Effect of pomegranate peel powder on cooked spent layers chicken meatballs[#]

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Abstract

The present study was conducted to see the effect of pomegranate peel powder (PPP) on chicken meatballs from spent layers at three different levels (i.e., 1, 1.5 and 2% based on w/w). The effects of this powder on physico-chemical characteristics, texture profiles, microbial counts and sensory attributes were evaluated. Results showed that the addition of PPP significantly ($p<0.05$) improved the cooking yield, total ash and crude fibre of meat products. The treated products had significantly ($p<0.05$) lower values of peroxide and thiobarbituric acid (TBA) value and higher value of 1, 1-diphenyl-2 picrylhydrazyl (DPPH) radical scavenging activity. The treated products had better sensory and textural properties than control. Shelf life is also enhanced in treated products during products stored at refrigerated temperature of $4\pm1^{\circ}\text{C}$ for a period of 15 days. The results demonstrated that PPP can be used in meat industry and other muscle food industries to increase the product stability and storability without affecting its quality and acceptability as well as to fulfill the consumer expectations for making the products healthy by reducing fat content.

Key words: Chicken meatballs, Pomegranate peel powder, Spent layers

Highlights

- PPP has high phenolic compounds and antioxidants properties.
- PPP significantly reduced the peroxide value and lipid oxidation of meat products.
- PPP could be used as natural additive to enhance the shelf life of meat products.
- PPP could be used in the formation of healthy, stable and wholesome meat products.

INTRODUCTION

Pomegranate peel powder is considered to provide a novel source of natural antioxidants agents, dietary fibre and overall nutritional properties due to its higher phenolic compounds and antioxidant properties (Quideau *et al.*, 2011; Smaoui *et al.*, 2019; Gullón *et al.*, 2020) which provide numerous health benefits such as their ability to decrease blood cholesterol level, improve insulin response, minimise postprandial blood glucose, insulin, and triglyceride concentrations, reduce hyperlipidemia and hypertension, contribute to gastrointestinal health and prevent of certain cancers such as colon cancer (Ranjitha *et al.*,

2018). It also acts as antimicrobial agents due to possess of gallic acid, ellagic acid and punicalagin, along with their free radical scavenging properties (Das *et al.*, 2021). It exhibits antibacterial activities against intestinal flora, especially enteric pathogens such as *Escherichia coli*, *Salmonella* spp., *Shigella* spp., and *Vibrio cholera* (Negi *et al.*, 2003; Gullon *et al.*, 2016; Kaur *et al.*, 2018; Karthikeyan and Vidya, 2019; Singh *et al.*, 2019).

Meat has a high biological value and is a good source of proteins and is an ideal source of soluble minerals, vitamins, essential fats, amino acids and many other nutrients having a

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specific function to the body (Biesalski, 2005; Gálvez *et al.*, 2019; Das *et al.*, 2020). Due to its rich nutritional profile, meat and meat products are highly susceptible for microbial deterioration (Lorenzo *et al.*, 2014; Cunha *et al.*, 2018; Lorenzo *et al.*, 2018; Domínguez *et al.*, 2019). Simultaneously, meat also contains metal catalysts, haem pigment, oxidizing agents, and unsaturated fatty acids which are responsible for protein and fat oxidation especially when exposed to extreme environmental conditions such as high temperature, air, and light (El-Hadary and Taha, 2020). Therefore, the meat products become rancid and several sensory attributes of the products, such as changes of colour, flavour and structural changes of products, have been deteriorated during storage period, and consequently shorten the shelf life of the products (Hygreeva and Pandey, 2016; Pateiro *et al.*, 2018; Das *et al.*, 2019; de Carvalho *et al.*, 2019; Domínguez *et al.*, 2019; Madane *et al.*, 2019; Banerjee *et al.*, 2020).

