



### The Effects of Phytic Acid, Carnosine and Butylated Hydroxyanisole on Some Properties of Mechanically Deboned Chicken Patties during Frozen Storage

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#### ABSTRACT

This research investigates that the effects of carnosine, phytic acid and butylated hydroxyanisole (BHA) using to mechanically deboned chicken (MDCM) patties on pH, thiobarbituric acid reactives (TBARS), metmyoglobin, haem iron during 180 days of storage at -18°C. Color characteristics ( $L$ ,  $a^*$ ,  $b^*$ , Hue and chroma values) and sensory analysis were also examined in the mechanically deboned chicken patties. Treated with BHA and carnosine decreased the TBARS values when comparing with control group (without antioxidant), except phytic acid group. Metmyoglobin formation was inhibited in MDCM patties by BHA, carnosine, phytic acid at the end of the frozen storage. The initial  $a^*$  value (18.63-20.80) decreased (9.13-12.49) during storage.

#### 1. Introduction

The popularity of chicken meat and meat products has been increasing throughout the world due to easy preparation and higher nutritional value (Chumngoen et al 2018; Mupalla & Chawla, 2018). The higher price of meat has promoted the meat manufacturer to evaluate the possibility of utilization of low cost substances such as mechanically deboned chicken meat (MDCM) (Mohamed & Monsour, 2012). Deboned chicken meat products all over the world have become more and more popular because of the requirements of convenience by foodservice and consumers (Zhuang & Savage, 2011). MDCM can be ensured by processing of mechanical force to chicken carcasses from which meat parts have been removed and forcing the milled mixture to remove bone particles (Froning, 1981; Püssa et al 2009; Mohamed & Monsour, 2012). MDCM has been used in several meat products (sausage, patty etc.) to raise nutritional and sensory characteristics (Song et al 2014; Wubshet et al 2019).

Mechanically deboned chicken meat is a higher heme and fat content. Although MDCM has a valuable co-product of chicken meat processing, it is very sensitive to the oxidative rancidity throughout deboning process and the compositional nature of the meat (Dawson & Gartner 1983; Hassan & Fan 2005).

Autooxidation occurs during frozen storage of MDCM and decreases the properties of products (Mielnik et al 2003). The lipid oxidation of these meat products can be prevented or delayed by the using of antioxidants.

Antioxidants have been used to retard, delay or prevent lipid oxidation. Although synthetic antioxidation such as butylated hydroxyanisole (BHA), butylated hydroxytoluene (BHT) and tertiarybutylhydroquinone (TBHQ) are widely used in food technology, they can cause potential toxicological and carcinogenic effects in humans (Karpinska et al 2001; Mohamed & Monsour, 2012; Zhang et al 2016). Natural antioxidants have been beginning to extend the lipid stability and improve the sensory attributes of poultry meat.

Nowadays, there has been special interest in using natural antioxidants due to the worldwide trend to avoid or minimize the synthetic additives (Bekhit et al 2003; Frankel, 1996). However, some recent attention has about antioxidant potential of phytic acid and carnosine in processed meat products (Badr, 2007; Stodolak et al 2007). Phytic acid is a common plant compound and shows important antioxidant properties because of its high binding affinity for iron (Graf & Eaton, 1990; Stodolak et al 2007). Due to the antioxidative potential, it is used for inhibition of the lipid oxidation in a model meat system (Lee et al 1998). Carnosin acted as a bioactive antioxidant is naturally

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found in meat, poultry and some fish but not in foods of plant origin and is an important compound in animal tissues (Ferraris et al 1988; Peiretti et al 2012 Boldyrev et al 2013). It is composed of  $\beta$ -alanyl-L-histidine and performs its antioxidant effect by a number of mechanisms (Sánchez-Escalante et al 2003; Zhou & Decker, 1999). Carnosin could restricted lipid oxidation due to the combination of free radical scavenging and metal chelation (Chan & Decker, 1994). Carnosine has been shown to be an effective antioxidant in model systems and meats (Decker et al 1992; O'Neill et al 1999; Sánchez-Escalante et al 2001; Sánchez-Escalante et al 2003; Badr, 2007). Therefore, the aim of this research was to determine the effect of using carnosine and phytic acid on some properties of mechanically deboned chicken patties during frozen storage.

