4% to chicken thigh patties registered significantly ($P<0.05$) higher sensory scores for various eating quality attributes. Meanwhile, 2 and 4% GK containing patties registered higher sensory scores and were significantly different ($P<0.05$) than all other treatments and control. Therefore, pomegranate and red grapes by-products at 2 and 4% can be used as a good natural antioxidant in minced chicken thighs to improve its quality during frozen storage.

Keywords: Chicken thigh mince, Pomegranate rind powder, Pomegranate seed powder, red grapes seed and skin powders, natural antioxidants, phenolics, lipid oxidation, sensory evaluation.

INTRODUCTION

Modern trends towards convenience foods have resulted in increased production and consumption of ground meat products (Devatkal and Naveena, 2010). Chicken meat and products are widely consumed all over the world. They have many desirable nutritional characteristics such as low lipid contents and relatively high concentrations of polyunsaturated fatty acids. However, a high degree of poly-unsaturation accelerates oxidative processes leading to deterioration in meat flavor, color, texture and nutritional value (Mielnick *et al.,* 2006).

Grinding of meat disrupt the integrity of muscle membranes and exposes lipid membranes to metal ions and facilitates the interaction of proxidant with unsaturated fatty acids resulting in generation of free radical and propagation of oxidative reaction (Asghar *et al.,* 1990).

Reduction of lipid oxidation during storage of meat and meat products can be accomplished with antioxidants. Synthetic antioxidants, have been successfully used to reduce the lipid oxidation induced changes in meat products. However, reports of adverse health effects on human and food industry of these synthetic chemicals have increased the resistance to use synthetic antioxidants (Sanchez-Alonso *et al.,* 2007).

The interest in the role of dietary antioxidants in human health has promoted research in the field of food science. Fruits are good sources of these bioactive and rich with polyphenolic compounds, which has their marketing strategies on antioxidant potency (Gonzalez-Molina *et al.*, 2009).

Waste products from processing of fruits and vegetables offer a practical and economic source of potent antioxidant that could replace synthetic preservatives (Naveena *et al.,* 2008a). The peel and seed fractions of some fruits have higher bioactivities than the pulp fractions (Guo *et al.,* 2003).

Pomegranate by products is an important source of bioactive compounds and has been used for folk medicine for many centries. It has been reported that it possesses scavenging activities against super oxide anions and inhibitory action on low density lipoprotein oxidation (Li *et al.,* 2006 and Guo *et al.*, 2003).
Grapes by-products contain significant amounts of phenolic compounds, mostly flavonoids (Mazza, 1995), they are also rich in dietary fibers (Bravo and Saura-Calixo, 1998) which have been reported to have beneficial effects on lipid metabolism and delaying lipid oxidation (Pazos *et al.*, 2005a and Pazos *et al.*, 2005b).

The potential use of different fruits as natural antioxidants in meat and meat products have been studied in the last decade i.e. cherry fruit (Britt *et al.* 1998) apple (Osada *et al.*, 2000) citrus fruit by products (Fernandez-Lopez *et al.*, 2004) green tea leaves (Bozkurt *et al.*, 2006) pomegranate (Naveena *et al.,* 2008a and Kinnow fruit by-product (Devatkal *et al.,* 2011).

The growing awareness and concern about the quality and safety of meat have led to numerous developments in meat preservation. Meat industry is increasingly seeking for natural solutions to minimize oxidative rancidity and extent the shelf life of meat products.

Little work has been focused on evaluating the effect of these plants when used as whole powder in formulations. The objective of the present study aims to investigate the antioxidant potential of some fruit by-products (pomegranate rind and seed powders and Red Romy grapes seeds and skin powders) incorporated with chicken thigh mince- in extending their shelf life and maintain the quality of meat during frozen storage at -18°C for 3 months.

MATERIALS AND METHODS

Materials

Twenty-five kg of Red Romy grapes and Twenty-two kg of mature pomegranate fruit (*Punica granatam*) were purchased from a local fruit market in Alexandria city, Egypt.

Twenty-five kilograms of chicken thighs were prepared from whole chicken in the chilling department of Carefour processing plant, Alexandria city, Egypt. Each chicken thigh weight ranged between (200-400 g).

Preparation of pomegranate and red grapes fruit by-products:

The grape seeds were separated manually, gathered and washed. The remaining pomace was squeezed using a manual squeezer which separated the juice from the skin. Mature pomegranate fruit were washed and cut manually to separate the rind and seeds. The obtained rind was then cut into small pieces using sharp knife. The separated portions from the grapes and pomegranate were sent to a processing plant for dehydrating fruit and vegetables (Agro Misr) located in Al-Rass EL-Soda Alexandria, Egypt. The separated portions from pomegranate (rind and seeds) and from grapes (skin and seeds) were dried at 60°C for 24 hrs in cabinets' compartment dryers. The dried portions were then ground to pass through 60 mesh sieve and stored in glass Kilnar jars at room temperature until analysis.

Preparation of chicken thighs and formulation

The chicken thighs were stripped from the skin and bones then minced through a 4 mm plate (National UK -G 20 NR, Japan). The chicken thighs mince was further divided into equal portions to be mixed with the natural ingredients (w/w) used as antioxidants in the present study as follows: a) 2 and 4% grape seeds powder (GS), b) 2 and 4% grape skins powder (GK), c) 2 and 4% pomegranates rind powder (PR), d) 2 and 4% pomegranates seeds powder (PS), e) 100% chicken thighs minced “control” (C).

The aforementioned percentages were adopted after Sanchez- Alonso *et. al.* (2007) with slight modification. The treatments were further divided for chemical and sensory evaluation, packed in polyethylene bags and displayed in a deep freezer at -18°C for 3 months frozen storage. Samples were periodically monitored for chemical and sensory evaluation on monthly basis.

Methods

Proximate chemical analysis:

The proximate chemical composition was determined in the samples of raw minced chicken and plant ingredients. The moisture content was determined by drying the minced samples in an oven at 105°C until a constant weight was obtained according to method 934.01 AOAC (1995). The crude protein content was determined by the micro-kjeldahl method 978.02 as described in AOAC (1995) using the conversion factor (6.25×N). The crude fat content was determined using Soxhlet apparatus as described by AOAC

(1995). The ash content was determined using a muffle -furnace at 550°C for 24 hrs (AOAC,1995). The aforementioned experiments were carried out in triplicates. Crude fiber content in the plant ingredients were determined according to (Egan *et al.,* 1981). The carbohydrate content in the plant ingredients was determined as Nitrogen Free Extract (NFE) calculated as follows NFE =100- (% moisture + % crude protein + % crude fat +% Ash +% fiber).

