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Effect of Clove Powder and Modified Atmosphere Packaging on the Oxidative and Sensory Quality of Chicken Meat Caruncles During Ambient Storage (35±2^{0}C) Conditions

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ABSTRACT

The individual as well as synergistic effect of modified atmosphere packaging and clove powder as natural preservative on the oxidative and sensory quality of chicken meat caruncles during storage at 35±2°C at 70% R.H. for 60 days was evaluated. For this, four different batches of chicken meat caruncles were prepared i.e. CA (control, aerobic packaging), CMAP (Control, 50:50 CO_2/N_2 modified atmosphere packaging), TA (treated with 0.2% clove powder, aerobic packaging) and TMAP (treated with 0.2% clove powder, 50:50 CO_2/N_2 modified atmosphere packaging). In oxidative quality, TBARS value of TMAP sample was significantly lower ($P<0.05$) than CA sample and was marginally lower than CMAP and TA samples. TA and TMAP samples showed significantly higher ($P<0.05$) DPPH % inhibition as compared to control counterparts (CA and CMAP). The ABTS % inhibition was significantly higher ($P<0.05$) in TA (88.26) and TMAP (89.81) as compared to CA (56.93) and CMAP (71.43) samples. Among sensory attributes, colour / appearance was significantly higher ($P<0.05$) in TA batch than CMAP and TMAP. Flavour score of TA sample was significantly higher ($P<0.05$) than CA. Crispiness of TMAP was significantly higher ($P<0.05$) than TA. The scores of all the samples for after-taste, meat flavour intensity and overall acceptability did not vary significantly among themselves. The use of 50%CO_2+50%N_2 (MAP) in combination with 0.2% clove powder was effective for maintaining the oxidative and sensory quality of chicken meat caruncles at ambient storage conditions.

Keywords *:Chicken meat caruncles, Clove powder, Modified atmosphere packaging, Oxidative quality, Sensory attributes*

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INTRODUCTION

A snack is a convenient and miniature food item that is generally taken along with meals or in place of a meal. Snack can be sweet, savory light or substantial and they may be endowed with attributes such as 'healthy' or 'just for fun' *et al*. 2012). Snacks may be classified as first generation (conventional potato chips and baked crackers), second generation (directly expanded snacks) and third generation (semi-products or pellets, half-products or intermediate-products) (Pansawat 2007). Food industry is mainly dominated by cereal snacks which lack some essential amino acids such as threonine, lysine and tryptophan (Chaiyakul *et al*. 2009). So incorporation of spent hen meat to these snacks may revolutionize this industry by adding to its nutritional value along with some sensory attributes like flavour and taste (Singh *et al*. 2013a). The meat obtained from spent hens is quite heavy, tough, dry and sinewy due to its higher collagen content and is thus not well accepted by the masses (Kiran *et al*. 2013; Sobana *et al*. 2013). Therefore, it can be utilized in snacks only after tenderization. Various meat based snacks such as beef jerky, fermented/cured low-moisture meat sticks, popped pork rinds etc are very popular (Park *et al*. 1993). These products are convenient, easy to carry, highly crispy, attractive (Zeuthen 1984), nutritionally sound and shelf-stable in nature (Bhattarcharya *et al*. 1988).

In extruded snack foods, the quality evaluation seems to be correlated with sensory, instrumental and microstructure characteristics which all together will account for a product with high acceptability (Anton and Luciano 2007). In meat based snack products, lack of crispiness, lipid oxidation and growth of yeast and mold are the major bottle necks which should be combated to improve its shelf life and acceptability amongst the masses. In sensory analysis of extruded snack foods, highly trained panels are usually the most applied techniques. Even though the meat snacks are ready-to-eat and fat rich foods and thus are prone to lipid oxidation resulting in deteriorating the quality by adversely affecting the colour, flavour and nutritional value. During lipid oxidation, the decrease in nutritional value occurs due to loss of essential fatty acids and vitamins and generation of toxic products such as malonaldehyde and cholesterol oxidation products (Tang *et al*. 2001). The process of lipid oxidation is influenced by a number of factors including temperature, light and concentration of oxygen in the surrounding atmosphere, degree of unsaturation of fatty acids, presence of anti-oxidants and pro-oxidants and the presence of enzymes (Skibsted *et al.* 1998). To combat this problem, the use of synthetic compounds is debatable due to adverse effects on human health. This issue has revived the search for natural preservatives such as clove powder (Kumar and Tanwar 2011), ginger (Gupta and

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Ravishankar 2005), garlic (Yin and Cheng 2003) etc. Clove (*Syzygium aromaticum*) is known to have antioxidant and antimicrobial activity for long time due to its active ingredient - eugenol (Cort 1974; Shan *et al*. 2009). This is an effective way to minimize lipid per-oxidation in meat products, thus maintaining nutritional quality.

Modified atmosphere packaging (MAP) is also a promising technique used by meat processing industries to extend the shelf-life as well as to keep the quality characteristics of meat products. Many research workers documented the effects of natural preservatives and MAP on the storage quality of meat products viz. oregano oil and MAP on microbiological profile of beef fillets during the storage at 5°C (Tsigarida *et al*. 2000), rosemary extract and MAP on oxidative and sensory quality of hamburger patties under refrigerated storage (Muhlisin *et al*. 2013), clove and MAP on microbiological quality of fresh pork under refrigerated storage (Zhang *et al*. 2009), MAP on oxidative, sensory and microbiological quality of pre-cooked chicken during storage at 4°C (Patsias *et al*. 2006), MAP on oxidative and microbiological quality of dehydrated beef at 4 and 10°C for 150 days (Aksu and Kaya 2005).