## 2. Materials and Methods

### 2.1 Materials

Mechanically deboned chicken meat samples were obtained from a commercial manufacturer (Bolu, Turkey). The fresh meat samples were transported to the laboratory in a cooling conditions at  $-4\text{ }^{\circ}\text{C}$ . All the reagents and chemicals used for the research were of analytical grade and procured from Sigma Chemical Co. (St. Louis, MO).

### 2.2. Preparing the patties

In the preparation of patties, all ingredients (mechanically deboned chicken meat, salt, rusk flour) were added into a mixer. These mixtures were separated into four groups as (1) Control (no added antioxidant), (2)  $300\text{ mg.kg}^{-1}$  L-carnosine (3)  $300\text{ mg.kg}^{-1}$  phytic acid (according to the researches) (4)  $200\text{ mg.kg}^{-1}$  BHA (according to the permitted level). L-carnosine, phytic acid and BHA were mixed with salt (1.5%) and 20 mL water and then added to each batch of patties.

The patty dough was homogeneously kneaded and formed with a diameter of 4.5 cm. Samples were individually packaged into polyethylene bags. These patties were kept in deep freeze for 180 days and at  $-18\text{ }^{\circ}\text{C}$  until analysis and thawed in a refrigerator at  $4\text{ }^{\circ}\text{C}$  for 12-24 h prior to analysis.

Moisture, protein and fat level analysis were performed in the MDCM. TBARS, pH, colour, haem iron and metmyoglobin analyses were also performed in the frozen stored patty samples at 0, 60, 120 and 180 days. Experiments were carried out with three replications, and two samples were used for each replicate.

### 2.3. pH and proximate analysis

10 g sample was homogenized in 100 mL of distilled water for 1 min using a blender (Waring Commercial Blendor®, USA) and pH values of the samples were measured with a pH meter (pH 315i/SET WTW, Germany) (Ockerman 1985). Water activity ( $a_w$ ) of patties samples from each group was measured at  $25\text{ }^{\circ}\text{C}$

using a Water Activity Meters (Aqualab instrument CX / 2, Decagon Devices, Inc., Pullman, WA, USA).

Moisture (hot air oven), protein (Kjeldahl) and fat (ether extraction) contents of the samples were determined using standard methods of AOAC (2000). Moisture (g water/100 g sample) was determined after drying 3 g sample at  $105^{\circ}\text{C}$  in order to provide constant weight. Protein (g protein/100 g sample) was analyzed according to the Kjeldahl method. Factor 6.25 was used for conversion of nitrogen to crude protein. Fat level (g fat/100 g sample) was determined by using a Soxhlet fat extraction apparatus.

### 2.4. Determination of TBARS

The method described by Tarladgis et al (1960) was used to determine the extent of lipid oxidation of the patties samples in 0, 60, 90, 120 days after processing. The samples were blended in a commercial blender (Waring Commercial Blendor®, USA), and then 10 g of the blended samples was mixed with 2.5 mL of concentrated HCl and 97.5 mL of distilled water. This homogenat was heated, distilled and 5 mL of the distillate were treated with 5 mL of TBA reagent. The mixture was heated in a boiling water bath for 35 min. A standard curve was prepared using 1.1.3.3-tetraethoxypropane (TEP). The absorbance was measured (UV-160 A, UV-Visible Recording Spectrophotometer, Shimadzu, Tokyo, Japan) at 532 nm against a reagent blank by a factor of 7.03 determined from the standard curve.

