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PRODUCTION OF HEALTHY SAUSAGE WITH TOMATO PEEL POWDER AND POMEGRANATE PEEL POWDER

Ghofran M. Hussien*, M.A.S. Abdel-samie[1], B.A. AbdElSalam[2] and S.I. Goneim[1]

1. Dept. Food and Dairy Sci. and Technol., Fac. Environ. Agric. Sci., Arish Univ., Egypt
2. Dept. Dairy Res., Inst. Food Technol. Res., Agric. Res. Cent., Egypt

ABSTRACT

The antioxidant potency of Tomato peel powder (TP) or Pomegranate peel powder (PP) at different levels in chicken sausages was evaluated and compared to Butylated hydroxy toluene (BHT) as synthetic antioxidant. The chemical, physical, cooking, microbiological and sensorial properties of different chicken sausages treatments stored at -18°C for 4 months were monthly determined. The results revealed that the thiobarbituric acid **(**TBA) values of chicken sausage were decreased with increasing PP or TP levels. The positive effect of PP on TBA value was higher than those of TP. The water holding capacity (WHC) of chicken sausages was improved by adding PP or TP. The highest WHC value was recorded with TP (1.5%) chicken sausage at the end of storage period. The PP or TP chicken sausages recorded lower cooking loss values compared to control through the storage period. The total bacterial count and sporeforming bacteria of chicken sausages decreased by adding PP or TP during storage period. The coliform and yeasts & molds were not detected through storage period for different studied chicken sausages. Sensory scores indicated that the addition of PP or TP at different levels improved all studied sensorial characteristics. The TP (2.5%) chicken sausage treatment scored the highest values of all studied sensorial characteristics at the end of storage period followed by TP (2%) and PP (2.5%) chicken sausage treatments. Therefore, the TP or PP can be used in chicken sausages as a safe and cheap source of natural antioxidant to protect chicken sausages from lipid oxidation and improve cooking and sensorial properties.

Key words: Chicken sausage, tomato peel powder, pomegranate peel powder, antioxidant, butylated hydroxy toluene (BHT), thiobarbituric acid **(**TBA).

INTRODUCTION

In the past few years, increasing demand towards convenience foods has led to increased production and consumption of ground meat products. Grinding of meat disrupts the integrity of muscle membranes and exposes lipid membranes to metal ions and facilitates the interaction of pro-oxidants with unsaturated fatty acids resulting in generation of free radicals and propagation of oxidative reaction **Devatkal *et al.* (2010)**. Lipid oxidation is a major cause of off-flavor in meat and meat products as well as deterioration limit shelf-life via changes in flavor, texture, color, and nutritional value of meat. These variations would result in a product that is unacceptable for human consumption. Hence, it is necessary to prevent and reduce the lipid oxidation during storage of meat and meat products that can effectively prolong the shelf life of these products **Zhang *et al.* (2013).** The addition of antioxidants into processed meat products is one of the accepted methods to delay the onset of lipid oxidation by reacting with free radicals and quenching the metal ions.

* **Corresponding author: Tel.:** +201090553265
E-mail address: ghofranammohomed.hussien@gmail.com

Antioxidants are compounds that are capable of donating hydrogen (Ho^+) radicals for pairing with other available free radicals to prevent the propagation reaction during the oxidation process. This effectively minimizes rancidity, retards lipid oxidation, without any damage to the sensory or nutritional properties, resulting in maintaining quality and shelf-life of meat products. Antioxidants reduces or prevent the oxidation and have ability to counteract damaging effects of free radicals in tissues and thus are believed to protect against cancer, atherosclerosis, heart disease and several other diseases **(Juntachote *et al*., 2006).** The use of natural antioxidants has the advantage of being more acceptable by the consumers as these are considered as non-chemical. In addition, they don't require safety tests before being used. Moreover, natural antioxidants are reported to be more powerful than the synthetics. The demand for natural antioxidants has recently increased because of the toxicity and carcinogenicity of synthetic antioxidants the attention is now being paid to increasing the use of natural antioxidant to overcome the diffidence of synthetic antioxidant and it is proved as safe and more effective compare to synthetic antioxidants. Plant extracts having good antioxidant and antimicrobial properties so it will help in preservation of food. The use of synthetic antioxidants like Butylated hydroxyl toluene (BHT), Butylated hydroxy anisole (BHA) and Tertbutyl hydroquinone (TBHQ) in food has been decreased due to their suspected action as promoters of carcinogenesis, as well for the general consumer rejection of synthetic food additives **(Mutahar *et al*., 2012).**

Pomegranate (*Punica granatum* L.) rind is an inedible part/byproduct obtained during processing of pomegranate juice. Rind and seeds of pomegranate fruits have been demonstrated to be high in antioxidant activity **Devatkal *et al.* (2010).** Pomegranate peel or rind extract had scavenging activity against super oxide anions and inhibitory action on low density lipoprotein oxidation **Li *et al*. (2006).**

Tomatoes (*Solanum lycopersicum* L.) are widely consumed either raw or after processing and can provide a significant proportion of the total antioxidants in the diet **(Martinez-Valvercle *et al.,* 2002).** Tomatoes constitute the predominant source of lycopene and phenols in diet (**George *et al.*, 2004).** The peel fraction of tomato waste contains lycopene up to five times more than the pulp (on wet basis), **(Kaur *et al.,* 2008).** The lycopene is responsible for the antioxidant activity of tomatoes, which are related to the extensive conjugation of double bonds, since it quenches the singlet oxygen.

Hence, this study was performed to improve the quality of chicken sausage using tomato peel powder and pomegranate peel powder as natural antioxidants and to determine their effects on chemical, physical, microbiological, coocking characteristics and sensorial properties of this products during freezing storage.