Total phenolics determination

Five grams of each of plant ingredient powder (pomegranate rind & seeds) and (grapes skin & seeds) were homogenized with 25 ml of 70% actetone and kept overnight for extraction at refrigeration temperature). Using the Folin-Ciocalteus (F-C) assay (Negi and Jayapraksaha, 2003). Suitable aliquots of extracts were taken in a test tube and the volume were made to 0.5 ml with distilled water followed by the addition of 0.25 ml sodium carbonate solution (20%). The tubes were vortexed and the absorbance recorded at 725 nm after 40 min. The amount of total phenolics was calculated as tannic acid equivalent for the pomegranate powders and as gallic acid equivalent for the grape powders from the calibration curve using 0.1 mg /ml of both standards.

Quality control analysis monitored during frozen storage:

pH determination

Ten grams of mined chicken samples blended with 90 ml distilled water were measured with a standard combined electrode attached to a digital pH meter (Metrohm 744, Metrohm Ltd., CH-g 101 Herisan, Switzerland) as described by Vareltzis *et al*. (1997).

Peroxide value (PV)

The peroxide value as an indicator of primary lipid oxidation was determined according to the method described in BSI (1976). The peroxide value was calculated after the equation:

Peroxide value (meq/kg) = $\frac{(V-V_0)T}{M} \times 10^3$

Where

V =volume of Sodium-thioulphate($Na_2S_2O_3$)

V_0 = Blank

T = Molarity of thiosulphate solution

M= Weight of fat by grams

Thiobarbituric acid reactive substances (TBARS) value

The TBARS as an indicator of secondary lipid oxidation was determined according to the method described by Tarledgis *et al*. (1960). Ten grams of chicken patties were marcerated with 50 ml water for 2 min and washed into distillation flask with 47.5 ml water then 2.5 ml of 4.0 N hydrochloric acid was added to bring the pH to 1.5, followed by an antifoaming preparation and a few glass beads. The flask was heated by means of an electric mantle so that 50 ml distillate was collected in 10 min from the time of boiling commences. Five ml of distillate was pipetted into a glass stopper tube, 5 ml TBA reagent (0.2883g/

100 ml of 90 percent glacial acetic acid) was added, stoppered, shaked and heated in boiling water for 35 min. A blank was prepared using 5 ml distilled water with 5 ml reagent, then the tubes were cooled in water for 10 min and measure by using a specterphotometer (Beckeman Du 7400, USA), the absorbance (D) was measured against the blank at 538 nm using 1cm cell
TBARS (as mg malonaldehyde/ kg sample) = 7.8 × D

Cooking loss

The cooking loss (CL %) for minced chicken were measured by weight difference before and after cooking to an internal temperature of 71.7°C (George and Berry, 2000).

Sensory evaluation

Chicken mince were shaped for sensory evaluation into patties of approximately 57±2 g. Patties were fried (using corn oil) for 2 min at each side at 180°C. Samples were served along with water and unsalted crackers to 5 trained member and specialist panel from the Dept. of Food Science Fac. Agric., Saba Basha, Alex., Egypt. Panelists were instructed to rinse with water and consume crackers after tasting each sample and relax for 20 to 30s before tasting the next samples. Empty cups were provided for expectoration of the samples (Kramer and Twigg, 1970). Sensory scores for colour, taste, odour, texture and overall acceptance were determined using a ten-point hedonic scale where 10= non detectable off flavour and 1= extreme off flavour; 10= typical cooked color and 1= faint colouration and 10= firm and juicy and 1= soft and fibrous for texture (IFT /SED,1981).

Statistical analysis

Data were subjected to ANOVA using the Generalized linear model procedures of SAS (SAS Institute, Inc., 2003). Differences among treatments were separated by Duncan multiple comparison tests at ($P<0.05$).

RESULTS AND DISCUSSION

Proximate chemical composition of chicken thigh

Mean values of the proximate chemical composition of chicken thighs are shown in Table (1). The moisture (71.27%), protein (16.61%), crude fat (10.09%) and total ash (2.04%) of the chicken thighs were quite comparable to those reported by Shaltout (2005). On the other hand, Giannenas *et al.* (2016) showed that the chemical composition of fresh minced chicken flesh contained 70.2% moisture, crude protein 20.1% fat 8.4% and 1.3% ash. The slight differences in the chemical composition may be due to the components of feed and age before slaughter (Fakolade, 2015).

Proximate chemical composition of dried pomegranate (rind and seeds) and red grapes (skin and seeds)

Table (2) shows that the mean values of moisture of all by-products used in the present study ranged between (6.14-9.10%) with no significant differences between them with the exception of pomegranate rind powder which exhibited a rather higher moisture as compared to the other by- products. The mean protein content of all studied ingredients ranged between (0.66-1.90%) with no significant differences between them except for grapes skin powder which exhibited the lowest protein content. The mean fat content ranged between (0.66-2.00%) where both red grapes skin and seeds exhibited the lowest values in this respect. The mean ash content showed significant differences ($p<0.05$) between the four ingredients where red grapes skin contained the highest value being 4.62%. The fiber content of all tested ingredients (Table 2) ranged between 1.79-4.35% where GS exhibited the highest fiber content and GK exhibited the least. It's worth mentioning that Sanchez-Alonso *et al.* (2008) reported that white grapes pomace are rich in both dietary fiber and total polyphenolic compounds. The nitrogen free extract was calculated by difference and ranged between 83.74-89.90%.

Table (1). Proximate chemical composition of minced chicken thighs minces

Components*	(%)
Moisture	71.27±0.73
Protein	16.61±0.38
Fat	10.07±0.40
Ash	2.04±0.07

* on wet basis % ** Means of triplicates ± S.D.

Table (2). Proximate chemical composition of dried pomegranate (rind and seeds) and red grapes (skin and seeds)

Parameters / Treatment	PR	PS	GS	GK
Moisture	9.10±0.22^{a}	6.50±0.01^{bc}	6.14±0.10^{c}	6.85±0.05^{b}
Protein	1.08±0.02^{a}	1.90±0.06^{a}	1.18±0.03^{a}	0.66±0.05^{b}
Fat	2.05±0.02^{a}	2.00±0.05^{a}	0.66±0.00^{b}	0.67±0.01^{b}
Ash	4.05±0.08^{b}	3.51±0.17^{c}	2.13±0.03^{d}	4.62±0.06^{a}
Fiber	1.88±0.18^{c}	2.76±0.31^{b}	4.35±0.20^{a}	1.79±0.13^{c}
Nitrogen free extract	83.74±0.14^{c}	86.93±0.19^{b}	89.90±0.12^{a}	87.35±0.16^{b}

Means with different superscript in raw or column are significantly different at $P<0.05$.
PR: Pomegranate rind powder. PS: Pomegranate seed powder.
GS: Grapes seed powder. GK: Grapes skin powder.

Total phenolic content of pomegranate rind and seeds

Total phenolic content of pomegranate rind (PR) and seeds (PS) powders are illustrated in Fig. (1). It can be seen that PR exhibited a high content of total phenol being 118 mg/ml as tannic acid equivalent compared to 7.4 mg/ml for pomegranate seeds (PS). Phenolic compounds are secondary metabolites products by the plants, are generally responsible for the antioxidant activity of many fruits and vegetables (Kanatt *et al.*, 2010). They are important molecules contributing to antioxidant and pharmacological properties (Labbé *et al.*, 2010). Most pomegranate fruit parts are known to contain higher polyphenolic compounds (Ozkal and Dine, 1994).