### 2.5. Metmyoglobin (%) and haem iron content

The analysis of metmyoglobin content was performed as described by Krzywicki (1982). The samples were blended in a commercial mixer (Waring Commercial Blendor®, USA), and 5 g of the ground samples and 25 mL ice-cold phosphate buffer (pH 6.80, 40 mM) was placed into a 50 mL polypropylene centrifuge tube. The mixture in the tube was homogenized with an Ultra-Turrax T25 (Janke & Kinkel, Staufen, Germany). The homogenate was kept for 1 h at  $4\text{ }^{\circ}\text{C}$  and centrifuged using a centrifuge (Nuve, NF-800-R Model, Turkey) at  $4\text{ }^{\circ}\text{C}$ . The supernatant was filtered with Whatman 1 filter paper, and the absorbance was read at 525, 545, 565 and 572 nm by spectrophotometer (Hitachi U-1800 Model, Japan). The percentage of metmyoglobin was calculated by Krzywicki (1982).

Determination of haem iron content of chicken patties was performed by Clark et al (1997). 2 g ground sample and 9 ml of acid acetone mixture (90% acetone, 8% deionised water, and 2% HCl) was transferred into a 50 ml centrifuge tube. The mixtures were waited for 1 h at room temperature then they were centrifuged (Nuve, NF-800-R Model, Turkey) for 10 minutes. The supernatant was filtered with Whatman 42 filter paper, and the absorbance was read at 640 nm against the acid acetone blank by spectrophotometer (Hitachi U-1800 Model, Japan). The total pigments were calculated as

haematin using the following formula (Lee et al 1999):  
 Total pigment ( $\text{mg.kg}^{-1}$ ) =  $A640 \times 680$

Haem iron was calculated according to Clark et al (1997):

Haem iron ( $\text{mg.kg}^{-1}$ ) = Total pigment ( $\text{mg.kg}^{-1}$ )  $\times$  8.82/100.

### 2.6. Color properties of patties

Color measurements were performed using a chroma meter CR-400 (Konica Minolta, Inc., Osaka, Japan) with illuminant D65, 2° observer, Diffuse/O mode, 8 mm aperture of the instrument for illumination and 8 mm for measurement. The instrument was calibrated with a white reference tile ( $L^* = 97.10$ ,  $a^* = 4.88$ ,  $b^* = 7.04$ ) before the measurements. The  $L^*$ ,  $a^*$  ( $\pm$ red–green) and  $b^*$  ( $\pm$ yellow–blue) color coordinates were determined according to the CIE Lab color space system. Chroma ( $C^*$ ) and hue-angle ( $h^\circ$ ) were calculated by the following formula:  $C^* = (a^{*2} + b^{*2})^{1/2}$ ,  $h^\circ = \tan^{-1} [b^*/a^*]$ . American Meat Science Association (AMSA) guidelines for color measurements were followed (Hunt et al 1991). Measurements were made directly upon the minced meat samples and carried out 6 times, 1 in the middle and 5 on different parts of the samples.

### 2.7. Sensory analysis

The sensory evaluation of the samples was evaluated by 9 experienced panelists after grilled patties. The cooking process continued until the central temperature reached 75 °C. Then the taste, odor, flavor, appearance, texture and overall impression were assessed using a 9-points hedonic scale (1 = dislike extremely, 2 = dislike very much, 3 = dislike moderately, 4 = dislike slightly, 5 = neither like nor dislike, 6 = like slightly, 7 = like moderately, 8 = like very much, 9 = like extremely) (Choe et al 2011).

### 2.8. Statistical analysis

The data obtained in this research were submitted to two-way analysis of variance. Each parameter was tested in triplicate samples with two replications. MINITAB for Windows Release 14 (2000) was used to calculate means and standard deviations as statistical methods. Duncan's Multiple Range test was used for comparison of means, with significance assigned at  $P < 0.05$  and  $P < 0.01$  (Snedecor & Cochran 1989).

## 3. Results and Discussion

Mechanically deboned chicken meat samples were determined to contain approximately 29.71% of dry matter, 19.43% of protein and 9.02% of fat, while dry matter, protein and fat contents of MDCM patties were found 36.71-38.42%, 19.37-20.71% and 7.79-8.28, respectively. Water activities of MDCM patties were found between 0.909 and 0.935. Daros et al (2005)

reported MDCM had 35.7% dry matter, 22.65% fat and 12.20% protein value. Mohamed & Mansour (2012) found that significant decrease of the protein and increase of the fat level of patties formulated with mechanically deboned poultry meat. This could be likely about to originate from the proximate composition of mechanically deboned poultry meat they used.