MATERIALS AND METHODS

Materials

Preparation of Peel Powders

Pomegranate peel powder

Pomegranate (*Punica granatum* L.) fruits were washed then cut manually, and the peels of pomegranate fruits were manually removed and their edible portions were carefully separated. The peels were dried in an air-oven drier (DHG-9140A; Yiheng Instrument Co., Ltd., Shanghai, China) at 40±1°C for 48 h. The dried peels were ground to a fine powder and passed through a 30-mesh sieve then packed in polyethylene bags and stored at -18 ºC until used **(Qin *et al*., 2013).**

Tomato peel powder

The tomato (*Solanum lycopersicum* L.) fruits were washed and boiled for 5 min in water then separated manually. peel was dehydrated at 50ºC for 24 h in a ventilated oven and ground to a fine powder then packaged in polyethylene bags and stored at -18ºC until used **(Namir *et al.*, 2015)**.

Preparation of chicken sausage

The chicken sausage was prepared using the formula **(Bails *et al.*, 2011)** indicated in Table 1. The dried ingredients (salt, sugar, refined wheat flour, spice mix, condiment mix) were added to the chicken breasts meat and visceral fat and skins and mixed .This mixture was divide to 10 parts, the first part saved as a control, the second part supplemented with 0.15% Butylated hydroxy toluene (BHT), the other parts supplemented with (1%, 1.5%, 2%, 2.5%) tomato peel powder (TP) or pomegranate peel powder (PP) The all chicken sausage samples were then placed in natural casings and stored at -18^{o}C for 4 months. The all chicken sausage samples were monthly analyzed for chemical, physical, cooking, microbiological and sensorial properties monthly.

Chemical Analyses

The moisture, protein, fat and ash contents were analysed according to AOAC method **(AOAC, 2012**) Carbohydrates content were then calculated by subtracting the total of other components (moisture, protein, fat, and ash) from the total value (100%). The pH value of chicken sausage was determined using a calibrated pH meter (ED11 pH meter-Hunvary made in Romania) according to the method described by **Sebranek *et al.* (2001).** Total volatile nitrogen (T.V.N) was determined according to **Malle and Poumeyrol (1989).**

Thiobarbituric Acid (T.B.A)

The thiobarbituric acid was determined according to **Witte *et al.* (1970)**.

Physical analysis

Water Holding Capacity (WHC) was determined by filter press method as described by **Wierbicki and Deatherage (1958**).

Cooking Properties of Chicken Sausage

Cooking loss (%)

The chicken sausage samples were weighted before and after cooking to determine cook loss according to the method of **Lee *et al.* (2008)** using the following equations**:**

$$\text{Cookingloss}\% = \frac{\text{rawweight} - \text{cookedweight}}{\text{rawweight}} x100$$

Change in length and diameter

Change in length and diameter for chicken sausage was measured on cooked samples as mentioned by **George and Berry (2000)**

Microbiological Analyses of Chicken Sausage

Total plate count agar was determined by the method described by **APHA (1992)** using plate count agar at 37^{o}C for 48h. The coliforming bacterial count of chicken samples was determined according to **ICMSF (1996)** using Violet Red Bill Agar medium at 37^{o}C/24 h. Yeast and mould count and sporeformes count were determined by the method described by **APAH (1992)** using the following equations: $N = N_0$- Kt **Antonio *et al.* (2015)**

Sensory Evaluation

Samples of chicken sausage were sensorially evaluated according to the method described by **Garcia *et al.* (2009).**

Statistical analysis

The statistical analysis was carried out using one way analysis of variance (ANOVA) under significant level of 0.05 for the whole results using Duncan's test was applied the statistical program Costat (Ver. 6.400) according to **Steel *et al.* (1997).** To as certain the significant among means of different samples.

Table (1): Chicken sausage formula.

Ingredients	Control (%)	Treatment							
		TP				PP			
		T_1	T_2	T_3	T_4	T_1	T_2	T_3	T_4
Chicken breast meat	**60**	60	60	60	60	60	60	60	60
Visceral fat and skin	**10**	10	10	10	10	10	10	10	10
Ice crystal	**14**	14	14	14	14	14	14	14	14
Salt	**3**	3	3	3	3	3	3	3	3
Sugar	**1**	1	1	1	1	1	1	1	1
Refined wheat flour	**5**	5	5	5	5	5	5	5	5
Spice mix	**2.5**	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5
Condiment mix	**4.5**	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5
BHT	**0.15%**	-	-	-	-	-	-	-	-
TP powder		1	1.5	2	2.5	-	-	-	-
PP powder		-	-	-	-	1	1.5	2	2.5

T_1= tomato peel powder 1%, T_2= tomato peel powder 1.5%
T_3= tomato peel powder 2%, T_4= tomato peel powder 2.5
P_1= pomegranate peel powder 1%, P_2= pomegranate peel powder1.5%
P_3= pomegranate peel powder 2%, P_4=pomegranate peel powder2.5%
BHT= Butylated hydroxy toluene 0.15% Control = without addition

RESULTS AND DISCUSSION

Chemical Characteristics of Chicken Sausage during Frozen Storage Period

The changes in chemical properties of chicken sausage contains tomato Peel powder (TP) and pomegranate peel powder (PP) as antioxidants during frozen storage at -18^{o}C for 4 months are presented in Table 2. It could be noted from the obtained results that the pH value of chicken sausage contains tomato peel powder (TP), pomegranate peel powder or Butylated hydroxy toluene (BHT) significantly decreased with progressing of storage period and reached the lowest values at the fourth month of storage period. Also, the pH of control decreased from the third month of storage period. The pH values slightly decreased with increasing of TP or PP powder concentrations. These results are in accordance with the findings of **El-Nashi *et al.* (2015)** who found that the pH of beef sausage with 1,2 and 3% pomegranate peel powder reduced during the storage period. A decrease in the pH value of beef sausage containing tomato peel have been reported by **Moawad *et al.* (2012) and Salem (2013).** The results show that the moisture of all chicken sausage treatments decreased with increasing of storage period. The decrease in moisture of control chicken sausage was higher than those of with TP, PP or BHT allover storage period. Also, the moisture content was decreased with increasing of TP or PP level. The moisture of TP chicken sausage samples was lower than those of with PP during storage period. The loss in moisture of sausage during storage period may be due to moisture vapor migration from the surfaces of the samples as a result of difference in vapor water pressure with the surrounding cold air (**El-Nashi *et al.*, 2015)**. The protein content was significantly decreased as the storage period increased.