Meatballs are emulsion type products and are used at fast food outlets. Due to its short shelf life, as various deteriorative changes occurred during storage period, an experiment was conducted to see the effect of pomegranate peel powder on chicken meatballs from spent layers at refrigerated temperature ($4\pm1^{\circ}\text{C}$) on various qualities attributes such as physico-chemical characteristics, antioxidant properties, antimicrobial properties, sensory properties and shelf life of the products.

MATERIALS AND METHODS

Raw materials: Spent layer birds were procured from State Poultry Farm, Tollygunge, Kolkata. Spent layers birds were subjected to ante-mortem inspection and maintained for 6 hours by giving water only. The age of all birds was above 80 weeks. After observing 6 hours in ante-mortem inspection, spent layers birds were found free from any abnormalities. Slaughter and dressing was done in the Poultry Processing unit of the Department of Livestock Products Technology, West Bengal University of Animal and Fishery Sciences, Kolkata as per the standard procedure mentioned by Sahoo

and Panda (1983) with little bit modification.

Outer covers of pomegranate fruit were removed and placed into sun dried. After completely drying, it ran into the grinder. This powder was then sieved through a fine mesh in order to obtain a powder with an average particle size of $<1.0\text{ mm}$ (Costa *et al.*, 2009).

Condiment mixture was prepared by blending peeled and sliced onion, garlic and ginger in the ratio of 3:1:1, respectively, in a fine paste. For spice mixtures, aniseed (saunf), black pepper (kali mirch), red chilli (lal-mirch), caraway (shahi-jeera) seed, cinnamon (dalchini), cardamom (elaichi), clove (laung), coriander (dhaniya), cumin (jeera) seed, turmeric (haldi), nutmeg (jaiphal), mace (javitri), dried ginger (saunth) were taken appropriately and then those spices are powdered separately and mixed thoroughly.

Meatball emulsions: The meat was weighed and cut into small chunks and placed in the meat mincer. Meat was minced by using a 10 mm plate followed by a 5 mm diameter plate subsequently. Meatballs emulsions were prepared by adding lean meat (70%), rice bran oil (7.0%), ice flakes (8.7%), salt (1.6%), refined wheat flour (5%), dry spice mix (1.80%), condiment mixture (4%), egg albumin (1.285%), sugar (0.3%), tripolyphosphate (0.3%), and sodium nitrite (0.015%).

Meatballs preparation: Meatball emulsion was divided equally into 4 parts. One is for control and three were divided for treatments. Treatments were treated with pomegranate peel powder at three different levels viz 1.0%, 1.5% and 2.0%, respectively, on w/w basis. Now, uniformed meatballs (diameter 2 cm) were prepared from each portion (total 4 portions) mechanically. The individual part of meatballs (total 4 parts) was placed in metal containers and steam cooked at 121°C temperature for 20 minutes under a pressure of 6.8 kg (Kumar *et al.*, 2013). After that, cooked meatballs were cooled at room temperature. One portion from each part was taken for analysis on 0 day and the rest of the portions were kept under refrigerated condition ($4\pm1^{\circ}\text{C}$) for further analysis.

Parameters tested: Physico-chemical parameters such as pH, cooking yield percentage, water hold

ing capacity, proximate analysis and texture profile analysis were determined and methodologies were followed as per procedure set up by Troutt *et al.* (1992), Murphy *et al.* (1975), Dzudie *et al.* (2004), AOAC (2001), Bourne (1978), respectively.

Different oxidation and antioxidant properties such as peroxide value, DPPH scavenging activity assay and TBA value were determined and the methodologies were followed as per procedure described by Koniecko (1979), Kato *et al.* (1988) and Tarladgis *et al.* (1960), respectively.

Microbiological parameters which are generally responsible for deterioration of the meat products were also tested. Total plate count, yeast and mould count, *Staphylococcus aureus*, lactic acid bacteria, *Escherichia coli*, total Coliform count and *Salmonella* sp. were determined and the procedure was followed as mentioned by APHA (2001) and the same procedure was followed for shelf life studies in which products were kept under refrigerated conditions at $4\pm1^{\circ}\text{C}$ for 15 days.