The effects of the treatment and storage days on pH value of frozen mechanically deboned chicken meat patties are indicated in Table 1. Carnosine added samples had higher pH values other samples. During storage time, the lowest pH values of patties groups were found in day of 60, except control group. Then the pH values began to increase. It was probably that an increase in pH values is because of the accumulation of metabolites caused microorganisms in meat (Jay 1996, Goddard et al 1996). Our findings are in good agreement with Naveena et al (2006) who reported that decrease of the pH values of meat which were added lactic acid, clove oil, vitamin C during storage, then to begin to increase in the samples.

Determination of thiobarbituric acid reactive substances (TBARS) values is one of the most important indicator for lipid oxidation in meat and meat products (Fernandez-Lopez et al 1997; Mohamed & Mansour, 2012). The treatment and storage days had a statistically significant ( $P < 0.05$ ) effect on TBARS values of MDCM patties. Using BHA to patties had a lowest TBARS values of samples, as the highest TBARS values was found in patties with the addition of phytic acid. As seen in Table 1, the effects of treatment groups had not statistically significant in the initial day, while the highest TBARS value was found in patties with carnosine in the day of 60. On the 120<sup>th</sup> day, the highest TBA value (13.31 mg MDA/kg sample) was determined in the group containing phytic acid. Carnosine and BHA group inhibited the lipid oxidation on the 180<sup>th</sup> day. Decker & Crum (1991, 1993) reported carnosine was the most effective at inhibiting oxidation in salted ground pork after 30 day of frozen storage. Jiang & Xiong (2016) indicated carnosine could be used as a promising natural antioxidant to prevent the advanced lipid oxidation end products in thermally processed meat. In another study, the MDCM samples treated with 3% *Pistacia khinjuk* essential oil (PEO) observed with higher TBARS values than those containing 1% and 2% (Azimi et al 2017). They also reported that the efficiency of BHA and TBHQ to MDCM inhibiting lipid oxidation was higher than natural essential oil during freeze storage. Mielnik et al (2003) stated retarding effect of antioxidants on the development of oxidation depended on the level and type antioxidants. In their research, TBARS values increased as concentration of ascorbic acid in the meat increased due to the ascorbic acid could act as a prooxidant at low concentrations.

Table 1

Effect of treatments and storage time on the pH values, TBARS values, metmyoglobin formations and haem iron contents of MDCM patties with different treatments during frozen storage