The decrease in protein content of treated chicken sausage samples during storage period could be explained by the loss of soluble protein associated with the loss of water content of chicken sausage and may be associated to activity of proteolytic bacterial enzymes. Slightly significant differences were observed in

Table (2): Changes in chemical properties of chicken sausage supplemented with tomatoes peel powder (TP) and pomegranate peel powder (PP) as antioxidant during storage at -18°c for 4 months.

Storage period (month)	Treatment									
	Control	BHT	T_1	T_2	T_3	T_4	P_1	P_2	P_3	P_4
					pH					
0	6.6 b A	6.5 bc A	6.8 aA	6.6 b A	6.5 bc A	6.2 d A	6.8 aA	6.6 b A	6.5 bc A	6.4 c A
1	6.5 ab A	6.3 cd B	6.5 ab B	6.4 bc B	6.2 d B	5.8 e B	6.6 a B	6.4 bcB	6.4 bc A	6.3 d A
2	6.5 aA	6.1 de C	6.3 bc C	6.2 cd C	6 e C	5.7 f BC	6.4 ab C	6.2 cd C	6.1 de B	6 e B
3	6.3 a B	6 cd CD	6.2 ab C	6.0 cd D	5.9 d C	5.6 e C	6.1 bc D	6.0 cd D	5.9 d C	5.6 e C
4	6.1 a C	5.9 b D	5.9 b D	5.7 c E	5.6 cd D	5.4 ef D	5.9 b E	5.7 c E	5.5 de D	5.3 f D
					Moisture					
0	68 aA	67 b A	67 b A	67 b A	65 c A	67 b A	67 b A	67 b A	67 b A	65 c A
1	58 d B	60 b B	58 d B	59 c B	60 b B	60 b B	58 d B	58 d B	60 b B	61 a B
2	50.47 f C	53.66 d C	52.02 e C	54.5 cd C	58.13 b C	58.80abC	55.2 c C	55.39 c C	58.96 ab C	59.32 a C
3	45.54 g D	49.25 ef D	49.013 f D	49.98 deD	51.99 c D	53.56 bD	50.8 d D	51.85 c D	53.85 b D	55.88 a D
4	43.84 f E	43.85 f E	45.89 e E	48.95 d E	49.80 d E	52.59 b E	45.95 e E	49.57 d E	51.32 c E	53.96 a E
					Protein					
0	11.2 g A	11.5 f A	12.0 c A	12.3 b A	12.8 aA	12.9 aA	11.53 f A	11.59 ef A	11.71 de A	11.8 d A
1	11.1 de B	11.0 eb B	11.61 c B	12.22 b B	12.62 a B	12.70 a B	11.00 e B	11.22 d B	11.60 c B	11.72 c AB
2	11.0 ef B	10.85 f B	11.42 d C	12.0 b B	12.13 b B	12.33 a C	10.90 f B	11.11 eBC	11.45 cdBC	11.6 c BC
3	10.5 g C	10.63 fg C	11.12 e D	11.79 b C	11.82 b C	12.00 a D	10.69 f C	10.95 e C	11.3 d C	11.49 c C
4	10.00 h D	10.30 g D	11.00 cd D	11.11 c D	11.49 b D	11.85 a D	10.51 f D	10.7 e D	10.9 d D	11.1 c D
					Fat					
0	13.54 f E	13.55 ef E	14.60 b E	14.70 b E	15,00 a D	14.30 c D	13.60 ef E	13.63 ef D	13.73 de D	13.90 d E
1	13.80 f D	13.90 ef D	15.00 c D	15.30 b D	15.62 a C	15.71 a C	13.80 f D	13.99 e C	14.00 e C	14.30 d D
2	13.99 f C	14.30 e C	15.40 c C	15.50 c C	16.51 b B	16.75 a B	14.00 f C	14.10 f C	14.30 e B	14.62 d C
3	14.40 de B	14.80 c B	15.60 b B	15.72 b B	16.80 aA	16.88 a B	14.23 e B	14.44 d B	14.79 c A	14.91 c B
4	14.90 f A	15.20 e A	15.83 c A	16.00 c A	16.89 b A	17.30 aA	14.51 h A	14.69 g A	14.95 f A	15.50 d A
					Ash					
0	2.30 d E	2.40 cd E	2.43 bcd E	2.53 bc E	2.60 b E	2.90 a E	2.38 cd C	2.41 bcd C	2.50 bc D	2.56 bc C
1	2.50 de D	2.60 d D	2.81 c D	3.11 b D	3.33 a D	3.50 a D	2.40 e C	2.43 de C	2.55 de D	2.60 d C
2	2.81 e C	3.01 d C	3.22 c C	3.41 b C	3.57 b C	3.91 a C	2.80 e B	2.80 e B	2.81 e C	2.95 de B
3	3.13 e B	3.31 d B	3.53 c B	3.60 c B	4.12 b B	4.32 a B	2.91 f B	2.93 f B	3.14 de B	3.49 c A
4	3.40 cd A	3.51 c A	3.85 b A	3.85 b A	4.42 aA	4.55 aA	3.29 aA	3.36 d A	3.42 cd A	3.52 c A
					Carbohydrate					
0	4.96 e E	5.55 c E	3.97 g E	3.47 h E	4.5 f E	2.90 I E	5.49 c E	5.74 b E	5.17 d E	6.82 a E
1	14.6 b D	12.50 d D	12.58 d D	10.37 f D	8.43 g D	8.09 h D	14.8 a D	14.36 c D	11.85 e D	10.38 f D
2	21.73 a C	18.18 b C	17.94 c C	14.59 f C	9.66 I C	8.21 j C	17.1 d C	16.6 e C	12.48 g C	11.51 h C
3	26.43 a B	22.01 b B	20.62 c B	18.91 e B	15.27 g B	13.24 I B	22.09 b B	19.83 d B	16.92 f B	14.23 h B
4	27.86 aA	27.14 b A	23.43 d A	20.09 f A	17.40 h A	13.71 j A	25.74 c A	21.68 e A	19.41 g A	15.92 I A
					Total volatile nitrogen (T.V.N)					
0	9.38 c E	9.80 a E	9.71 ab E	9.57 b E	9.66 ab E	9.80 a E	9.67 ab E	9.56 b E	9.72 ab E	9.80 a E
1	15.91 h D	12.90 a D	14.90 b D	14.00 d D	13.80 e D	13.20 g D	14.30 c D	13.50 f D	13.00 h D	12.31 i D
2	24.90 a C	17.00 d C	23.80 a C	22.00 abC	19.10 bcd C	17.50 d C	21.30 abcC	18.00 cd C	17.20 d C	16.21 d C
3	34.2 a B	20.2 i B	32.2 b B	29.5 c B	26.2 e B	25.9 f B	28.4 d B	25.9 f B	23.5 g B	21.41 h B
4	40.21 aA	30.00 i A	39.40 b A	37.20 d A	33.80 f A	31.90 h A	37.90 c A	35.10 d A	32.50 g A	29.30 j A