Studies on the effect of MAP in combination with natural preservatives on the quality of meat based snack products are still limited. Therefore, this study was conducted to evaluate the individual as well as synergistic effect of MAP and clove powder on the oxidative and sensory quality chicken meat caruncles and to investigate whether synergistic effect of MAP and clove powder provides better caruncle quality or not.

MATERIALS AND METHODS

Preparation of chicken meat caruncles

About 80-100 weeks old spent hens (White Leghorn) were procured from the poultry farm of Guru Angad Dev Veterinary and Animal Sciences University (GADVASU), Ludhiana. The birds were humanely slaughtered complying with the local regulations of animal welfare and ethics protocols approved by GADVASU, Animal Ethical Committee.The dressed carcasses were brought to the laboratory and deboned manually. The deboned meat chunks were tenderized by dipping in a solution containing 2.5% of papain (w/w) and 0.15 M calcium chloride (w/v) for about 36-40 hours at 4±1°C as per the procedure outlined by Biswas *et al*. (2009). After thorough washing and draining the extra moisture, meat chunks were packed in low density polyethylene (LDPE) bags and kept at -18±1°C for subsequent use. Frozen tenderized meat sample was taken out as per requirement and cut into smaller cubes after partial thawing in a refrigerator (4±1°C). The meat chunks were then double minced using 6 mm and 4 mm grinder plates (KL-32, Kalsi, Ludhiana, India) to get fine tenderized minced chicken meat (TMCM). Two batches of chicken meat emulsion-control and treated, were prepared by blending 65% TMCM with 1% common salt (TATA salt, Tata chemicals Ltd. Mumbai) and 1% sugar and mixed in Inalsa mixer for 1 min, followed by mixing of 0.5% baking powder (Ajanta Baking powder, Ajanta Food Products Co., Solan, India; Code No. 288668), 0.7% carboxymethyl cellulose (Sodium salt high viscosity carboxymethyl, S d fine-CHEM Ltd., Mumbai, India; Code No. 56095) and14% refined wheat flour, 21% tapioca starch (Shubham Starch Chemical Pvt. Limited, Faridabad, Haryana) and 5% refined oil (FORTUNE Soybean oil) up to 30 sec in the mixer. In addition to this, 0.2% clove powder was added to treated batch as per the study of Raj *et al.* (2005). With the help of a manually operated stainless steel extruder, the prepared chicken meat emulsion was extruded in the form of thin chip like caruncles in a microwave plate. Cooking was done by putting this plate (filled with raw chicken meat caruncles) in a microwave oven (Inalsa microwave ovens, New Delhi, India) for 4 min (2 min on one side and 2 min on other side). Cooked chicken meat caruncles (CMC) were divided into two separate groups. The first group was packaged in low density polyethylene for aerobic packaging and second group was packaged in Roschermatic packaging machine, type 19/S/CL, Germany, using 50:50 CO_2/N_2 gas mixture in MAP laminated pouches (polyethylene/polypropylene 100/100 μm) as per the study of Gok *et al.* (2008). Finally four different variants of CMC were prepared viz. control aerobic (CA), control modified (CMAP), treated aerobic (TA) and treated modified (TMAP). All the samples were stored in controlled temperature humidity cabinet (Sonar plus BOD 1062M, Associated Scientific Technologies, Delhi, India) at 35±2°C and 70% RH for a storage period of 60 days. The samples were evaluated at 10 days interval for oxidative quality (TBARS number, DPPH % inhibition and ABTS % inhibition) and sensory quality attributes (colour, flavour, crispiness, after-taste, meat flavour intensity and overall acceptability).

Oxidative Stability Parameters

Thiobarbituric acid reactive substances (TBARS)

Lipid oxidation was evaluated using TBARS method as described by Witte *et al.* (1970). Ten gram of sample was triturated with 25 ml of pre-cooled 20% trichloroacetic acid (TCA) in 2 M orthophosphoric acid solution for 2 min. The content was filtered through Whatman filter paper No. 1 to get TCA extract.Three ml of this TCA extract was mixed with 3 ml of TBA reagent (0.005 M) in test tubes and placed in a dark room for 16 hrs. A blank sample was prepared by mixing 1.5 ml of 20% TCA, 1.5 ml distilled water and 3 ml of 0.005 M TBA reagent. Absorbance (O.D.) was measured at fixed wavelength of 532 nm with a scanning range of 531 nm to 533 nm using UV-VIS spectrophotometer (Elico SL-159, Mumbai, India). TBARS was calculated as mg malonaldehyde per kg of sample by multiplying O.D. value with a factor 5.2.

1, 1-diphenyl-2-picrylhydrazyl (DPPH)radical scavenging activity

The ability to scavenge 1, 1 diphenyl-2picrylhydrazyl (DPPH) radical by added clove powder in CMC was estimated following the method of Kato *et al*. (1988) with slight modifications. DPPH can make stable free radicals in aqueous or ethanol solution, however, fresh DPPH solution was prepared before every measurement. Sample extract was prepared by blending 10 gm of CMC with 20 ml of ethanol for 2 min. Priorto use, about 1 ml of DPPH stock solution was diluted with 9 ml of ethanol to make working solution. Then, 200 μl of the sample extract was mixed with 1300 μl of 0.1M Tris-HCl buffer previously adjusted to a pH of 7.4 and 1 ml of DPPH working solution (250 μM) in test tubes. Ethanol was used as blank sample. After properly mixing the samples, the absorbance (At_0) at time t=0 min, was measured at 517-518 nm using a UV-VIS Spectrophotometer (Elico India Limited, Mumbai) and then incubated at room temperature in dark for 20 min. After 20 min,the absorbance (At_{20}) at time t=20 min was measured at the same wavelength. The free radical scavenging activity was calculated as a decrease of absorbance from the equation,

Scavenging activity (% inhibition) = $100 - [(At_{20}/At_0) \times 100]$.