Ten trained sensory panelists were performed for sensory analysis as it was described by Wichchukit and O'Mahony (2015). Sensory tests were conducted on 0 day, 3rd day, 5th day, 7th day and 15th day.

Statistical analysis: All data were analyzed in IBM® SPSS® software using a general linear model. Univariate data were analyzed by the

statistical method of ANOVA according to Tukey's HSD (Honest Significant Difference) test (Tukey, 1949). All the results were presented in term of mean and standard error (SE). A probability value of ($p<0.05$) was noted as significant and probability value of ($p<0.01$) was noted as highly significant.

RESULTS

Physico-chemical properties: Table 1 shows the cooking yield percentage and Fig. 1 shows the pH and water holding capacity indicating the effect of pomegranate peel powder for both control and meatballs treated with different percentages of pomegranate peel powder (PPP). The mean value showed gradual increase in the

Table. 1. Effect of cooking yield of cooked spent layers chicken meatballs from different treatment groups

Treatment	Cooking yield (%)
Control	82.45 $\pm$ 0.09 ^a
PPP 1%	84.35 $\pm$ 0.09 ^b
PPP 1.5%	86.10 $\pm$ 0.12 ^c
PPP 2%	87.35 $\pm$ 0.09 ^d

N = 4, Data (Mean $\pm$ standard error) with different small letter superscripts in the same column differ significantly ($p<0.05$)

[Values of means $\pm$ standard error (SE) of quadruplets independent experiments. Different small letters indicate significant differences ($p<0.05$) within the samples in the same day]

Fig. 1. Effect of PPP on pH and water holding capacity of spent layer chicken meatballs

[Values of means $\pm$ standard error (SE) of quadruplets independent experiments. Different small letters indicate significant differences ($p < 0.05$) within the samples in the same day]

Fig. 2. Effect of PPP on proximate analysis of spent layer chicken meatballs

cooking yield when increasing the PPP% in the meatballs. pH of the treated products decreases with the increase of PPP%, whereas, water holding capacity increased significantly ($p < 0.05$) with the increase of PPP%.

Proximate analysis: Proximate analysis shows the significant effect of PPP on spent layers cooked meatballs (Fig. 2). The amount of crude

fibre, total ash increased significantly ($p < 0.05$) due to increase of PPP%. On the other hand moisture percentage, crude protein, crude fat were decreased significantly ($p < 0.05$) with the increase of PPP%.

Oxidation and anti-oxidative properties: Fig. 3 shows the oxidation and anti-oxidative properties of PPP. Peroxide and TBA value

[Values of means $\pm$ standard error (SE) of quadruplets independent experiments. Different small letters indicate significant differences ($p < 0.05$) within the samples in the same day]

Fig. 3. Effect of PPP on oxidation and antioxidative properties of spent layer chicken meatballs

[Values of means $\pm$ standard error (SE) of quadruplets independent experiments. Different small letters indicate significant differences ($p < 0.05$) within the samples in the same day]

Fig. 4. Effect of PPP on textural attributes of spent layer chicken meatballs

[Values of means $\pm$ standard error (SE) of quadruplets independent experiments. Different small letters indicate significant differences ($p < 0.05$) within the samples in the same day]

Fig. 5. Effect of PPP on microbial quality of spent layer chicken meatballs

reduced significantly ($p < 0.05$) with the increase of fruit by products in the meatballs. DPPH radical scavenging activity increased significantly ($p < 0.05$) with the increase of PPP % in the meatballs.