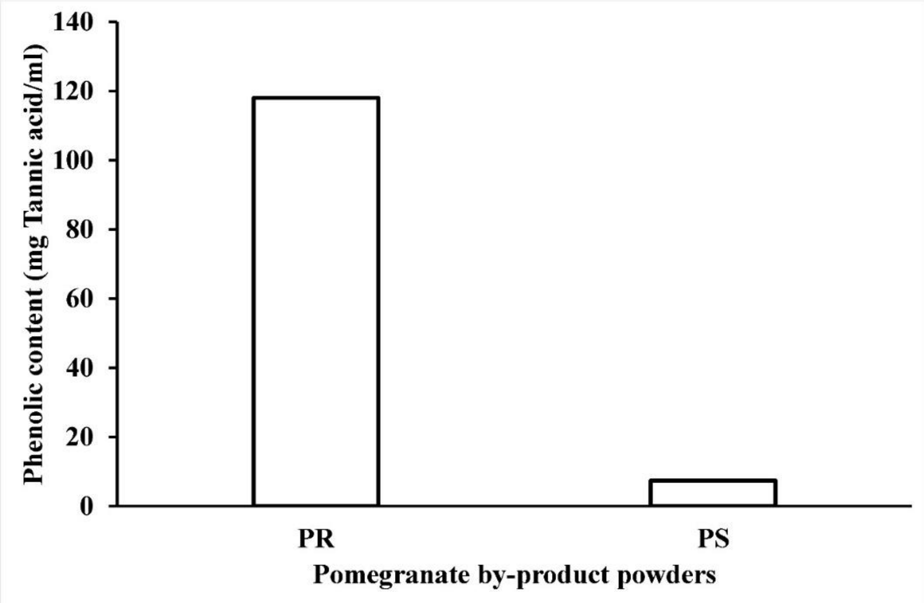

Fig (1). Total phenolic content (mg/mL) of pomegranate rind (PR) and seed (PS) powders

Pomegranate by-products (rind and seeds) have substantial amount of phenolic compounds and significant free radical scavenging activity (Devatkal *et al.*, 2010a). In spite of the high total phenolic content of PR, it was reported by Devatkal *et al.* (2010b) that PS demonstrated significant ($p<0.05$) greater free radical activity than PR. As a matter of fact, significant higher radical scavenging activity was observed by Naveena *et al.* (2008a) in pomegranate rind powder compared to pomegranate juice. The radical scavenging activity of the pomegranate fruit juice phenolic (PFJP) might be due to its hydrogen-donating ability of the phenolic hydroxyl groups, forming a stable end product that does not initiate or propagate further oxidation of lipids (Sherwin, 1976).

It was reported by Pin-Der (1998) that the reducing power of pomegranate rinds is generally associated with the presence of reductones. Gordon (1990) reported that the antioxidant action of reductones is based on the breaking of free radical chain by the donation of hydrogen atom. Reductones also react with certain precursors of peroxides thus preventing peroxide formation.

Total phenolic content of red grapes seeds and skins

Figure (2) shows the total phenolic content of red grapes seeds and skin (peel) powder. Results showed that grapes seeds powder is twice higher in pholyphenolic content than grapes skin, being 4.3 and 2.1 mg/ml as gallic acid aquivalent. It was reported by Sanchez-Alonso *et al.* (2008); Sáyago-Ayerdi *et al*. (2009a) that grape extract contains a wide range of polyphenols, however, its effectiviness is limited due to the fact that the grape extract used is composed of polyphenols which are hydrophilic. It was also reported by Sayago-Ayerdi *et al*. (2009b) that grape skin and seed pomace contain several flavonoids including (+) catechins, (–) epicatechin and procyanidins.

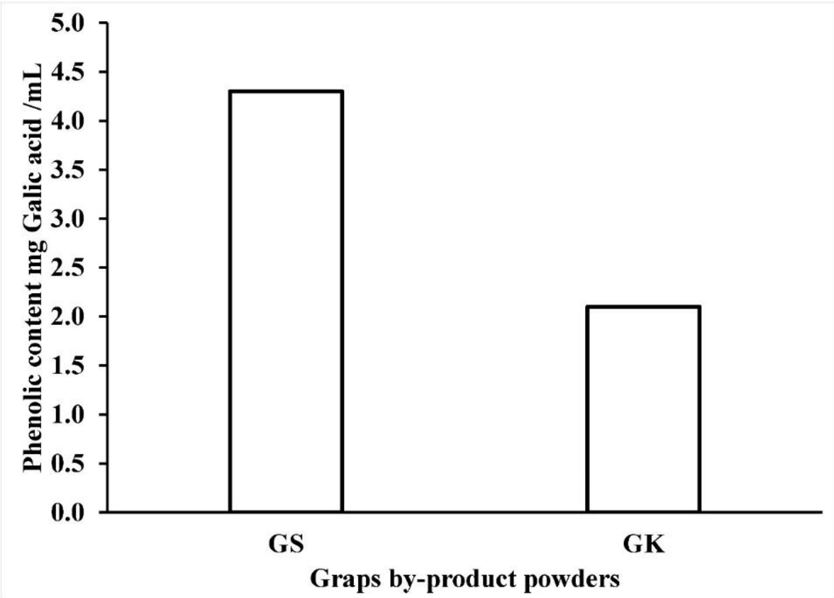

Fig. (2). Total phenolics content mg/ml of red grapes seeds (GS) and skin powders (GK)

It is believed that most polyphenols which remain in grape seed and skin pomace are hydrophobic, and thus may be very effective components to stabilize free radicals (Stamatis *et al*., 2001).

However, it was reported by Pastrana-Bonilla *et al.* (2003) that among the different parts of the grape plant, grape seeds exhibit the highest antioxidant activity followed by the skin and juice.

pH changes

pH value is considered as an important factor in the field of meat quality because of its influence on many characteristics, including shelf life, color, water-holding capacity and texture of meat and meat products (Clarke *et al*., 1988).

The mean pH values of minced chicken thighs with different levels of pomegranate rind (PR) and seeds (PS) are illustrated in Fig (3). As it can be seen, the overall mean pH values of the minced chicken thighs incorporated with 2 and 4% of PR and PS had significant ($p<0.05$) lower values than control. The pH decrease of the later treated samples could be attributed to the acidic and polyphenolic compounds in the pomegranate powder (Lansky and Newman, 2007). High meat pH is usually an indication of spoilage, hence it is important that meat reaches as low a pH as possible to ensure shelf-life stability (Jalosinska and Wilczak, 2009). The antibacterial activity of pomegranate by products may be due to the presence of tannins and phenolics (Devatkhal *et al.,* 2013).