T_1= tomato peel powder 1%, T_2= tomato peel powder 1.5% T_3= tomato peel powder 2%,
T_4 = tomato peel powder 2.5%, BHT= Butylated hydroxy to luene 0.15%
P_1= pomegranate peel powder 1%, P_2= pomegranate peel powder 1.5% P_3= pomegranate peel powder 2%,
P_4= pomegranate peel powder 2.5%, Control= without addition
Means with the same capital letters in the same column are not significantly different;
Means with the same small letters in the same raw are not significantly different

respect of protein content of PP chicken sausage treatments. This may be due to the lower protein content of PP **(Kumar and Neeraj, 2018).** Fat and ash contents of TP chicken sausage treatments were higher than those of with PP through storage period and these contents increased with increasing storage period. Carbohydrate content increased with progressing of storage period and was higher with PP chicken sausage treatments compared to TP treatments. These results were in agreement with those of **El-Nashi *et al.* (2015).** Finally, the data (Table 2) showed that the total volatile nitrogen (TVN) content of all chicken sausage treatments increased with progressing of storage period. The increase of TVN for control was higher than those of with TP, PP or BHT and this may be due to the antimicrobial effect of TP or PP compounds, especially proteolytic microorganisms which breaks down of protein resulting in TVN **(Kanatt *et al.*, 2010; Agourram *et al.*, 2013).**

Changes in Thiobarbituric acid (TBA) Value

Lipid oxidation is one of the main limiting factors for the quality and acceptability of meat and meat products. Thiobarbituric acid (TBA) value (malonaldehyde mg/ kg) is used as an index for measuring oxidative rancidity which takes place in meat products during storage. Table 3 shows the effect of PP or TP on the oxidative stability of chicken sausage during frozen storage. The data showed that the TBA value use increased as the storage time increased. The TBA values of chicken sausage were decreased with increasing PP or TP levels. The positive effect of PP on TBA value was higher than those of TP. These results are in agreement with **Naveena *et al.* (2008) as well as El-Gharably and Ashoush (2011)** who found that pomegranate peels powder improved the storage stability of meat products especially at refrigerated storage by reducing the rate of lipid oxidation expressed as TBARS values of prepared samples. Pomegranate peels are reported to possess significant antioxidant activity due to their polyphenolic compounds and other biochemical compounds that mainly contribute to the antioxidant activity **(Kumar and Neeraj, 2018).** Also, **Salem (2013)** found that positive effect of tomato peel on TBA of beef sausage may be due to the antioxidative activity of lycopene present in tomato.

Physical Characteristics of Chicken Sausage during Storage Period

The changes in water holding capacity (WHC) of different chicken sausage treatments during storage period are illustrated in Table 4. The results showed that the water holding capacity (cm^2) of chicken sausage is decreased as storage time increased. The decrease in WHC may be due to the protein aggregation or to the biochemical changes associated with cooling of meat products, as reported by **Qin *et al.* (2013).** The reduction in WHC values at the end of refrigerated storage could be ascribed to the loss of water by evaporation, rather than to any improvement of water holding capacity. The highest WHC value was recorded with TP (1.5%) chicken sausage at the end of storage period. These results are in agreement with those reported by **Moawad *et al.* (2012)**.

Cooking Characteristics of Chicken Sausage during Storage Period

Cooking characteristics of different PP or TP chicken sausage treatments were presented in Table 5. It could be noticed from the results that, the cooking loss of all studied treatments increased with increasing of the storage period. The PP or TP chicken sausages recorded lower cooking loss values compared to control through the storage period. The PP or TP at 2% showed almost the same effect of BHT on cooking loss. These results are in agreement with those obtained by **Gibriel *et al.* (2007)** and **Abdel Fattah *et al.* (2016)** who reported that, the cooking loss was progressively increased as the period of storage increased.