2-2-azinobis-3ethylbenthiazoline-6-sulphonic acid(ABTS) radical scavenging activity

The Spectrophotometric analysis of $ABTS^+$ radical scavenging activity was determined according to method of ABTS, also a relatively stable free radical (Shirwaikar *et al.* 2006). This method is based on the ability of antioxidants to quench the long-lived ABTS radical cation, a blue/green chromophore with characteristic absorption at 734 nm, in comparison to that of standard antioxidants. $ABTS^+$ was dissolved in water to a 7 mM concentration. ABTS radical cation ($ABTS^+$) was produced by reacting $ABTS^+$ stock solution with 2.45 mM potassium persulphate ($K_2S_2O_8$) and allowing the mixture to stand in the dark at room temperature for 16 hrs before use. Because $ABTS^+$ and potassium persulphate react stoichiometrically at a ratio of 1:0.5 (mol/mol), this will result in complete oxidation of $ABTS^+$. Oxidation of $ABTS^+$ commenced immediately, but the absorbance was not maximal and stable until 6 hrs had elapsed. The radical was stable in this form more than two days, when stored in dark at room temperature. Prior to use, the stock solution was diluted with ethanol to an absorbance of 0.70 at t_0 (t=0 min) and equilibrated at 30°C exactly 6 min after initial mixing. About 2 ml of $ABTS^+$ working standard solution was mixed with 1ml of sample extract (as mentioned for DPPH) and absorbance was measured after 20 min (t_{20}) at 734 nm. The $ABTS^+$ activity was calculated by using formula

$ABTS^+$ activity (% inhibition) = $[(0.7 - At_{20})/ 0.7] \times 100$

Sensory evaluation

Samples of CMC were subjected to sensory evaluation by seven experienced panelists from the staff at the Department of Livestock Products Technology, College of Veterinary Science, GADVASU, for different sensory attributes viz. colour/ appearance, flavour, crispiness, after-taste, meat flavour intensity and overall acceptability, following 8- point hedonic scale (Keeton 1983) where 8=extremely desirable and 1=extremely undesirable. In all the trials, mean value of each sensory attribute (n = 7) was taken as the value of response variable.Three replicates (n=21) were conducted.

Statistical analysis

Experiment was carried out thrice in duplicates (n=6) and data were analyzed on SPSS-16.0 software package (SPSS Inc. Chicago, IL, USA) as per standard procedures (Snedecor and Cochran 1994) for analysis of variance using Duncan's Multiple Range Tests and Homogeneity tests to test the significance of difference between means at 5% level ($P<0.05$) of significance.

RESULTS AND DISCUSSION

Oxidative quality of chicken meat caruncles

TBARS is considered as a marker of lipid per-oxidation in meat and meat products (Shahidi *et al*. 1987). Perusal of table 1 revealed that there was no significant difference ($P>0.05$) in TBARS number among CMAP, TA and TMAP samples at the beginning of the storage. TBARS number of TMAP sample was significantly lower ($P<0.05$) than CA sample and was marginally lower than CMAP and TA sample on day 0. This indicated that CP and MAP treatment was very much effective from the beginning of storage to prevent lipid oxidation in the product. Similar trend was observed in treated samples (TA and TMAP) on subsequent storage intervals till the end of storage on day 60 whereas no significant difference was observed in TBARS number between CA and CMAP was found on day 30 but subsequently on day 40, 50 and 60, CMAP samples exhibited significantly lower TBARS number till the end of the storage. It was observed that MAP is more effective in reducing TBARS number than aerobic packaging. Gok *et al.* (2008) also reported lowest TBARS values for MAP than aerobically packaged *pastrima*(dry cured beef). Moreover, the values observed were in consonance with the results of Askar *et al.*(1993); Yagli and Ertas (1998) and Aksu(1999), who reporteda threshold limit of TBARS as 0.16 to 2.46 mg malonaldehyde/kg for dehydrated meat products. Also as the storage period advanced, TBARS number in all the batches increased marginally irrespective of type of packaging as concluded by Jin *et al.* (2010) in dry cured pork. Other workers also reported significant increase in TBARS values in salmon jerky snack sticks (Kong *et al*. 2010), chicken snacks (Singh *et al*. 2011), beef snacks (Park *et al*. 1993), *pastirma* (Aksu and Kaya 2005) and variety of sausage products treated with natural

antioxidant and packaged under modified atmosphere conditions (Viuda-Martos *et al*. 2010).

There was no significant variation (P>0.05) in DPPH % inhibition between TA and TMAP as well as between CA and CMAP samples whereas both the treated batches were having significantly higher (P<0.05) DPPH % inhibition than the control samples (Table 1). This indicated that there was good effect of CP and MAP packaging to scavenge the free radicals even at the beginning of the storage on day 0. All through the storage period TA and TMAP had significantly higher (P<0.05) or marginally higher DPPH % inhibition as compared to control counterparts (CA and CMAP). Study of MAP showed that it was effective both in control and in treated samples to protect the food product against lipid changes during storage. This is because in all storage intervals both CMAP and TMAP showed higher or marginally higher DPPH % inhibition than CA and TA samples. Further it was noticed that combination of natural preservative (clove powder) and MAP produced synergistic effect as evidenced by significantly higher or marginally higher DPPH % inhibition in TMAP samples as compared to other variants (CA, CMAP and TA). Kong *et al.* (2010) also observed highest DPPH activity of clove among other natural preservatives.