Parameter	Days	Control	BHA	CAR	PA
		M±SD	M±SD	M±SD	M±SD
pH	0	6.25±0.01 <sup>ab</sup>	6.25±0.01 <sup>ab</sup>	6.29±0.01 <sup>aA</sup>	6.24±0.01 <sup>ab</sup>
	60	6.19±0.06 <sup>aA</sup>	6.13±0.01 <sup>cAB</sup>	6.15±0.01 <sup>cAB</sup>	6.11±0.02 <sup>cb</sup>
	120	6.25±0.03 <sup>aA</sup>	6.19±0.01 <sup>bAB</sup>	6.23±0.03 <sup>bA</sup>	6.15±0.01 <sup>bb</sup>
	180	6.27±0.02 <sup>aA</sup>	6.20±0.01 <sup>bb</sup>	6.22±0.01 <sup>bb</sup>	6.21±0.01 <sup>ab</sup>
TBARS	0	0.39±0.11 <sup>dA</sup>	0.32±0.06 <sup>dA</sup>	0.23±0.04 <sup>dA</sup>	0.27±0.05 <sup>dA</sup>
	60	0.62±0.02 <sup>cD</sup>	1.24±0.01 <sup>cC</sup>	5.88±0.04 <sup>aA</sup>	4.35±0.32 <sup>cb</sup>
	120	2.21±0.11 <sup>bD</sup>	3.64±0.12 <sup>aC</sup>	4.84±0.07 <sup>bb</sup>	13.31±0.22 <sup>aA</sup>
	180	5.66±0.02 <sup>ab</sup>	1.62±0.04 <sup>bd</sup>	4.12±0.02 <sup>cC</sup>	5.94±0.02 <sup>bA</sup>
Metmyoglobin	0	26.31±0.34 <sup>cD</sup>	32.22±0.12 <sup>cC</sup>	36.53±0.23 <sup>bA</sup>	35.46±0.09 <sup>bb</sup>
	60	31.74±0.22 <sup>bc</sup>	36.23±0.19 <sup>bA</sup>	36.56±0.12 <sup>bA</sup>	34.66±0.08 <sup>cb</sup>
	120	37.77±0.19 <sup>aC</sup>	37.33±0.23 <sup>aC</sup>	40.88±0.11 <sup>ab</sup>	45.86±0.16 <sup>aA</sup>
	180	38.23±0.19 <sup>aA</sup>	29.37±0.09 <sup>dD</sup>	33.54±0.06 <sup>cC</sup>	34.64±0.08 <sup>cb</sup>
Haem iron	0	10.37±0.53 <sup>aA</sup>	9.77±1.81 <sup>aA</sup>	12.93±4.59 <sup>aA</sup>	19.43±0.58 <sup>aA</sup>
	60	10.39±0.30 <sup>ab</sup>	10.35±0.03 <sup>ab</sup>	10.23±0.07 <sup>ab</sup>	10.87±0.03 <sup>aA</sup>
	120	9.23±0.12 <sup>bA</sup>	9.03±0.70 <sup>aAB</sup>	9.19±0.07 <sup>aA</sup>	8.91±0.07 <sup>bb</sup>
	180	9.84±0.55 <sup>abAB</sup>	9.52±0.14 <sup>abC</sup>	11.04±0.83 <sup>aA</sup>	8.42±0.12 <sup>bc</sup>
a <sub>w</sub>	0	0.917±0.002 <sup>bA</sup>	0.926±0.003 <sup>aA</sup>	0.925±0.005 <sup>aA</sup>	0.928±0.001 <sup>aA</sup>
	60	0.913±0.004 <sup>bc</sup>	0.922±0.002 <sup>abAB</sup>	0.927±0.002 <sup>aA</sup>	0.919±0.002 <sup>bcB</sup>
	120	0.911±0.003 <sup>bb</sup>	0.910±0.003 <sup>bb</sup>	0.921±0.001 <sup>aA</sup>	0.908±0.002 <sup>cb</sup>
	180	0.925±0.002 <sup>aAB</sup>	0.935±0.009 <sup>aA</sup>	0.919±0.001 <sup>ab</sup>	0.927±0.002 <sup>aAB</sup>

<sup>a-d</sup> Means within a column with different letters are significantly different ( $P < 0.05$ ). Means based on six values. ( $n=6$ ).

<sup>A-D</sup> Means within a row with different letters are significantly different ( $P < 0.05$ ).

Control (no added antioxidant); BHA: 200 mg.kg<sup>-1</sup> butylated hydroxyanisole; CAR: 300 mg.kg<sup>-1</sup> L-carnosin; PA: 300 mg.kg<sup>-1</sup> phytic acid

Brito et al (2011) the TBARS values for the irradiated samples increased significantly ( $P < 0.05$ ) in comparison with the control samples after the 7th day of refrigerated storage.