Table (3): Changes in Effect of tomato peel powder and pomegranate peel powder on thiobarbituric acid (TBA) malonaldehyde mg/kg during storage at -18°C in chicken sausage for 4 months.

Treatment	Storage period (month)				
	Zero	1	2	3	4
control	0.1092 a E	0.390 a D	0.642 ab C	0.992 a B	1.490 aA
BHT	0.1196 a C	0.191 bc C	0.390 c B	0.659 d A	0.790 de A
T_1	0.1192 a D	0.380 ab C	0.691 a B	0.731 bcd B	1.1373 b A
T_2	0.1116 a D	0.379 ab C	0.513 abc C	0.912 ab B	1.1369 b A
T_3	0.1146 a D	0.275 abc D	0.525 abc C	0.851 abd B	1.1303 b A
T_4	0.1142 a D	0.191 bc D	0.420 c C	0.668 d B	0.9385 cd A
P_1	0.1169 a E	0.310 abc D	0.511 abc C	0.881 abc B	1.1013 bc A
P_2	0.1128 a D	0.300 abc C	0.493 bc B	0.841 abd B	0.995 bc A
P_3	0.1116 a D	0.193 bc D	0.405 c C	0.710 cd B	0.980 bc A
P_4	0.1128 a C	0.163 c C	0.371 c B	0.696 cd A	0.716 e A

T_1= tomato peel powder 1%, T_2= tomato peel powder 1.5%
T_3= tomato peel powder 2%, T_4= tomato peel powder 2.5%
P_1= pomegranate peel powder 1%, P_2= pomegranate peel powder 1.5%
P_3= pomegranate peel powder 2%, P_4= pomegranate peel powder 2.5%
BHT= Butylated hydroxy toluene 0.15% control=without addition.
Means with the same capital letters in the same raw are not significantly different.
Means with the same small letters in the same column are not significantly different.

Table (4): Changes in water holding capacity (WHC cm^2) of tomato peel powder and pomegranate peel powder chicken sausages during storage at -18°C for 4 months.

Treatment	Storage period (month)				
	Zero	1	2	3	4
control	8.88 b A	6.65 e B	5.77 f C	4.035 h D	3.95 g D
BHT	9.66 aA	8.65 c B	7.42 d C	6.23 g D	5.82 f E
T_1	9.69 aA	9.66 a B	8.73 a B	7.04 d C	6.69 c D
T_2	9.66 aA	9.60 a B	8.28 b B	8.20 a B	7.80 a C
T_3	9.70 aA	9.55 b B	8.20 b B	8.00 b C	7.76 a D
T_4	9.68 aA	9.00 d B	7.88 c C	7.66 c D	7.34 b E
P_1	8.38 c A	7.89 d B	7.35 d C	6.85 e D	6.42 d E
P_2	8.40 c A	7.98 d B	7.28 d C	6.57 f D	6.15 e E
P_3	8.39 c A	7.87 d B	7.06 e C	6.34 g D	6.09 e E
P_4	8.42 c A	7.81 d B	7.00 e C	6.21 g D	6.00 e E

T_1= tomato peel powder 1%, T2= tomato peel powder 1.5%
T_3= tomato peel powder 2%, T_4= tomato peel powder 2.5%
P_1= pomegranate peel powder 1%, P_2= pomegranate peel powder 1.5%
P_3= pomegranate peel powder 2%, P_4= pomegranate peel powder 2.5%
BHT= Butylated hydroxy toluene 0.15% control=without addition.
Means with the same capital letters in the same raw are not significantly different.
Means with the same small letters in the same column are not significantly different.

Also, the diameter and length (Table 5) of all studied treatments showed the similar trend of cooking loss. The improved cooking characteristics of different PP the chicken sausage samples may be due to the physiochemical properties of pomegranate peels powder as a water binding material which was the most important factor in improving cooking characteristics of meat products **(El- Nashi *et al.*, 2015).**

Changes in Microbiological Properties of Tomato Peel Powder and Pomegranate Peel Powder Chicken Sausages during Storage at -18^{o}C for 4 Months

The results of changes in microbiological properties of PP or TP chicken sausages during storage at -18^{o}C are presented in Table 6. It could be observed that the total bacterial count of control significantly increased with progressing of storage period. The total bacterial count of PP or TP chicken sausage samples reduced with increasing storage period or PP &TP levels. The lowest total bacterial count was recorded with PP (2.5%) chicken sausage treatment and this may be due to antimicrobial effect of PP or TP especially at high level. Also, the sporeforming bacterial count of all PP or TP chicken sausage treatments reduced allover storage period. The coliforming bacterial count was $7x10^{1}$ for all studied treatments at zero time of storage period, but not detected during the studied storage period for all studied treatments because of pH and temperature. Yeasts and molds were not detected from zero time until the end of storage time for all studied treatments due to microbial properties of tomato peel powder and pomegranate peel powder. The observed results are in agreement with the results of **Al-Zoreky (2009), Kanatt *et al.* (2010) Agourram *et al.* (2013) and Salem (2013)**.