The ABTS % inhibition was significantly higher (P<0.05) in TA (88.26) and TMAP (89.81) as compared to CA (56.93) and CMAP (71.43). The MAP sample of both control and treated batches showed higher ABTS % inhibition showing that MAP was effective in scavenging the free radicals even at very beginning of the storage. Similar trend was maintained on subsequent storage intervals. The treated CMC showed better results in terms of ABTS % inhibition than both the control batches (CA and CMAP). This indicated that clove powder is very much effective to scavenge the free radicals during the storage period of 60 days at room temperature. All through the storage period TMAP samples showed either marginally or significantly higher ABTS % inhibition than the TA sample indicating that there is synergistic effect of clove powder and MAP in terms of scavenging the free radicals produced during storage. In general it was observed that there was a significant decrease in ABTS % inhibition at the end of storage on day 60 as compared to beginning of storage i.e. day 0. Gulcin *et al.* (2012) also reported significant ABTS % inhibitionactivity of clove than other preservatives. The results of oxidative quality parameters were in consonance with other parameters such as peroxide value, free fatty acid value, pH etc (Singh *et al*. 2013b).

Table 1 : Effect of clove powder and modified atmosphere packaging on oxidative quality of chicken meat caruncles stored at 35±2°C and 70% R.H

Tmts/Days	Day 0	Day 10	Day 20	Day 30	Day 40	Day 50	Day 60
				TBARS number (mg MDA/kg)			
CA	0.89 ± 0.09^{Ab}	0.93 ± 0.07^{ABb}	0.99 ± 0.07^{ABb}	1.10 ± 0.05^{Bc}	1.29 ± 0.04^{Cc}	1.36 ± 0.06^{Cc}	1.44 ± 0.06^{Cc}
	0.84 ± 0.08^{Aab}	0.88 ± 0.06^{ABab}	0.92 ± 0.06^{ABab}	1.01 ± 0.06^{BCbc}	1.13 ± 0.03^{CDb}	$1.21\pm0.02D^{Eb}$	1.30 ± 0.01^{Eb}
TA	0.67 ± 0.09^{Aab}	0.79 ± 0.06^{ABab}	0.82 ± 0.06^{ABab}	0.86 ± 0.06^{Bab}	1.03 ± 0.02^{Cab}	1.11 ± 0.03^{CDab}	1.21 ± 0.03^{Dab}
	0.61 ± 0.10^{Aa}	0.70 ± 0.06^{ABa}	0.75 ± 0.05^{ABa}	0.79 ± 0.05^{Ba}	0.96 ± 0.03^{Ca}	1.03 ± 0.03^{CDa}	1.13 ± 0.03^{Da}
				DPPH (% inhibition)			
CA	22.39 ± 1.92^{Aa}	25.05 ± 3.88^{Aa}	18.28 ± 1.10^{Aa}	24.10 ± 2.40^{Aab}	19.50 ± 2.73^{Aab}	19.30 ± 1.49^{Aab}	20.12 ± 1.61^{Aa}
CMAP	21.27 ± 1.53^{Ba}	22.93 ± 3.83^{Ba}	15.15 ± 2.16^{ABa}	17.91 ± 3.04^{ABa}	11.67 ± 4.12^{Aa}	14.34 ± 2.84^{ABa}	16.86 ± 2.20^{ABa}
TA	28.46 ± 2.40^{Ab}	28.46 ± 4.48^{Aa}	20.42 ± 1.99^{Aab}	26.50 ± 2.30^{Aab}	23.21 ± 3.27^{Ab}	21.27 ± 1.78^{Ab}	21.89 ± 2.86^{Aa}
TMAP	32.14 ± 2.13^{Bb}	31.03 ± 3.62^{Ba}	24.29 ± 1.37^{ABb}	27.51 ± 3.24^{ABb}	20.96 ± 2.63^{Aab}	21.79 ± 2.13^{Ab}	22.24 ± 2.18^{Aa}
				ABTS (% inhibition)			
CA	56.93 ± 0.81^{Fa}	53.81 ± 1.36^{Ea}	52.36 ± 0.89^{DEa}	50.17 ± 0.64^{CDa}	48.17 ± 1.10^{BCa}	46.69 ± 0.94^{Ba}	43.05 ± 0.43^{Aa}
CMAP	71.43 ± 2.51^{Db}	67.93 ± 1.35^{CDb}	65.43 ± 0.77^{CDb}	62.69 ± 1.24^{BCb}	58.93 ± 3.01^{ABb}	56.41 ± 2.74^{ABb}	54.19 ± 2.35^{Ab}
TA	88.26 ± 0.51^{Ec}	83.17 ± 1.20^{Dc}	80.43 ± 1.03^{CDc}	78.48 ± 0.96^{BCc}	77.17 ± 0.70^{Bc}	74.17 ± 1.16^{Ac}	71.81 ± 0.96^{Ac}
TMAP	89.81 ± 0.62^{Ec}	86.88 ± 1.57^{DEc}	85.45 ± 1.29^{Dd}	84.29 ± 1.28^{CDd}	81.64 ± 0.86^{BCc}	79.00 ± 0.99^{ABd}	77.12 ± 1.33^{Ad}