For the control group, an increase in TBARS values is observed periodically during the storage period (Table 1). In the day of 120, TBARS levels were significantly increased in BHA and PA groups, except CAR. TBARS values of the patty samples increased at the beginning of frozen storage, then started to decrease. Melton (1983) reported malonaldehyde was a secondary product of oxidative rancidity and this did not necessarily mean that the TBARS level continued to increase during the storage. At the end of the storage time (180 day), TBARS values for all samples treated with BHA and carnosine were significantly ( $P < 0.05$ ) lower than the values of the control and PA samples. Addition of phytic acid increased the oxidative rancidity of MDCM patties. Similarly, Stodolak et al (2007) reported that an important increase of TBARS was determined in raw beef and pork homogenates with added different phytic acid concentration stored for 3

days at 4 °C. However, they were also stated phytic acid, at 5 mM, effectively inhibited the accumulation of TBARS occurring in cooked beef and pork homogenates. Lee et al (1998) found that phytic acid was effective for inhibition of the oxidative changes in a model beef system. According these results, TBARS values in the mechanically deboned chicken meat samples depended on treatment, storage type, storage time, antioxidant type, concentration of antioxidant, etc.

Analysis of variance (ANOVA) of metmyoglobin for MDCM patties treated with different antioxidants treatments and stored at -18 °C for 180 days, showed significant ( $P < 0.05$ ) effects of storage time and type of antioxidant (Table 1). In terms of storage, the highest metmyoglobin value was determined on the 120<sup>th</sup> day for all treatment groups. According to the treatment, the use of antioxidants increased the formation of metmyoglobin on day 0, 60 and 120. The efficiency of various antioxidants formation metmyoglobin on the day of 180 was in the following order: control > phytic acid > carnosine > BHA.

Table 2

Effect of treatments and storage time on the lightness ( $L^*$ ), redness ( $a^*$ ), yellowness ( $b^*$ ), hue-angle ( $h$ ) and chroma ( $C^*$ ) of raw chicken patties with different treatments during frozen storage

Parameter	Days	Control	BHA	CAR	PA
		M±SD	M±SD	M±SD	M±SD
$L^*$	0	47.95±1.64 <sup>aA</sup>	47.59±0.29 <sup>aA</sup>	48.00±0.88 <sup>aA</sup>	47.68±0.73 <sup>aA</sup>
	60	42.07±1.24 <sup>bAB</sup>	43.33±1.53 <sup>bA</sup>	40.76±1.55 <sup>bB</sup>	42.11±1.00 <sup>bAB</sup>
	120	38.29±1.09 <sup>cB</sup>	40.28±1.21 <sup>cA</sup>	39.25±0.95 <sup>bAB</sup>	39.52±0.83 <sup>cAB</sup>
	180	48.70±0.38 <sup>aA</sup>	48.09±0.77 <sup>aA</sup>	48.95±1.20 <sup>aA</sup>	48.21±1.30 <sup>aA</sup>
$a^*$	0	20.80±1.74 <sup>aA</sup>	19.97±2.56 <sup>aA</sup>	19.30±1.03 <sup>aA</sup>	18.63±0.52 <sup>aA</sup>
	60	14.83±2.56 <sup>bA</sup>	11.29±1.17 <sup>bB</sup>	14.27±1.04 <sup>bAB</sup>	12.20±1.81 <sup>bAB</sup>
	120	12.00±0.74 <sup>bcA</sup>	10.67±1.10 <sup>bAB</sup>	9.77±0.36 <sup>cB</sup>	9.42±0.76 <sup>cB</sup>
	180	9.81±0.44 <sup>cB</sup>	12.49±0.78 <sup>bA</sup>	9.13±0.82 <sup>cB</sup>	9.76±0.77 <sup>cB</sup>
$b^*$	0	14.25±0.62 <sup>aA</sup>	14.68±0.80 <sup>aA</sup>	13.62±1.22 <sup>aA</sup>	14.73±2.55 <sup>aA</sup>
	60	9.13±0.84 <sup>cA</sup>	9.29±0.40 <sup>cA</sup>	9.39±0.42 <sup>bA</sup>	9.37±1.18 <sup>bA</sup>
	120	7.55±0.48 <sup>dA</sup>	7.42±0.54 <sup>dA</sup>	7.64±0.57 <sup>cA</sup>	7.37±0.46 <sup>bA</sup>
	180	12.62±0.68 <sup>bA</sup>	12.32±0.43 <sup>bA</sup>	13.23±0.61 <sup>aA</sup>	12.98±1.06 <sup>aA</sup>
Hue-angle( $h^\circ$ )	0	34.49±1.68 <sup>bA</sup>	36.50±2.71 <sup>bA</sup>	35.18±2.09 <sup>bcA</sup>	38.09±4.23 <sup>bA</sup>
	60	31.88±3.37 <sup>bB</sup>	39.56±2.66 <sup>bA</sup>	33.39±1.70 <sup>cB</sup>	37.70±5.01 <sup>bAB</sup>
	120	32.21±2.27 <sup>bB</sup>	34.91±2.78 <sup>bAB</sup>	37.97±1.89 <sup>bA</sup>	38.07±2.23 <sup>bA</sup>
	180	51.09±1.91 <sup>aB</sup>	44.64±2.20 <sup>aC</sup>	55.42±2.34 <sup>aA</sup>	53.04±1.23 <sup>aB</sup>
Chroma( $C^*$ )	0	25.23±1.69 <sup>aA</sup>	24.80±2.44 <sup>aA</sup>	23.63±1.35 <sup>aA</sup>	23.80±1.88 <sup>aA</sup>
	60	17.44±2.51 <sup>bA</sup>	14.64±1.03 <sup>cA</sup>	17.09±0.99 <sup>bA</sup>	15.43±1.73 <sup>bA</sup>
	120	14.19±0.68 <sup>cA</sup>	13.00±1.06 <sup>cAB</sup>	12.41±0.54 <sup>cB</sup>	11.97±0.76 <sup>cB</sup>
	180	15.63±0.61 <sup>bcB</sup>	17.55±0.57 <sup>bA</sup>	16.09±0.77 <sup>bAB</sup>	16.24±1.27 <sup>bAB</sup>