Changes in Sensorial Properties of Tomato Peel Powder and Pomegranate Peel Powder Chicken Sausages during Storage at -18^{o}C for 4 Months

Sensory evaluation is an important indicator of potential consumer preferences. sensorial characteristics, appearance, color, tenderness, juiciness, flavor and overall acceptability of PP or TP chicken sausage samples were evaluated and the results are presented in Table 7. It could be noticed that, all sensory characteristics are decreased with increasing the storage time but it generally acceptable. The TP (2.5%) chicken sausage treatment scored the highest values of all studied sensorial characteristics at the end of storage period followed by TP (2%) and PP (2.5%) chicken sausage treatments. The lowest sensorial characteristics were recorded with control chicken sausage. These results are in agreement with those obtained by **Hoe *et al.* (2006) and Salem (2013)** who reported that the addition of tomato peel increased the color scores and beef sausage were found to be more acceptable by the panelists. Also, **El-Nashi *et al.* (2015)** reported that the addition of pomegranate peel improved the sensorial characteristics of beef sausage.

Conclusion

It could be concluded from the obtained results that, the addition of pomegranate peel (PP) or Tomato peel (TP) at different levels (1, 1.5, 2, 2.5%) improved all studied sensorial characteristics. The TP (2.5%) chicken sausage treatment scored the highest values of all studied sensorial characteristics at the end of storage period (4 months) at -18^{o}C followed by TP (2%) and PP (2.5%) chicken sausage treatments. Hence, the Tomato or pomegranate peels can be added to chicken sausage as a natural antioxidants to produce healthy product and to prolong of shelf life.

Table (5): Change in cooking characteristics of tomato peel powder and pomegranate peel powder chicken sausages during storage at -18°C for 4 months.

storage period (Month)	Treatment									
	Control	BHT	T_1	T_2	T_3	T_4	P_1	P_2	P_3	P_4
					Cooking loss (%)					
0	13.30 a D	12.36 b D	12.10 cd E	12.20 bc E	12.33 b E	11.90 e E	12.00 de E	12.21 bc E	12.00 de E	11.50 f E
1	16.3 a C	15.4 b C	14.5 c D	14.2 g D	13.0 g D	13.0 d D	14.0 e D	13.9 e D	13.62 f D	13.5 f D
2	25.30 a B	19.30 e B	22.00 b C	20.91 d C	17.90 f C	17.60 g C	21.60 c C	20.84 d C	19.42 e C	17.40 h C
3	31.25 aA	25.00 c A	25.00 c B	24.90 c B	25.80 b B	24.00 e B	25.00 c B	24.90 c B	24.70 d B	23.10 f B
4	31.20 aA	25.00 h A	27.50 b A	27.10 c A	26.00 d A	25.90 de A	25.80 e A	25.60 f A	25.28 g A	24.20 I A
					Length (%)					
0	10.0 d D	11.1 b E	11.1 b E	10.2 c E	11.1 b E	16.6 a E	11.1 b E	9.09 e E	9.09 e E	11.1 b E
1	14.6 a C	12.3 I D	14.2 b D	14.1 bc D	13.8 ef D	13.4 g D	14.0 cd D	13.9 de D	13.7 f D	13.0 h D
2	16.6 a B	15.5 d C	15.8 b C	15.7 bc C	15.0 f C	14.8 g C	15.6 cd C	15.2 e C	14.9 fg C	14.8 g C
3	16.66 a B	16.0 b B	16.0 b B	15.9 bc B	15.9 bc B	15.7 d B	15.9 bc B	15.9 bc B	15.8 cd B	15.5 e B
4	20.0 aA	18.5 de A	18.9 b A	18.7 c A	18.5 de A	17.9 g A	18.6 cd A	18.4 e A	18.18 f A	17.6 h A
					Diameter (%)					
0	8.3 a E	8.0 b E	8.0 b E	7.9 b E	7.6 c E	7.2 c E	7.9 d E	7.6 b E	7.5 c E	7.3 d E
1	12.0 c D	10.9 g D	12.5 a D	12.3 b D	11.8 d D	11.2 f D	11.8 d D	11.5 g D	10.9 g D	10.3 h D
2	16.2 a C	12.9 ef C	13.9 b C	13.6 c C	13.3 d C	13.0 a C	13.7 c C	13.4 d C	12.8 f C	12.6 g C
3	17.4 a B	15.9 f B	17.0 b B	16.7 c B	16.4 d B	16.1 e B	16.5 d B	16.2 e B	15.9 f B	15.2 g B
4	18.3 aA	16.3 e A	17.2 b A	17.0 c A	16.9 c A	16.5 d A	17.0 c A	16.6 d A	16.2 e A	15.9 f A

T_1= tomato peel powder 1%, T_2= tomato peel powder 1.5%
T_3= tomato peel powder 2%, T_4= tomato peel powder 2.5%
P_1= pomegranate peel powder 1%, P_2= pomegranate peel powder 1.5%
P_3= pomegranate peel powder 2%, P_4= pomegranate peel powder 2.5%
BHT= Butylated hydroxy toluene o.15% Control=without addition
Means with the same capital letters in the same raw are not significantly different.
Means with the same small letters in the same column are not significantly different.

Table (6): Changes in microbiological properties (log cfu/g) of chicken sausage incorporated with dried tomatoes peel and pomegranate peel at -18°c during storage.