Mean±S.E. with different superscripts row wise (capital alphabets) and column wise (small alphabets) differ significantly (P<0.05). CA = Control aerobic, CMAP = Control modified atmosphere packaging (without preservative); TA = Treated aerobic and TMAP = Treated modified atmosphere packaging (0.2 % CP)

Sensory quality of chicken meat caruncles

Data pertaining to different sensory attributes of CMC viz. colour, flavour, crispiness, after-taste, meat flavour intensity and overall acceptability were presented in Table 2. The colour or appearance was significantly higher (P<0.05) in TA batch (7.62) than CMAP (7.33) and TMAP (7.31) but did not significantly vary from CA (7.48) sample at the beginning of storage on day 0. The effect of clove powder in improving the

colour was evidenced even at the beginning of storage but on subsequent storage intervals colour scores did not significantly vary among control and treated batches. Starting from day 10 to day 60, clove powder treated (TA) showed a marginally lower colour scores as compared to its control counterpart (CA) showing that clove powder treatment could not signify change in improving the colour and appearance of the product. The TMAP sample had marginally higher colour scores as compared to CMAP sample from day 30 onwards till the end of storage. This might be due to combination effect of clove powder and modified atmospheres. Similar results were reported by Gok *et al.* (2008), who also concluded that as the storage time increased, colour scores of *Pastrima* declined with the lowest scores observed on day 120. Also decrease in colour scores in all samples with the advancement of storage days could be attributed to non-enzymatic browning resulted from reaction between lipid oxidation products and amino acids (Che Man *et al*. 1995). The treated CMC (TA and TMAP) remained good to very good and the two controls (CA and CMAP) remained fair to good at the end of the storage period.

Flavour score of TA sample (7.48) was significantly higher ($P<0.05$) than CA sample but did not vary significantly from CMAP and TMAP batches. This indicated that clove powder treatment induced better flavour even at the beginning of storage on day 0 whereas MAP did not show its effect in improving flavour score on the same day. There was no significant difference in flavour score among the two control and two treated batches on subsequent storage intervals till the end of storage period. However, at the end of storage period (day 60) TA (6.12) and TMAP (6.14) samples showed a marginally higher flavour score as compared to their control counterparts i.e. CA (6.02) and CMAP (6.07). This indicates that natural preservative clove powder improved the flavour score to some extent. Since the TBARS values in all the samples were less than the threshold limits i.e. 2 mg malonaldehyde/kg which was not detected by the panelists in terms of flavour score even at the end of storage period. Moreover, the decrease in flavour scores for all samples as storage time progressed could be attributed to the oxidation of fat (production of malonaldehyde compounds), liberation of free fatty acids and increased microbial load (Sahoo and Ajaneyulu 1997). Similar findings were reported by Cilla *et al.* (2006) in dry-cured Iberian ham slices packed in vacuum and modified atmospheres.

Crispiness of CMC showed highest sensory scores in TMAP batches on day 0 but it was not significantly varied from CA and CMAP samples. While the crispiness score of TMAP was significantly higher ($P<0.05$) than TA showing that MAP was effective in improving the crispiness even at the beginning of storage. On day 10 to 60 crispiness score did not vary significantly among CA, CMAP, TA and TMAP samples. But on day 60, crispiness score was marginally higher in TA (6.12) and TMAP (6.14) samples as compared to CA (6.00) and CMAP (6.10). All the CMC samples were good to very good with respect to crispiness at the end of storage period.

After-taste score of four different variants of CMC did not significantly vary among themselves on day 0 and it ranged from 7.12 to 7.26 on 8 point descriptive scale. On subsequent storage days, similar trend was observed showing no significant change in after-taste score due to the treatment of clove powder as natural preservative and MAP. However, towards the end of storage on day 50 and 60, two treated samples (TA and TMAP) showed marginally higher flavour scores than control counterparts (CA and CMAP). All the samples were maintained at good to very good at the end of storage period. In general, after-taste scores decreased as the storage period advanced in all the CMC samples.

Meat flavour intensity did not show any significant change due to clove powder and MAP from the beginning of the storage till the end. In general meat flavour intensity decreased in all the samples as the storage period progressed. However, the meat flavour intensity remained marginally higher in TMAP samples on day 50 and 60 as compared to CA, CMAP and TA. This indicated that clove powder and MAP were helpful in enhancing the meat flavour intensity to some extent during storage. All the CMC samples were good to very good even after two months of storage period.

The overall acceptability scores ranged from 7.29-7.45 between four different batches without any significant variation among them. On subsequent storage till day 60 no significant variation in overall acceptability scores were noticed among two control and two treated batches of CMC. However, at the end of storage on day 60, TMAP showed marginally higher overall acceptability scores as compared to other variants indicating that MAP was useful in improving the overall acceptability scores of product to some extent. In general overall acceptability scores decreased as the storage period advanced and followed the same pattern that observed for other sensory attributes. Gok *et al.* (2008) also showed similar decreasing trends of overall acceptability of pastrimas packaged under MAP conditions with increase in the storage period.

With the advancement of storage period, all the sensory attributes namely colour, flavour, crispiness, after-taste, meat flavour intensity and overall acceptability decreased irrespective of the type of product. The statement is strongly supported by the findings of Singh *et al.* (2011), who reported that sensory attributes of chicken snacks showed in significant decreasing trend during a storage period of 30 days. Sharma and Nanda (2002) also reported similar results in chicken chips during the storage period of 12 weeks. Kalra *et al.* (1987) also observed similar trends in sensory scores of colour and texture of snacks during storage at room temperature for a period of 6 months.