Texture profile analysis: The control samples had the higher hardness, cohesiveness, gumminess and chewiness values, whereas for springiness, the samples treated with 1% PPP showed the highest. With an increase of the

[Values of means $\pm$ standard error (SE) of quadruplets independent experiments. Different small letters indicate significant differences ($p < 0.05$) within the samples in the same day]

Fig. 6. Effect of PPP on sensory attributes of spent layer chicken meatballs

storage period, there was a gradual decrease in hardness, springiness, cohesiveness, gumminess and chewiness. All values were statistically significant ($p < 0.05$).

Microbiological analysis: Evaluation of TPC, yeast and mould Count, *Staphylococcus aureus* and Lactic acid bacteria showed that incorporation of PPP on chicken meatballs from spent layers was very much effective ($P < 0.05$) in controlling the microbial counts throughout

the 15 days of storage period kept at refrigerator temperature of $4 \pm 1^\circ\text{C}$. Microbial counts in meat products decreased in a manner proportional to the levels of PPP. However, detection of *Salmonella* spp., *Escherichia coli* and total Coliform count were also performed, but those microbes were not detected throughout the storage period of 15 days.

Sensory analysis: Data of organoleptic attributes of the spent layers chicken meatballs

showed that the addition of PPP made significant ($P < 0.05$) effects on various attributes. Appearance and colour decreased with the increase of PPP %. On the other hand, juiciness, flavour, texture and overall acceptability increased with the increase of PPP %.

DISCUSSION

Physico-chemical properties: Cooking yield is generally performed to see the influence of non-meat ingredients, such as macromolecular hydrocolloids, starches and fibre which are known to have water binding capacity, on the treated products. The mean value showed gradual increase in the cooking yield when increasing the PPP % in the meatballs. A particular trend of increase in cooking yield with increase of fruit by products powder concentration was observed for treated meatballs. The reason behind such findings may be due to the presence of fibre which could have retained moisture in the final product and thus increase its cooking yield. The observation of this study was synchronized with the observation made by Huda *et al.* (2014), Banerjee *et al.* (2015), Ho and Dahri (2016), Das *et al.* (2008) and Morsy *et al.* (2018).

pH measurement is required to see the freshness of products which in turn determines the quality and shelf life of meat products (Das *et al.*, 2021). Incorporation of PPP decreased the pH of the cooked meatballs. Similar findings were reported by Naveena *et al.* (2008), Habib *et al.* (2018), Firuzi *et al.* (2019) and Mehdizadeh *et al.* (2020). Whereas, Sharma and Yadav (2020) found non-significantly lower pH in cooked chicken patties prepared from pomegranate by-products and extracts. Increase of water holding capacity was observed with the increase of PPP % in the meatballs. This might be due to the fact that higher levels of PPP % retain more water and thereby increase the water holding capacity. The results obtained in this study were in commensurate with the studies conducted by Akhtar *et al.* (2015) in raw beef sausage incorporated with 3% pomegranate rind powder, Morsy *et al.* (2018)

in beef meatballs using lyophilized pomegranate peel nanoparticles, Serdaroglu *et al.* (2005) in frozen low fat beef meatballs containing legume flours and Das *et al.* (2008) in frozen goat meat nuggets using textured soy granules and full fat soy paste.

Proximate analysis: Moisture and fat percentage decreased gradually with the increased concentration of PPP. Similar findings were also observed by Lubis *et al.* (2020) and Mohammad *et al.* (2021). Reduction of crude protein percentage was observed with the increase of PPP in the meatballs. According to Ranjitha *et al.* (2018), pomegranate peel powder contains 3.74% protein. This factor aids to the protein content of the spent layer chicken meatballs. Although meat does not contain any fibre, a small amount of crude fibre content was found in control treatments. This may be due to the presence of crude fibre contributed by spices and condiments present in control treatments. Therefore, an increase of crude fibre percentage was observed with the increase of PPP in the meatballs. Increase of total ash percentage was observed with the increase of PPP in the meatballs. This finding are conforming with the findings made by Al-Sayed and Abdelrahman (2013), Verma *et al.* (2013), Das *et al.* (2014), Banerjee *et al.* (2015), Ho and Dahri (2016), Naknaen *et al.* (2016), Thomas *et al.* (2016) and Vivar-Vera *et al.* (2018). But, this observation is not conforming to the observations made by Bhat *et al.* (2015) who added aloe vera gel in chicken nuggets and Huda *et al.* (2014) who incorporated apple pomace in mutton nuggets. The results showed the opposite because they added gel and paste form, respectively, which added moisture in the final products and thus reduced the total ash content in the finished products.