Figure (4) shows the pH of frozen stored minced chicken thighs with added different levels of red grapes seeds and skins. Results indicated the

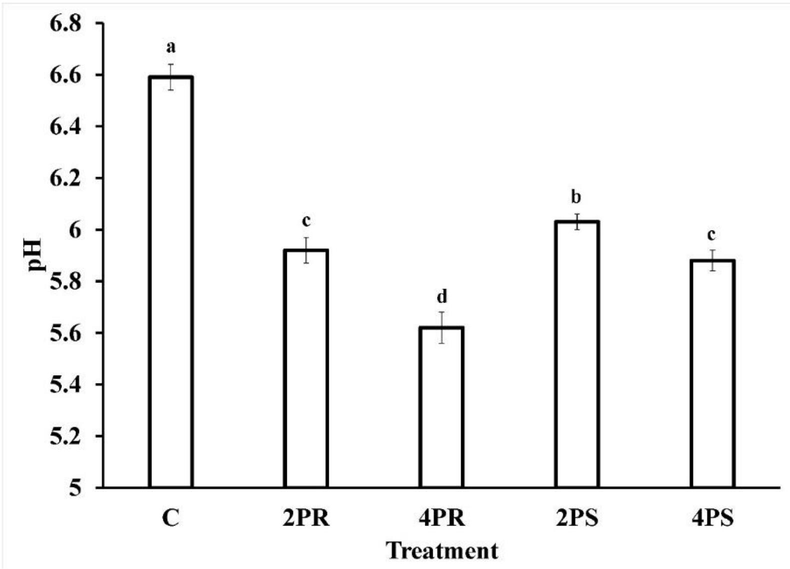

Fig. (3). Effect of different levels of pomegranate (rind and seed) powders on pH of frozen chicken mince. C: minced chicken thighs, 2PR: minced chicken thigh + 2% pomegranate rind powder, 4PR: minced chicken thigh + 4% pomegranate rind powder, 2PS: minced chicken thigh + 2% pomegranate seed powder, 4PS: minced chicken thigh + 4% pomegranate seed powder.

Means with different superscript differ significantly at ($P<0.05$)

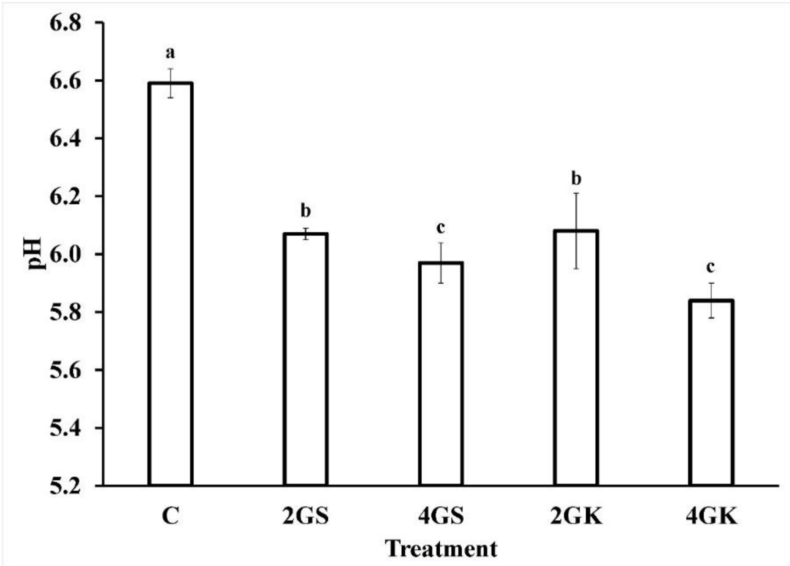

Fig. (4). Effect of different levels of red grapes seeds and skin on pH of frozen chicken mince thighs. C: minced chicken thighs, 2GS: minced chicken thigh + 2% red grapes seeds, 4GS: minced chicken thigh + 4% red grapes seeds, 2GK: minced chicken thigh + 2% red grapes seeds, 4GK: minced chicken thigh + 4% red grapes seeds.

Means with different superscript differ significantly at ($P<0.05$)

same trend as in treated minced chicken thighs with PR and PS. As a matter of fact, 4% grape seeds significantly lowered of the pH values than 2% ones. Meanwhile, all treatments were significantly lower than the control.

Changes in peroxide value

Lipid peroxidation is one of the main reasons for deterioration of food products during processing and storage. Fig (5) shows the effect of different added levels (2 and 4%) of pomegranate rind and seeds powder on peroxide value (POV) during frozen storage at –18°C for 3 months.

Results indicated that all treated samples exhibited low POV values as compared to control except for 2% pomegranate seed powder (5.26 meq/kg) which was greater than control (3.34 meq/kg) and all other treatments. As a matter of fact, as the level of added PS increased the POV decreased as compared to 2% PS and control. However, both added levels of PR significantly ($P<0.05$) lowered POV of minced chicken with no significant differences ($p<0.05$) between them and were less than both PS and control. It is well documented that pomegranate by-products (rind and seeds) have substantial amount of phenolic compounds and significant free radical scavenging activity (Devatkal *et al*., 2010b). However, the level of increase of the PV did not exceed the permissible levels known (10 meq/kg) with reference to the European pharmacopoeia and Norwegian Medicinal Standards. Thus, POV's for all treatments were in the acceptable range at the end of storage.

Figure (6) shows the PV of different levels of added red grapes (seeds and skin) to chicken meat mince. As a matter of fact, the high

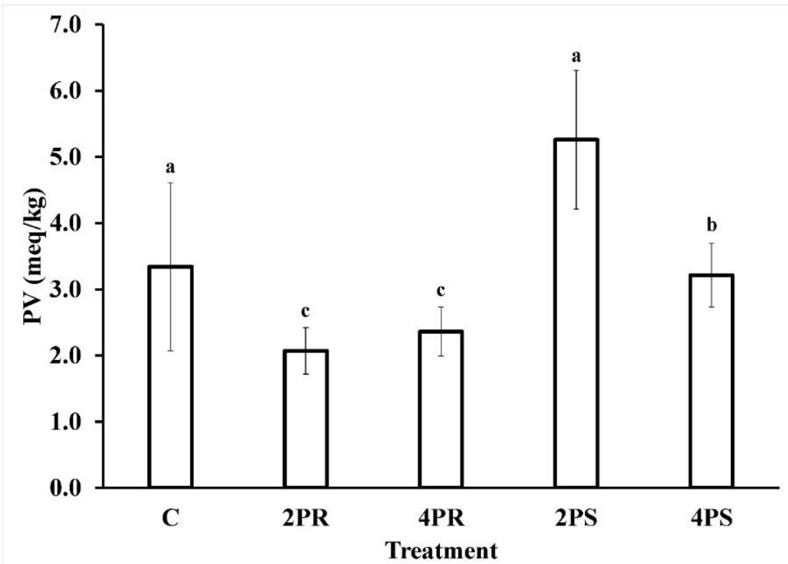

Fig (5). Effect of different levels of pomegranate rind and seed powder on PV of frozen minced chicken. C: minced chicken thighs, 2PR: minced chicken thigh + 2% pomegranate rind powder, 4PR: minced chicken thigh + 4% pomegranate rind powder, 2PS: minced chicken thigh + 2% pomegranate seed powder, 4PS: minced chicken thigh + 4% pomegranate seed powder.