Table 2 : Effect of clove powder and modified atmosphere packaging on sensory attributes of chicken meat caruncles stored at 35±2°C and 70% R.H

Tmts/Days	Day 0	Day 10	Day 20	Day 30	Day 40	Day 50	Day 60
				Colour/Appearance			
CA	7.48±0.10^{Eab}	7.10±0.07^{Da}	6.76±0.10^{Ca}	6.71±0.09^{Ca}	6.57±0.09^{Ca}	6.19±0.13^{Ba}	5.88±0.08^{Aa}
CMAP	7.33±0.09^{Ea}	7.02±0.07^{Da}	6.71±0.10^{Ca}	6.67±0.10^{Ca}	6.50±0.10^{BCa}	6.24±0.12^{Ba}	5.93±0.09^{Aa}
TA	7.62±0.10^{Db}	7.14±0.13^{Ca}	6.74±0.10^{Ba}	6.69±0.10^{Ba}	6.50±0.09^{Ba}	6.07±0.13^{Aa}	6.02±0.09^{Aa}
TMAP	7.31±0.09^{Da}	7.12±0.07^{Da}	6.52±0.10^{BCa}	6.76±0.08^{Ca}	6.62±0.09^{Ca}	6.29±0.13^{ABa}	6.04±0.08^{Aa}
				Flavour			
CA	7.19±0.07^{Ca}	7.07±0.06^{Ca}	6.62±0.13^{Ba}	6.64±0.06^{Ba}	6.67±0.09^{Ba}	6.26±0.13^{Aa}	6.02±0.06^{Aa}
CMAP	7.26±0.07^{Dab}	7.00±0.08^{Ca}	6.62±0.13^{Ba}	6.52±0.05^{Ba}	6.45±0.10^{Ba}	6.36±0.12^{Ba}	6.07±0.08^{Aa}
TA	7.48±0.09^{Db}	7.33±0.07^{Db}	6.62±0.13^{Ca}	6.50±0.06^{BCa}	6.62±0.09^{Ca}	6.24±0.13^{ABa}	6.12±0.08^{Aa}
TMAP	7.33±0.08^{Dab}	7.17±0.06^{Dab}	6.69±0.12^{Ca}	6.52±0.06^{BCa}	6.41±0.09^{ABa}	6.26±0.12^{ABa}	6.14±0.09^{Aa}
				Crispiness			
CA	7.24±0.06^{Eab}	7.05±0.07^{DEa}	6.93±0.11^{CDa}	6.69±0.09^{BCa}	6.55±0.10^{Ba}	6.50±0.11^{Ba}	6.00±0.09^{Aa}
CMAP	7.31±0.05^{Dab}	7.10±0.07^{Da}	6.81±0.12^{Ca}	6.64±0.10^{BCa}	6.50±0.09^{Ba}	6.55±0.10^{BCa}	6.10±0.08^{Aa}
TA	7.19±0.05^{Fa}	7.02±0.07^{EFa}	6.86±0.12^{DEa}	6.71±0.08^{CDa}	6.57±0.08^{BCa}	6.33±0.11^{ABa}	6.12±0.08^{Aa}
TMAP	7.38±0.06^{Eb}	6.98±0.06^{Da}	7.10±0.10^{Da}	6.74±0.08^{Ca}	6.50±0.09^{Ba}	6.31±0.10^{ABa}	6.14±0.09^{Aa}
				After-taste			
CA	7.19±0.12^{Ca}	7.14±0.07^{Ca}	6.57±0.10^{Ba}	6.48±0.09^{Ba}	6.52±0.09^{Ba}	6.29±0.14^{ABa}	6.12±0.07^{Aa}
	7.26±0.07^{Ea}	7.07±0.09^{Ea}	6.76±0.09^{Da}	6.45±0.10^{BCa}	6.52±0.09^{CDa}	6.24±0.13^{ABa}	6.14±0.08^{Aa}
TA	7.12±0.11^{Ca}	7.02±0.07^{Ca}	6.62±0.10^{Ba}	6.45±0.10^{ABa}	6.48±0.09^{ABa}	6.31±0.14^{Aa}	6.21±0.07^{Aa}
	7.24±0.11^{Ca}	7.07±0.06^{Ca}	6.50±0.10^{ABa}	6.62±0.10^{Ba}	6.57±0.08^{Ba}	6.38±0.13^{ABa}	6.21±0.08^{Aa}
				Meat flavour intensity			
CA	7.36±0.07^{Da}	6.93±0.07^{Ca}	6.98±0.09^{Ca}	6.74±0.09^{BCa}	6.60±0.10^{Ba}	6.19±0.12^{Aa}	6.12±0.08^{Aa}
	7.33±0.06^{Ea}	7.05±0.07^{Da}	6.98±0.09^{Da}	6.71±0.10^{Ca}	6.48±0.10^{BCa}	6.26±0.12^{ABa}	6.17±0.07^{Aa}
TA	7.36±0.06^{Ea}	7.10±0.06^{Da}	7.02±0.06^{Da}	6.69±0.09^{Ca}	6.50±0.10^{BCa}	6.29±0.11^{ABa}	6.17±0.08^{Aa}
	7.33±0.07^{Da}	7.07±0.06^{Ca}	6.86±0.10^{BCa}	6.67±0.09^{Ba}	6.41±0.10^{Aa}	6.33±0.12^{Aa}	6.19±0.08^{Aa}
				Overall acceptability			
CA	7.29±0.07^{Fa}	7.17±0.06^{EFa}	6.98±0.10^{DEa}	6.79±0.06^{CDa}	6.60±0.10^{BCa}	6.45±0.10^{Ba}	6.19±0.08^{Aa}
	7.33±0.08^{Da}	7.19±0.06^{CDa}	6.98±0.11^{Ca}	6.69±0.06^{Ba}	6.41±0.10^{Aa}	6.45±0.11^{ABa}	6.26±0.06^{Aa}
TA	7.45±0.08^{Ea}	7.24±0.10^{Ea}	6.98±0.10^{Da}	6.69±0.06^{Ca}	6.52±0.10^{BCa}	6.43±0.11^{ABa}	6.26±0.06^{Aa}
TMAP	7.29±0.07^{Ca}	7.26±0.07^{Ca}	7.05±0.10^{Ca}	6.71±0.07^{Ba}	6.38±0.09^{Aa}	6.41±0.11^{Aa}	6.29±0.06^{Aa}