Oxidation and anti-oxidative properties: Reduction of peroxide value and TBA value were observed with the increase of PPP in the meatballs. Whereas, an increased of DPPH radical scavenging activity was observed with

the increase of PPP in the meatballs. This result indicates that PPP is having a noticeable effect on scavenging free radicals. Pomegranate peel powders are high in antioxidant activity due to presence of high content of phenolic acids and flavonoids (Derakhshan *et al.*, 2018; Ranjitha *et al.*, 2018; de Oliveira *et al.*, 2020). So, this may be the reason for the decrease in oxidation in treated meat.

Texture profile analysis: Reduction of hardness, springiness, and cohesiveness were observed with the increase of PPP in the meatballs. Hardness depends on the moisture percentage of meatballs. Springiness is the ability of the product to regain its shape after deformation during the compression cycle. Springiness values were associated with the elastic properties of meatballs. So, reduction of springiness indicates that the elasticity of meatballs is decreased with the increase in the level of incorporation of phytomaterials (Rindhe *et al.*, 2018). Increases of gumminess and chewiness were observed with the increase of PPP in the meatballs. Gumminess and chewiness values are directed by hardness, cohesiveness and springiness values of the product. Incorporation of PPP in the meatballs leads to increase in chewiness significantly ($P < 0.05$). These findings are consistent with the results reported by Rindhe *et al.* (2018) and Das *et al.* (2020).

Microbiological analysis: A trend has been found that decrease of total plate count, yeast and mould, *Staphylococcus aureus*, Lactic acid bacteria were observed with the increase of PPP in the meatballs. This may be due to PPP having antimicrobial properties due to contain of total flavonoids and tannins content. Similar findings were reported by Hayrapetyan *et al.* (2012), Tayel *et al.* (2012), Casquete *et al.* (2015), Ismail *et al.* (2016), Martínez *et al.* (2019), Shahmirian *et al.* (2019) and Chen *et al.* (2020).

Sensory analysis: Appearance and colour were significantly ($P < 0.05$) lower than control which is opposite to Kumar *et al.* (2021) who reported

that the effect of goat meatballs were improved with PP. Increase of flavour was observed with the increase of PPP in the meatballs. This could be due to the reason that PPP might have acted as stabilizing agent for retaining the flavour by inhibiting the lipid oxidation. Meatballs containing PPP were found to be more juice than the control, which could be attributed to the increased moisture retention of the product during cooking. Similar findings were reported by Kumar *et al.* (2021). Overall acceptability scores in treated products remained stable and were acceptable even on the 15th day of storage.

The present study showed that the PPP can be used in the formation of healthy, stable and wholesome meat products for having properties of antioxidant, antimicrobial and bioactive components. Incorporation of PPP in the meat products has higher cooking yield, crude fibre and lesser in fat content along with great positive effects on texture profiles, organoleptic attributes and microbiological parameters. Hence, PPP could be used in meat industry and other muscle food industries to make the value added products by increasing the product stability and storability without affecting its quality and acceptability as well as by fulfilling the consumer expectations for making the products healthy by reducing fat content and increasing crude fibre content.

Conflict of interest: Authors have no conflict of interest in this study.

Author's contribution: DD: Performed this research work and made a preliminary draft of the manuscript; SB: Made conceptualization of this research work and critically redrafted; OB, GP and PK: Helped in performing the different methods and analysis the data.

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