Means with different superscript differ significantly at ($P<0.05$)

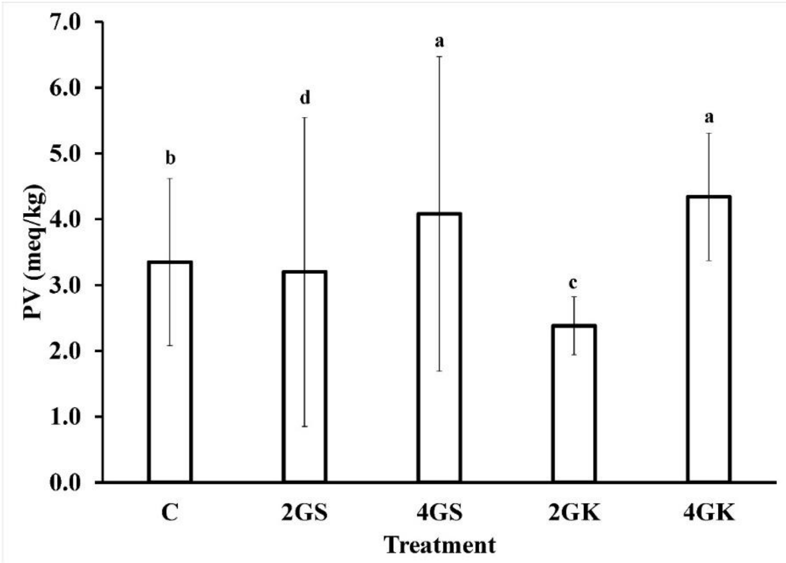

Fig (6). Effect of different levels of red grapes seeds and skin powder on PV of frozen minced chicken thighs. C: minced chicken thighs, 2GS: minced chicken thigh + 2% red grapes seeds, 4GS: minced chicken thigh + 4% red grapes seeds, 2GK: minced chicken thigh + 2% red grapes seeds, 4GK: minced chicken thigh + 4% red grapes seeds.

Means with different superscript differ significantly at ($P<0.05$)

level of addition (4%) of both seed and skin powder exhibited an increased level of PV being 4.08 and 4.34 meg/kg higher than both control and 2% level of addition. Results also showed that red grapes skin as 2% significantly difference in lowered PV than 2% grapes seed powder. The reason for this effect may be due either the chelating action of fibre on some prooxidant metals or the action of polyphenols associated with dietary fibre (Sanchez-Alonso *et al*., 2007).

TBARS values

TBARS values represent the content of secondary lipid oxidation products such as aldehydes, carbonyls and hydrocarbons which are considered to be responsible for the off flavors in meats.

Effects of pomegranate rind (PR), pomegranate seed (PS) powders on thiobarbituric acid reactive substances (TBARS) values in minced chicken meat are shown in Fig. (7). All treatments significantly ($p<0.05$) reduced the TBARS values throughout the frozen storage period as compared to control.

Also, the effect of red grapes seeds GS and skin GK on TBARS are shown in Fig. (8). Similarly, all treatments significantly ($p<0.05$) reduced the TBARS values as compared to control with no significant differences between them except for 4% GK which exhibited higher TBARS value. As a matter of fact, it can be observed from Figs. (7 & 8) that values of TBARS in minced chicken thighs with pomegranate rind and seed powders regardless the level of addition were

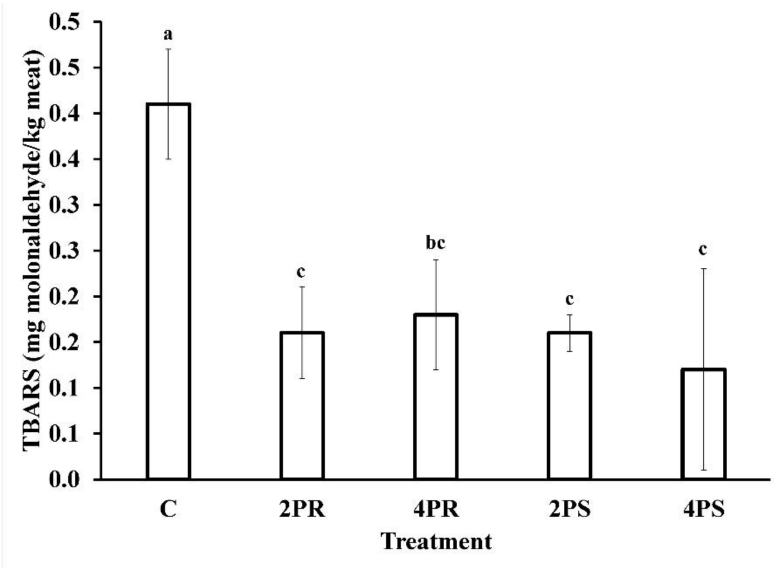

Fig (7). Effect of different levels of pomegranate rind and seed powder on TBARS of frozen minced chicken. C: minced chicken thighs, 2PR: minced chicken thigh + 2% pomegranate rind powder, 4PR: minced chicken thigh + 4% pomegranate rind powder, 2PS: minced chicken thigh + 2% pomegranate seed powder, 4PS: minced chicken thigh + 4% pomegranate seed powder.

Means with different superscript differ significantly at (P<0.05)

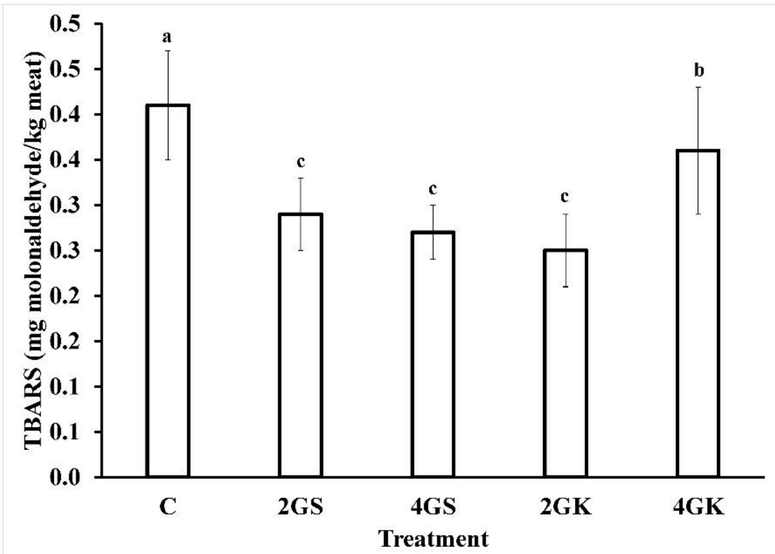

Fig (8). Effect of different levels of red grapes seeds and skins on TBARS of frozen minced chicken. C: minced chicken thighs, 2GS: minced chicken thigh + 2% red grapes seeds, 4GS: minced chicken thigh + 4% red grapes seeds, 2GK: minced chicken thigh + 2% red grapes seeds, 4GK: minced chicken thigh + 4% red grapes seeds.