Storage period	Control	BHT	T_1	T_2	T_3	T_4	P_1	P_2	P_3	P_4
					Total bacterial count					
0	$2.2233X10^3$ j E	$5.360X10^3$ b A	$3.750x10^3$ e A	$4.0100x10^3$ a A	$4.41x10^3$ c A	$3.42x10^3$ g A	$3.11x10^3$ I A	$3.33x10^3$ h A	$4.210x10^3$ d A	$3.425X10^3$ f A
1	$2.625X10^4$ a D	$2.975X10^3$ b B	$1.18250X10^3$ c B	$1.1025X10^3$ d B	$1.050X10^3$ e B	$9.6650X10^2$ f B	$9.3250X10^2$ g B	$7.1625X10^2$ h B	$6.2050X10^2$ I B	$4.3500X10^2$ j B
2	$2.94x10^4$ a C	$3.92x10^2$ b C	$7.2x10^2$ c C	$6.9x10^2$ d C	$6.7x10^2$ e C	$6.50X10^2$ f C	$5.4x10^2$ g C	$3.2x10^2$ h C	$2.50X10^2$ I C	$2.25X10^2$ j C
3	$2.34433X10^5$ a B	$2.41666X10^2$ b D	$6.6427X10^2$ c D	$5.90733X10^2$ d D	$5.32250X10^2$ e D	$4.42433X10^2$ f D	$2.94133X10^2$ g D	$2.52700X10^2$ h D	$1.93933X10^2$ i D	$1.63733X10^2$ j D
4	$2.36783X10^5$ a A	$2.16983X10^2$ g E	$3.91750X10^2$ b E	$3.68500X10^2$ c E	$2.90783X10^2$ d E	$2.70266X10^2$ e E	$2.69416X10^2$ f E	$2.125X10^2$ h E	$4.50116X10^1$ i E	$1.19266X10^1$ j E
					Spore forming bacteria					
0	$2.75X10^2$ a E	$2.800x10^2$ b E	$2.880x10^2$ fe E	$2.840x10^2$ bc E	$2.80x10^2$ c E	$2.70x10^2$ c E	$2.715x10^2$ d E	$2.855x10^2$ d E	$2.670x10^2$ e E	$2.855x10^2$ e E
1	$3.95x10^2$ a D	$3.750x10^2$ e D	$2.72x10^2$ ab D	$3.70x10^2$ b D	$3.69x10^2$ b D	$3.67x10^2$ e D	$3.50x10^2$ c D	$3.45x10^2$ d D	$3.20x10^2$ e D	$3.15x10^2$ f D
2	$4.75x10^2$ a C	$3.810x10^2$ b C	$4.70x10^2$ f C	$4.66x10^2$ g C	$4.657X10^2$ h C	$3.800X10^2$ i C	$3.99x10^2$ c C	$3.93x10^2$ d C	$3.80x10^2$ e C	$3.65x10^2$ i C
3	$9.762X10^3$ a B	$3.875X10^3$ b B	$9.47X10^2$ c B	$9.30X10^2$ d B	$8.15X10^2$ f B	$7.42X10^2$ g B	$1.507x10^3$ e B	$1.395x10^3$ h B	$1.347X10^3$ i A	$7.40X10^2$ j B
4	$9.937X10^3$ a A	$5.910X10^3$ b A	$3.15X10^3$ c A	$2.625X10^3$ d A	$1.915X10^3$ f A	$1.650X10^3$ g A	$2.125X10^3$ e A	$1.530X10^3$ h A	$1.100X10^3$ i B	$7.97X10^2$ j A

T_1= tomato peel powder 1%, T_2= tomato peel powder 1.5%
T_3= tomato peel powder 2%, T_4= tomato peel powder 2.5%
P_1= pomegranate peel powder 1%, P_2= pomegranate peel powder 1.5%
P_3= pomegranate peel powder 2%, P_4= pomegranate peel powder 2.5%
BHT= Butylated hydroxy toluene o.15% Control= without addition
Means with the same capital letters in the same raw are not significantly different
Means with the same small letters in the same column are not significantly different

Table (7): Change in sensory properties of tomato peel powder and pomegranate peel powder chicken sausage during storage at -18°C for 4 months

Treatment	Storage period (month)				
	Zero	1	2	3	4
			General apperance		
Control	7 c A	6 d B	5 d C	5 d C	4 d D
BHT	8 b A	8 b A	7 b B	7 b B	6 b C
T_1	7 c A	7 c A	7 b A	6 c B	6 b B
T_2	7 c A	6 d A	6 c B	6 c B	5 c C
T_3	8 b A	8 b A	7 b B	7 b B	6 b C
T_4	9 aA	9 aA	9 aA	8 a B	7 a C
P_1	7 c A	6 d A	6 c B	5 d C	5 c C
P_2	6 d A	6 d A	6 c A	5 d B	5 c C
P_3	6 d A	6 d A	6 c A	6 c A	5 c B
P_4	7 c A	7 c A	6 c B	6 c B	5 c B
			Color		
Control	7 b A	6 c B	5 d C	4 d D	4 d D
BHT	7 b A	6 c B	6 c B	5 c C	5 c C
T_1	6 c A	6 c A	5 d B	5 c B	5 c B
T_2	7 b A	7 b A	6 c B	6 b B	5 c C
T_3	7 b A	7 b A	7 b B	6 b B	6 b B
T_4	8 aA	8 aA	8 aA	7 a B	7 a B
P_1	6 c A	6 c A	5 d B	5 c B	5 c B
P_2	6 c A	6 c A	6 c A	5 c B	5 c B
P_3	6 c A	6 c A	6 c A	6 b A	5 c B
P_4	7 aA	7 b A	6 c B	6 b B	5 c C
			Flavor		
Control	7 b A	5 c B	4 d C	4 d C	4 d C
BHT	7 b A	6 c B	5 c C	4 c D	4 c D
T_1	6 c A	6 c A	5 d B	5 c B	5 c B
T_2	7 b A	7 b A	6 b C	6 b B	5 c C
T_3	8 b A	7 b B	6 aA	6 b C	6 b C
T_4	8 aA	8 aA	8 d B	7 a B	7 a B
P_1	6 c A	6 c A	5 c A	5 c B	5 c B
P_2	6 c A	6 c A	6 c A	5 c B	5 c B
P_3	7 c A	7 c A	6 c B	6 b B	5 c C
P_4	7 b A	7 b A	7 c A	6 b B	5 c C
			Tenderness		
Control	7 b A	6 d B	5 e C	5 d C	5 d C
BHT	7 b A	7 c A	6 d B	6 d B	6 d B
T_1	7 c A	7 c A	6 d B	6 c B	5 c C
T_2	7 b A	7 b A	7 c A	6 b B	6 c B
T_3	8 aA	8 b A	8 c A	7 b B	7 b B
T_4	8 aA	8 aA	8 aA	8 aA	7 a B
P_1	7 c A	6 c B	6 d B	5 c C	5 c C
P_2	7 c A	7 c A	6 c B	5 c C	5 c C
P_3	7 b A	7 b A	7 c A	6 b B	5 c C
P_4	7 b A	7 b A	7 b A	7 b A	6 c B
			Juiciness		
Control	7 b A	6 c B	6 c B	5c C	5 c C
BHT	7 b A	6 c B	6 c B	6 b B	5 c C
T_1	7 b A	6 c B	6 c B	6 b B	5 c C
T_2	7 b A	7 b A	7 b A	6 b B	6 b B
T_3	7 b A	7 b A	7 b A	6 b B	6 b B
T_4	8 aA	8 aA	8 aA	7 a B	7 a B
P_1	7 b A	6 c B	6 c B	5 c C	5 c C
P_2	7 b A	7 b A	6 c B	6 b B	5 c C
P_3	7 b A	7 b A	6 c B	6 b B	5 c C
P_4	7 b A	7 b A	7 b A	6 b B	6 b B
			Overall acceptability		
Control	7 b A	6 c B	5 c C	5 c C	5 c C
BHT	6 c A	6 c A	6 b A	5 c B	5 c B
T_1	7 b A	6 c B	6 b B	6 b B	5 c C
T_2	6 c A	6 c A	6 b A	6 b A	5 c B
T_3	8 aA	8 aA	7 a B	7 a B	6 b C
T_4	8 aA	8 aA	7 a B	7 a B	7 a B
P_1	7 b A	6 c B	5 c C	5 c C	5 c C
P_2	7 b A	6 c B	6 b B	5 c C	5 c C
P_3	7 b A	7 b A	6 b B	6 b B	5 c C
P_4	6 c A	6 c A	6 b A	5 c B	5 c B