The sensory attributes were based on 8- point hedonic scale. Mean±S.E. with different superscripts row wise (capital alphabets) and column wise (small alphabets) differ significantly ($P<0.05$). CA = Control aerobic, CMAP = Control modified atmosphere packaging, TA = Treated aerobic and TMAP = Treated modified atmosphere packaging

CONCLUSION

The current study revealed that addition of 0.2% clove powder showed lower TBARS value and higher DPPH and ABTS % inhibition in chicken meat caruncles than that of control samples without addition of clove powder. Also it imparted desirable colour to product at the beginning and end of the storage period. Moreover, clove powder with 50:50 CO_2/N_2 gas mixture in MAP showed synergistic effect and decreased lipid deterioration (TBARS, DPPH and ABTS) with improvement in all the sensory attributes with respect to their counter parts. Therefore, meat industry can effectively utilize 0.2% clove powder with 50:50 CO_2/N_2 gas mixture in MAP to improve the quality of meat snacks.

REFERENCES

Aksu MI (1999) Pastirma uretiminde starter kullanim imkanlari (Research on the possibility of starter culture use in pastirma production). Ph.D. Thesis, Atatu¨rk University, Graduate Institute of Science, Erzurum, Turkey

Aksu MI, Kaya M (2005) Effect of storage temperatures and time on shelf-life of sliced and modified atmosphere packaged *Pastirma*, a dried meat product produced from beef. J Sci Food Agric 85: 1305-1312

Anton AA, Luciano FB (2007) Instrumental texture evaluation of extruded snack foods: a review. Ciencia Y Tecnol Aliment 5: 245-251

Askar A, El-Samahy SK, Shehata HA, Tawfik M (1993) Pasterma and beef bouillon.The effect of substituting KCl and K lactate for sodium chloride. Fleischwirtschaft Int 73: 289-292

Bhattarcharya S, Das H, Bose AN (1988) Effect of extrusion process variables on *in vitro* protein digestibility of fish-wheat flour blends. Food Chem 28: 225-231

Biswas AK, Sahoo J, Chatli MK,Sharma DK (2009) Effect of lactic acid, calcium chloride and papain on the physico-chemical and sensory qualities of turkey meat chunks. Ind J Poult Sci 44: 131-133

Chaiyakul S, Jangchud K, Jangchud A, Wuttijumnong P, Winger R (2009) Effect of extrusion conditions on physical and chemical properties of high protein glutinous rice-based snack. LWT-Food Sci Technol 42: 781-787

Che Man YB, Bakar J, Mokri AAK (1995) Effect of packaging films on storage stability of intermediate deep fried mackerel. Int J Food Sci Technol 30: 175-181

Cilla I, Martinez L, Beltran JA, Roncales P (2006) Dry-cured ham quality and acceptability as affected by the preservation system used for retail sale. Meat Sci 73: 581-

Cort WM (1974) Hemoglobin peroxidation test screens antioxidants. Food Technol 28:60-66

Gok V, Obuz E, Akkaya L (2008) Effects of packaging method and storage time on the chemical, microbiological and sensory properties of Turkish pastrima - a dry cured beef product. Meat Sci 80: 335-344

Gulcin I, Elmastas M, Aboul-Enein HY (2012) Antioxidant activity of clove oil – a powerful antioxidant source. Arabian J Chemist 5: 489-499

Gupta S, Ravishankar S (2005) A comparison of the antimicrobial activity of garlic, ginger, carrot, and turmeric pastes against *Escherichia coli* O157:H7 in laboratory buffer and ground beef. Foodborne Patho Dis 2: 330-340

Jin SK, Mandal PK, Kim IS, Kang SN (2010) Effects of packaging methods and refrigerated storage on the quality of dry-cured pork neck. Asian J Anim Vet Adv 5: 526-536

Kalra CL, Kaur S, Sharma TC, Kulkarni SC, Berry SK (1987) Studies on the preparation, packaging and storage of potato snacks from cold stored potatoes. Indian Fd Packer 45: 30-39

Kato K, Terao S, Shimamoto N, Hirata M (1988) Studies on scavengers of active oxygen species: synthesis and biological activity of 2-o-alkylascorbic acids. J Med Chem 31: 793-798

Keeton JT (1983) Effect of fat and sodium chloride / phosphate levels on the chemical and sensory properties of pork patties. J Food Sci 48: 878-881

Kiran M, Sudhakar Reddy K, Kondal Reddy K, Madhav Rao T, Naveena BM (2013) Effect of blade tenderization on physicochemical and ultrastructural properties of spent hen meat. J Meat Sci 9: 16-20

Kong J, Zhang H, Xiong YL (2010) Antioxidant activity of spice extracts in a liposome system and in cooked pork patties and the possible mode of action. Meat Sci 85: 772-778