Means with different superscript differ significantly at (P<0.05) significantly ($p<0.05$) lower than those of red grapes formulations. However, these values were below the acceptable limit of 1mg malonaldehyde per kilogram (Witte *et al*., 1970). This may be due to the large amount of phenolics contained in pomegranate which act as reductones by donating electrons and reacting with free radicals to convert them to more stable products and terminate free radical chain reactions. The results are in accordance with Naveena *et al*. (2008a & b).

It may be concluded that the TBARS values for the treated minced chicken thigh samples with pomegranate rind and seeds powder may have more substantial amount of phenolic compounds and significant free radical scavenging activity compared to red grapes seeds and skin and control.

Cooking loss

Mean cooking loss of minced chicken thighs with different levels of PR and PS are shown in Fig (9).

Data showed that samples with added 2 and 4% PR and PS showed a significant increase in the cooking loss as compared to control which exhibited the least cooking loss value being 29.36%. As a matter of fact, 4% PR exhibited the least cooking loss as compared to the other treatments and showed no significant difference ($p<0.05$) (28.95%)as the control. This result may be due to the effect of the high percent of pomegranate rind powder which have been responsible for binding water (Nagi *et al*., 1998).

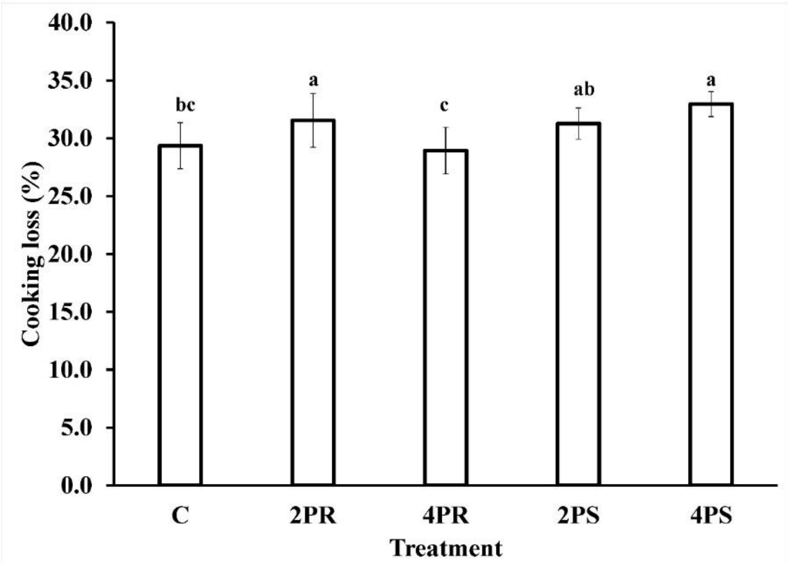

Fig (9). Effect of different levels of pomegranate rind and seed on cooking loss of frozen minced chicken thighs. C: minced chicken thighs, 2PR: minced chicken thigh + 2% pomegranate rind powder, 4PR: minced chicken thigh + 4% pomegranate rind powder, 2PS: minced chicken thigh + 2% pomegranate seed powder, 4PS: minced chicken thigh + 4% pomegranate seed powder.

Means with different superscript differ significantly at ($P<0.05$)

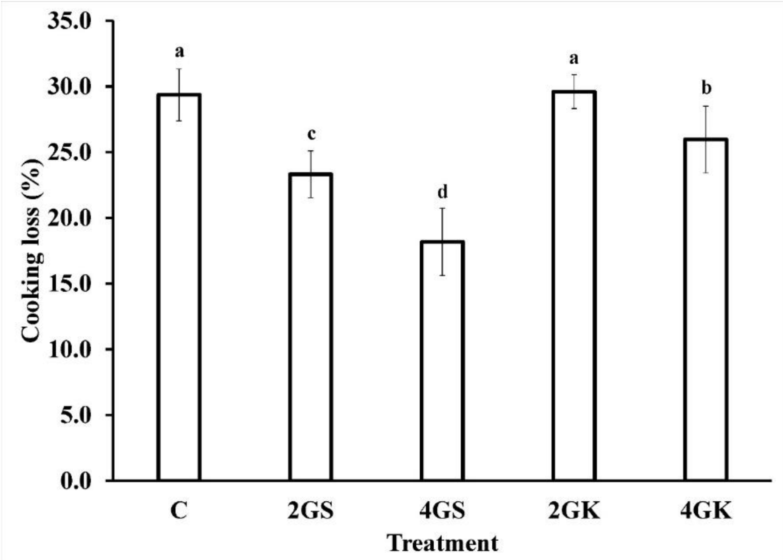

Fig (10). Effect of different levels of red grapes seeds and skins on cooking loss of frozen minced chicken thighs. C: minced chicken thighs, 2GS: minced chicken thigh + 2% red grapes seeds, 4GS: minced chicken thigh + 4% red grapes seeds, 2GK: minced chicken thigh + 2% red grapes seeds, 4GK: minced chicken thigh + 4% red grapes seeds.

Means with different superscript differ significantly at (P<0.05)

On the other hand, Fig (10) show the mean cooking loss of samples with different added levels of GS and GK. Results indicated a rather significant (p<0.05) decrease in all treated samples as compared to control except for 2GK which showed no significant difference with control. Results also showed that the 4% GS exhibited the least loss in this respect as compared to the other treatments and control. Thus it may be convenient to arrange the cooking loss of grapes seeds and skin powders descendingly as follows: C= 2GK > 4GK> 2GS> 4GS.

However, from Figs. (9 & 10) it might be seen that GS and GK obviously decreased the cooking loss of chicken thigh mince more than PR and PS. This may be due to the fiber content in the seed and skin powder which prevented shrinkage of restricted products during cooking (Borderia *et al*., 2005).

The increase in cooking loss might be attributed to moisture loss during storage. These findings were in agreement with Gibriel *et al*. (2007) and Babatunde and Adewumi (2015) who reported that the cooking loss progressively increased with prolonged storage period.

Sensory attributes of minced chicken patties with added pomegranate and red grapes by products during frozen storage

Table (3) shows the mean sensory scores of minced chicken thighs patties with different added levels of pomegranate rind and seeds powders during the course of frozen storage.