T_1= tomato peel powder 1% T_2= tomato peel powder 1.5% T_3= tomato peel powder 2%, T_4= tomato peel powder 2.5%
P_1= pomegranate peel powder 1%, P_2= pomegranate peel powder 1.5% P_3= pomegranate peel powder 2%,
P_4= pomegranate peel powder 2.5% BHT= Butylated hydroxy toluene o.15% control=without addition
Means with the same capital letters in the same raw are not significantly different
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الملخص العربي

إنتاج سجق صحي مع قشور الطماطم وقشور الرمان

غفران محمد حسين، محمد عبدالشافي عبدالسميع[١]، بركة أبواليزيد عبدالسلام[٢]، سمير إبراهيم غنيم[١]

١. قسم علوم وتكنولوجيا الاغذية والألبان، كلية العلوم الزراعية البيئية، جامعة العريش، مصر.

٢. قسم بحوث الألبان، معهد بحوث تكنولوجيا الأغذية، مركز البحوث الزراعية، وزارة الزراعة واستصلاح الأراضي، مصر.

تم تقيم إمكانية استخدام القشور المجففة للطماطم والرمان كمواد طبيعة مضادة للأكسدة وتم مقارنتها بـ Butylated hydroxy toluene (BHT) (مادة مضادة للأكسدة صناعية)، تم تقدير الخواص الكيماوية، الفيزيائية، خواص الطبخ، الاختبارات الميكروبيولوجية، والحسية للمعاملات المختلفة المخزنة علي -١٨°م شهريا لمدة ٤ شهور وقد أوضحت النتائج أن قيمة حمض الثيوباربتيوريك لسجق الفراخ قد قلت بزيادة نسبة القشور المجففة للطماطم أو الرمان، كان هناك تأثير إيجابي أعلي لقشور الرمان من قشور الطماطم علي حمض الثيوباربتيوريك، وتحسنت سعة احتفاظ سجق الفراخ بالماء بإضافة قشور الرمان وقشور الطماطم، وقد تم تسجيل أعلي قيمة لسعة الاحتفاظ بالماء مع سجق الفراخ المعاملة بـ ١,٥% قشور طماطم، وتم تسجيل أعلي قيم للفقد في الطبخ بإضافة قشور الطماطم أو الرمان مقارنة بالكنترول خلال فترة التخزين، كما لوحظ حدوث نقص في العدد الكلي للبكتريا والبكتريا المكونة للجراثيم في السجق المعامله بقشور الطماطم وقشور الرمان آثار التخزين، ولم تظهر الخمائر والفطريات وبكتريا القولون خلال مدة التخزين، وأدت إضافة قشور الرمان وقشور الطماطم بالنسب المختلفة المدروسة إلي تحسين في كل الخواص الحسية وقد سجلت معاملة السجق المضاف له ٢,٥% قشور طماطم أعلي درجة في كل الخصائص الحسية للعينات تحت الدراسة للمعاملة بقشور طماطم ٢%، ثم قشور الرمان ٢,٥%، وبناءً علي ذلك يمكن استخدام قشور الرمان وقشور الطماطم في إنتاج سجق صحي كمصدر أمن ورخيص وكمادة طبيعية مضادة للاكسدة لحماية سجق الفراخ من أكسدة الليبيدات ولتحسين خواص الطبخ والخواص الحسية.

الكلمات الإرشادية: سجق الفراخ، مسحوق قشر الطماطم، مسحوق قشر الرمان، مضادة الأكسدة، مضادات أكسدة صناعية (BHT)، حمض الثيوباربتيوريك.

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