Kumar D, Tanwar VK (2011) Utilization of clove powder as phyto preservative for chicken nuggets preparation. J Stored Prod Postharvest Res 2: 11-14

Muhlisin, Kang SM, Choi WH, Lee KT, Cheong SH, Lee SK (2013) The effect of modified atmosphere packaging and addition of rosemary extract, sodium acetate and calcium lactate mixture on the quality of pre-cooked hamburger patties during refrigerated storage. Asian-Aust J Anim Sci 26: 134-142

Pansawat N (2007) Development of an extruded snack supplemented with fish protein and N-3 fatty acids. Ph.D Thesis, Graduate School, Kasetsart University, Thailand

Park J, Rhee KS, Kim BK, Rhee KC (1993) High-protein texturized products of defatted soy flour, corn starch and beef: shelf-life, physical and sensory properties. J Food Sci 58: 21-27

Patsias A, Chouliara I, Badeka A, Savvaidis IN, Kontominas MG (2006) Shelf-life of a chilled pre-cooked chicken product stored in air and under modified atmospheres: microbiological, chemical and sensory attributes. Food Microbiol 23: 423-429

Raj R, Sahoo J, Karwasra RK, Hooda S (2005) Effect of ginger extract and clove powder as natural preservatives on the quality of microwave oven cooked chevon patties. J Food Sci Technol 42: 362-364

Sahoo J, Anjaneyulu ASR (1997) Effects of natural antioxidants and vacuum packing on the quality of buffalo meat nuggets during refrigerated storage. Meat Sci 47: 223-230

Shahidi F, Yun J, Rubin LJ, Wood DF (1987) The hexanal content as an indicator of oxidative stability and flavour acceptability in cooked ground pork. Can Inst Food Sci Technol J 20: 104-106

Shan B, Cai YZ, Brooks JD, Corke H (2009) Antibacterial and antioxidant effects of five spice and herb extracts as natural preservatives of raw pork. J Sci Food Agric 89: 1879-1885

Sharma BD, Nanda PK (2002) Studies on the development and storage stability of chicken chips. Ind J Poult Sci 37: 155-158

Shirwaikar A, Rajendran K, Punitha ISR (2006) *In vitro* antioxidant studies on Benzyl tetra isoquinoline alkaloid berberine. Biol Pharm Bull 29: 1906-1910

Singh P, Chatli MK, Sahoo J, Biswas AK (2012) Effect of different cooking methods on the physico-chemical and sensory attributes of chicken meat caruncles. Ind J Poult Sci 47: 363-367

Singh P, Sahoo J, Chatli MK, Biswas AK (2013a) Effect of different levels of baking powder on the physico-chemical and sensory attributes of chicken meat caruncles. Haryana Vet 47: 363-367

Singh P, Sahoo J, Chatli MK, Biswas AK (2013b) Effect of clove powder and modified atmosphere packaging on storage quality of chicken meat caruncles during ambient storage (35±2°C) conditions. J Vet Public Health11: 51-55

Singh VP, Sanyal MK, Dubey PC, Mendiratta SK (2011) Quality assessment of vacuum packaged chicken snacks stored at room temperature. J Stored Products Postharvest Res 2: 120-126

Skibsted LH, Mikkelsen A, Bertelsen G (1998) Lipid-derived off flavours in meat. In: ShahidiF (Ed.) Flavour of meat, meat productsand seafoods II, London: Blackie Academic & Professional. pp 217-248

Snedecor GW, Cochran WG (1994) Statistical methods, 8th Ed. Iowa State University Press, Ames, Iowa

Sobana AS, Kulkarni VV, Kalaikannan A, Santhi D (2013) Preparation, storage stabilityof shredded meat product at ambient temperature. J Meat Sci 9: 35-40

Tang S, Sheehan D, Buckley DJ, Morrissey PA, Kerry JP (2001) Antioxidant activity of added tea catchins on lipid oxidation of raw minced red meat, poultry and fish muscle. Int J Food Sci Technol 36: 685-692

Tsigarida E, Skandamis P, Nychas GJE (2000) Behavior of *Listeria monocytogenes* and autochthonous flora on meat stored under aerobic, vacuum and modified atmosphere packaging conditions with or without the presence of oregano essential oil at 5^0C. J Appl Microbiol 89: 901-909

Viuda-Martos M, Ruiz-Navajas Y, Fernández-López J, Pérez-Álvarez JA (2010) Effect of orange dietary fibre, oregano essential oil and packaging conditions on shelf-life of bologna sausages. Food Cont 21: 436-443

Witte VC, Krause GF, Bailey ME (1970) A new extraction method for determining 2-Thiobarbituric acid values of pork beef during storage. J Food Sci 35: 582-585

Yagli Gur H, Ertas AH (1998) Effect of sodium ascorbate on some quality characteristics of Turkish pastirma. Turk J Agric For 22: 515-520

Yin MC, Cheng WS (2003) Antioxidant and antimicrobial effects of four garlic derived organosulfur compounds in ground beef. Meat Sci 63: 23-28

Zeuthen P (1984) Industrial applications of extrusion cooking (present or potential). In: Zeuthen P (Ed.) Thermal Processing and Quality of Foods, London: Elsevier Applied Science Publishers Limited pp. 282

Zhang H, Kong B, Xiong YL, Sun X (2009) Antimicrobial activities of spice extracts against pathogenic and spoilage bacteria in modified atmosphere packaged fresh pork and vacuum packaged ham slices stored at 4^0C. Meat Sci 81: 686-692