Table (3). Effect of different added levels of pomegranate rind and seed as natural antioxidant on sensory scores means of chicken patties frozen at –18°C for 3 months

Treatments	Storage period (months)				Treatment means ($\bar{x}$)
	0	1	2	3	
			Colour		
C	8.40±0.40	6.00±0.63	7.00±0.63	6.40±0.24	**6.42±0.25^{b}**
2PR	8.40±0.50	8.00±0.44	7.40±0.24	7.20±0.20	**7.75±0.20^{a}**
4PR	8.80±0.48	7.00±0.54	7.00±0.44	8.40±0.40	**7.80±0.28^{a}**
2PS	8.00±0.54	7.70±0.30	8.00±0.31	8.40±0.24	**8.02±0.17^{a}**
4PS	8.60±0.67	7.80±0.37	7.40±0.24	8.00±0.70	**2.94±0.25^{a}**
Time ($\bar{x}$)	**8.04±0.27^{a}**	**7.25±0.25^{b}**	**7.36±0.18^{b}**	**7.66±0.22^{ab}**	**—**
			Flavour		
C	6.40±0.67	5.16±0.16	7.60±0.50	7.00±0.44	**6.47±0.29^{c}**
2PR	8.20±0.20	8.00±0.44	8.00±0.00	7.80±0.20	**8.00±0.12^{b}**
4PR	8.80±0.37	7.20±0.48	8.20±0.20	7.40±0.24	**7.90±0.21^{b}**
2PS	8.50±0.40	8.80±0.48	8.40±0.50	9.40±0.24	**8.80±0.20^{a}**
4PS	8.60±0.67	8.60±0.60	8.00±0.63	9.50±0.28	**8.63±0.29^{a}**
Time ($\bar{x}$)	**8.12±0.27^{a}**	**7.46±0.32^{b}**	**8.04±0.18^{a}**	**8.16±0.24^{a}**	**—**
			Texture		
C	7.00±0.70	6.66±0.49	7.40±0.50	7.40±0.24	**7.09±0.24^{b}**
2PR	8.60±0.24	7.60±0.24	8.40±0.40	7.20±0.20	**7.95±0.18^{a}**
4PR	9.00±0.31	7.00±0.54	8.20±0.37	8.20±0.20	**8.10±0.23^{a}**
2PS	8.40±0.40	8.00±0.44	8.20±0.37	8.40±0.24	**8.25±0.17^{a}**
4PS	8.00±0.77	7.40±0.74	8.20±0.37	8.50±0.28	**8.00±0.29^{a}**
Time ($\bar{x}$)	8.20±0.25^{a}	7.31±0.23^{b}	8.08±0.18^{a}	7.91±0.14^{a}	—
			Over all acceptance		
C	7.20±0.48	5.66±0.49	7.20±0.00	6.80±0.48	**6.66±0.27^{b}**
2PR	8.60±0.24	7.50±0.24	7.60±0.00	7.60±0.24	**7.85±0.15^{a}**
4PR	8.60±0.24	7.40±0.40	7.80±0.00	8.20±0.37	**8.00±0.17^{a}**
2PS	8.60±0.50	8.20±0.58	8.20±0.00	9.00±0.54	**8.50±0.24^{a}**
4PS	8.80±0.73	8.00±0.63	8.20±0.00	9.25±0.47	**8.52±0.31^{a}**
Time ($\bar{x}$)	**8.36±0.23^{a}**	**7.31±0.27^{b}**	**7.80±0.19^{ab}**	**8.13±0.25^{a}**	**—**

* Means with different superscript in raw or column are significantly different at $p<0.05$.
C: minced chicken thighs.
2PR: minced chicken thigh + 2% pomegranate rind powder.
4PR: minced chicken thigh + 4% pomegranate rind powder.
2PS: minced chicken thigh + 2% pomegranate seed powder.
4PS: minced chicken thigh + 4% pomegranate seed powder.

The colour of the treated patties with 2 and 4% PR and PS showed that there no significant change during the course of frozen storage. The incorporation of different levels of pomegranate rind and seed powders, did not show any significant difference in the colour of the patties but were significantly different from the control samples.

As for the flavor, significant differences ($p<0.05$) were observed among the panelists where the 2 and 4% PS containing patties were highly scored as compared to the control and to the pomegranate rind patties. As a matter of fact, the pomegranate rind patties were significantly ($p<0.05$) highly scored by panelists as compared to control but was less acceptable in taste than PS containing patties. The increased flavor in PS might be due to the unique flavor of pomegranate powder imparted to the product and to the unique flavor of pomegranate exhibiting fruity ordors. This is in agreement with the findings of Ibrahim *et al.* (2012) who also observed higher scores for the flavor of beef patties incorporated with pomegranate rind and seeds.

Furthermore, the panelists highly scored the texture of all treated patty samples containing PR and PS which were significantly different from control but could not detect any significant difference among treatments.

As a matter of fact, the panelists highly accepted all the patties containing different levels of PR and PS with no differences between them but they were all significantly different than control which got the least score (6.66) whereas, all the other treatments ranged between (7.85–8.52).

Table (4) shows the sensory scores of patties with added GS and GK during the course of frozen storage. Results indicated that the highest scores for colour were given to those patties containing 2 and 4% of grapes skins, which were significantly different ($p<0.05$) from both grape seeds and control. As a matter of fact, the colour of both 2% and 4% GS containing patties and control possessed the least scores by the panelists with no significant differences between them. Results also showed that panelists still highly scored the flavour of 2 and 4% GK than 2 & 4 % GS and control. The former scores were 8.5 and 8.68, respectively with no significant differences between them.

Also it can be observed that, the texture scores of 2 and 4% GK were significantly higher than GS treatments and control being 8.50 and 8.68, respectively. This may be due to the high fiber content in grape & peels. The diatry fiber content might improve stability flavor and tenderness as it may supply texture, water-holding and avoid the loss of these sensorial attributes (Sayago Ayerdi *et al.,* 2009b).

Results of the overall acceptance clearly emphasized the fact that both 2 and 4% GK exhibited the best sensory attributed and the highest scores by panelists and were significantly higher than GS and control.

Table (4). Effect of different added levels of red grapes seeds and skin powders as natural antioxidant on sensory scores means of chicken patties frozen at –18°C for 3 months