<sup>a-d</sup> Means within a column with different letters are significantly different ( $P < 0.05$ ). Means based on six values. ( $n=6$ ).

<sup>A-C</sup> Means within a row with different letters are significantly different ( $P < 0.05$ ).

Control (no added antioxidant); BHA: 200 mg.kg<sup>-1</sup> butylated hydroxyanisole; CAR: 300 mg.kg<sup>-1</sup> L-carnosin; PA: 300 mg.kg<sup>-1</sup> phytic acid

Stodolak et al (2007) reported phytic acid had not shown effect on the rate of metmyoglobin formation in pork homogenates, while metmyoglobin values decreased with adding of 5 mM phytic acid in beef homogenates. This case could be explained as the influence of phytic acid on these meat types could be associated with the heme compound of the meat types. Heme parts with transition some metal ions (iron), are identified modulators of peroxidation of polyunsaturated fatty acids found in the membranes of meat and meat products (Keller & Kinsella 1973; Stodolak et al 2007).

Color stability of meat and meat products could be explained by susceptibility of myoglobin to autoxidation (Renner et al 1992). The characterization of the compounds capable of oxidising Omb to MMb is unclear subject in meat system. Acton et al. (1993) reported that oxygen could initiate lipid oxidation, giving rise to the formation of prooxidant compounds capable of reacting with Omb which results in metmyoglobin formation. Lipid-oxy radicals and other prooxidant substances formed by oxygen impressed the Omb. Van Der Oord & Wesdorp (1971), Greene et al (1971),

Harrison (1977) stated that consumer rejection levels of metmyoglobin was 30% to 50%. In other study, metmyoglobin levels of chicken breast meat was determined as 62.15% (Min & Ahn 2009). Zipp & Kauzmann (1973) reported that metmyoglobin denaturation may be associated with rupture of hydrophobic linkages.

Myoglobin is the color pigment in meat and meat products. There were significant differences between storage days and treatment ( $P < 0.05$ ). The haem iron content of patties was constant throughout initial storage. On the day of 60, using phytic acid increased the haem iron levels while decreased at this time up to end of the frozen storage because of the release of free iron from haem. The lowest haem iron content was found in the PA group as the highest content was in the CAR group at the end of the storage time (180<sup>th</sup> day). This could be probably about the extractability of haem pigments. Some researchers stated reduction of haem iron was inversely depended on haem iron content (Benjakul & Bauer 2001, Gomez-Basauri & Regenstein 1992, Ozer & Sarıçoban 2010).

Color is one of the most important factors affecting consumer acceptability of meat and meat products. Table 2 indicates the values that highlight the color parameters for  $L^*$ ,  $a^*$ ,  $b^*$ , Hue-angle and Chroma.

Firstly, in all groups,  $L^*$  values had decreased until storage of 120<sup>th</sup> day, then the brightness had started to increase at the end of the storage.  $L^*$ ,  $a^*$ , hue-angle and chroma values of patties were not affected between treatment groups at the beginning of the storage. However,  $b^*$  values of samples were not affected between treatment groups all storage days (0, 60, 90, 120 and 180). The brightest patty was found in the added BHA group on the 60 and 120 day. As the storage period increased,  $a^*$  values had started to decrease in the samples. Hunt et al (1999) reported the meat had been stored for a longer time was thought to include mainly either oximyoglobin or metmyoglobin, while contrary to deoxymyoglobin. Adding antioxidants to MDCM

patties had reduced to redness values on the 60 and 120 day. The highest  $a^*$  values was determined in the BHA group on the 180<sup>th</sup> day. Our finding is good agreement with Fernández-López et al. (2005) who found that redness values decrease as lipid oxidation of meat increase, during storage.

Figure 1 shows taste, odor, flavor, appearance, texture and overall impression scores of mechanically deboned chicken meat patties added no antioxidant (Control) BHA, carnosine and phytic acid. Although there is no statistically significant difference, different scores were found in the samples. The PA group received slightly higher scores than the other groups. Azimi et al (2017) determined the samples treated with PEO, BHT, TBHQ in terms of flavor, odor had statistically same scores when comparing with the control, except MDPM enriched with 3% PEO.

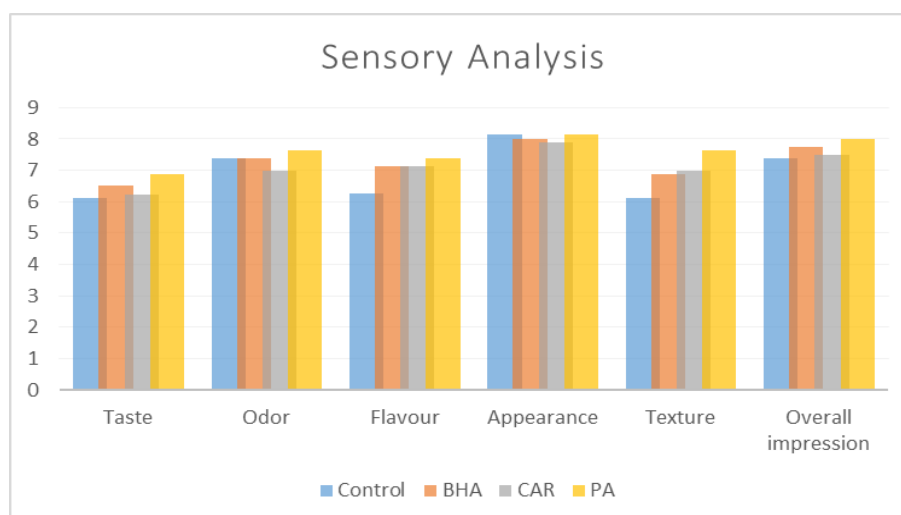


Figure 1

Sensory analysis scores of mechanically deboned chicken meat patties with different antioxidant.

#### 4. Conclusion

Mechanically deboned chicken meat is a good protein based foods; while its high oxidation potential may limit its use in further processed meat products. BHA, carnosine and phytic acid prevented metmyoglobin formation at the end of the storage when added to chicken patty. BHA showed the lowest TBARS value throughout the storage, carnosine groups followed this. Adding phytic acid to mechanically deboned meat can be more susceptible to oxidative damage than other groups during frozen storage. These results may be due to the concentrations used.

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