Treatments	Storage period (months)				Treatment means ($\bar{x}$)
	0	1	2	3	
Colour					
C	6.40±0.40	6.00±0.63	7.00±0.63	6.40±0.24	**6.42±0.25^{c}**
2GS	7.20±0.86	7.20±0.58	7.00±0.54	6.40±0.40	**6.95±0.29^{bc}**
4GS	7.40±0.74	6.80±0.80	7.60±0.54	7.80±0.20	**7.40±0.29^{b}**
2GK	8.70±0.37	9.00±0.31	8.80±0.17	7.40±0.60	**8.35±0.24^{a}**
4GK	9.00±0.54	9.00±0.31	8.40±0.24	8.50±0.28	**8.73±0.18^{a}**
Time ($\bar{x}$)	**7.64±0.31^{a}**	**7.53±0.33^{a}**	**7.76±0.24^{a}**	**7.25±0.22^{a}**	—
Flavour					
C	6.40±0.67	5.16±0.16	7.60±0.50	7.00±0.44	**6.47±0.29^{b}**
2GS	7.40±0.50	7.20±0.58	7.20±0.37	6.60±0.24	**7.10±0.21^{b}**
4GS	7.20±0.66	5.80±0.58	8.00±0.44	7.00±0.63	**7.00±0.32^{b}**
2GK	8.40±0.50	8.60±0.50	8.80±0.37	8.20±0.20	**8.50±0.19^{a}**
4GK	9.00±0.31	8.40±0.40	9.00±0.31	8.25±0.25	**8.68±0.17^{a}**
Time ($\bar{x}$)	**7.68±0.29^{a}**	**6.96±0.33^{c}**	**8.12±0.21^{a}**	**7.37±0.21^{bc}**	—
Texture					
C	7.00±0.70	6.66±0.49	7.40±0.50	7.40±0.24	**7.09±0.74^{b}**
2GS	6.00±0.44	6.80±0.58	7.60±0.50	6.80±0.20	**6.80±0.24^{b}**
4GS	6.70±0.58	6.70±0.58	8.00±0.31	6.80±0.37	**6.80±0.26^{b}**
2GK	8.80±0.37	8.80±0.37	9.00±0.31	8.20±0.20	**8.70±0.16^{a}**
4GK	9.00±0.31	8.80±0.42	9.00±0.31	8.25±0.25	**8.78±0.16^{a}**
Time ($\bar{x}$)	**7.40±0.32^{b}**	**7.42±0.29^{b}**	**8.20±0.21^{a}**	**7.45±0.11^{b}**	
Over all acceptance					
C	7.20±0.48	5.66±0.49	7.20±0.58	6.80±0.48	**6.66±0.27^{b}**
2GS	6.60±0.60	6.80±0.80	7.00±0.31	6.20±0.20	**6.65±0.20^{b}**
4GS	6.80±0.48	6.80±0.80	7.60±0.40	6.80±0.48	**7.00±0.25^{b}**
2GK	8.60±0.50	9.00±0.31	8.60±0.24	8.40±0.40	**8.65±0.20^{a}**
4GK	9.20±0.37	9.00±0.34	8.80±0.20	8.50±0.28	**8.84±0.15^{a}**
Time ($\bar{x}$)	**7.64±0.29^{a}**	**7.38±0.35^{a}**	**7.80±0.20^{a}**	**7.29±0.25^{a}**	

* Means with different superscript in raw or column are significantly different at $p<0.05$.
C: minced chicken thighs.
2GS: minced chicken thigh + 2% grapes seeds powder.
4GS: minced chicken thigh + 4% grapes seeds powder.
2GK: minced chicken thigh + 2% grapes seeds powder.
4GK: minced chicken thigh + 4% grapes seeds powder.

CONCLUSSION

Pomegranate (rind and seeds powders) as well as grapes (seeds and skin powders) significantly reduced lipid oxidation in chicken thigh minces during the course frozen storage. It also, improved the cooking yield and enhanced health (fibers) thus it may prove useful, safe and natural health promoting antioxidant to meat industry.

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الملخص العربي

تأثير مخلفات الرمان والعنب الأحمر كمضادات أكسدة على ثبات وجودة مفروم أفخاذ الدجاج أثناء التخزين

فاطمة محمد أبو النجا، أميمة السيد شلتوت، انتصار عبد المحسن الدفراوي، أيمن محمد أبو اليزيد
قسم علوم الأغذية - كلية الزراعة (ساباباشا) - جامعة الإسكندرية

تهدف هذه الدراسة إلى تقييم تأثير إضافة تركيزات مختلفة من كلاً من مخلفات الرمان (القلف، والبذور) والعنب الأحمر (البذور والقشور) بعد تجفيفها عند مستوى 2، 4% كمضادات أكسدة وإضافتها إلى مفروم أفخاذ الدجاج والحفظ بالتجميد على درجة –18°م لمدة ثلاثة شهور.
تم تقدير التركيب الكيماوي التقريبي لكل من مفروم لحم الدجاج ومخلفات الرمان والعنب علاوة على تقدير تركيز الأحماض الفينولية الكلية في المخلفات موضع الدراسة. كما تم دراسة محددات الجودة متمثلة في تقدير الأس الهيدروجيني ورقم البيروكسيد والتزنخ الثانوي مقاساً برقم حامض الباربيتيوريك علاوة على فاقد الطهي والتقييم الحسي للمنتج النهائي – وذلك بصفة دورية لمدة ثلاثة أشهر على درجة حرارة -18°م.
وقد أظهرت النتائج أن تركيز الأحماض الفينولية الكلية في قلف الرمان كان أعلى بكثير من بذور الرمان حيث كان المحتوى الأول 118مجم/مل في حين كان الثاني 7.4مجم/مل محسوباً على أساس مكافئ حامض التانيك، كما وجد أن تركيز الأحماض الفينولية الكلية في بذور العنب الأحمر كان ضعف ما هو موجود في القشور (4.3 و2.1 مجم/ مل) على التوالي محسوباً على أساس حاض الجاليك.
بينت نتائج الأس الهيدروجيني أن كلاً من 4% قلف رمان و2% بذور وقشور العنب الأحمر المضافة لمفروم لحم الدجاج كان لهما تأثير معنوي (P<0.05) في خفض الأس الهيدروجيني أثناء التخزين تحت التجميد. كما بينت النتائج أن كل من 2، 4% قلف رمان و2% بذور وقشور العنب الأحمر كان لديهما تأثيراً معنوياً في خفض قيمة البيروكسيد مقارنة بالكونترول والمعاملات الأخرى أثناء التخزين بالتجميد.
كما بينت نتائج رقم حامض الثيوباربيتيوريك أن جميع تركيزات قلف الرمان وبذوره كان لهما تأثير معنوي في خفض التزنخ الثانوي أثناء التخزين بالتجميد، كما أظهرت النتائج أن كل من 2% قشور عنب و2، 4% بذور عنب كان لهم تأثيراً معنوياً في خفض التزنخ والثانوي مقارنة بالكونترول والمعاملات الأخرى في نهاية التخزين المجمد.
وأوضحت نتائج فاقد الطهي أن كلاً من 4% قلف رمان و4% بذور العنب الأحمر أظهرا أقل فاقد طهي معنوي أثناء التخزين بالتجميد مقارنة بالمعاملات الأخرى.
بينت اختبارات التقييم الحسي أن كل تركيزات بذور وقشور الرمان (2، 4%) لديهما أعلى تقبل معنوي لجميع الخصائص الحسية لأقراص أفخاذ الدجاج مقارنة بالكونترول والمعاملات الأخرى. كما أن كل من مخلفات قشور والعنب الأحمر المجفف عند التركيزات موضع الدراسة أظهرا قدرة عالية عن حماية مفروم لحم الدجاج من التزنخ علاوة على تحسين جودة المنتج النهائي أثناء التخزين المجمد.