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Antioxidant Potential of Indian Gooseberry *(Emblica officinalis)* Paste in Chicken Meatballs

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ABSTRACT

The aim of the study was to evaluate the antioxidant potential of Indian gooseberry (*Emblica officinalis*) paste in chicken meatballs and its effect on physicochemical and sensory properties. Chicken meatballs were prepared with the inclusion of Indian gooseberry paste (GBP) at 0, 12%, 15%, and 18% levels. The emulsion pH, product pH, emulsion stability, and product yield were determined. DPPH Scavenging Activity (%) was studied to establish the antioxidant potential of the GBP in the product. Sensory properties were evaluated using 8 points hedonic scale. Emulsion pH and Product pH decreased significantly ($P<0.05$) with the addition of GBP. Product yield decreased significantly ($P<0.05$) with the addition of GBP for 15% and 18% levels. DPPH scavenging activity significantly ($P<0.01$) increased with an increase in the GBP inclusion level, where 18% treatment had the highest antioxidant potential followed by 15% and 12% treatments. The sensory scores for control and 12% treatment were comparable and significantly ($P<0.05$) lower for 15% and 18% treatments. From this study, it was observed that Indian gooseberry paste could be added as a potential antioxidant in the chicken meatballs, up to a level of 12% without affecting the sensory qualities of the product.

Key words: *Antioxidant activity, Chicken meatballs, Emblica officinalis, Physicochemical quality, Sensory properties*

INTRODUCTION

Poultry meat is preferred for consumption over other meats throughout the world since it is cheap, easily available, and has no religious taboos. Ready-to-eat meat products are acquiring popularity in recent years, and thus value-added meat products with healthier alternatives are being introduced in the markets to explore their potential in terms of consumer preference. The development of processed meat products involves the incorporation of non-meat ingredients or additives for enhancing the quality attributes, sensory profile, and shelflife. Varieties of meat products

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containing natural antioxidants, natural antimicrobials, dietary fiber, and other nutritive substances had been developed in recent years (Zinina et al. 2019; Bhuvana *et al*. 2020 and Ji *et al*. 2021).

The shelflife of meat products mainly depends upon the microbial growth and chemical changes that occur in the product during storage. In chemical deterioration, lipid oxidation is important in the processed meat industry, because it is one of the major causes of quality deterioration (Domínguez *et al*. 2019). Lipid oxidation can impart adverse effects not only on sensory attributes such as colour, texture, odour, and flavour but also on the nutritional quality of the products (Nunez de Gonzalez et al. 2008). Antioxidant substances in low concentrations are able to retard the oxidation of lipids and proteins. Reduced oxidation in meat products results in better shelf life during preservation.

Indian gooseberry (*Emblica officinalis*) is a widely distributed tropical medicinal plant with good therapeutic properties. Gooseberry is the richest source of antioxidants like vitamin C, emblicanin A and B, punigluconin, pedunculagin, superoxide dismutase, catalase, gluthathione peroxidase (Bhattacharya *et al*. 2000), tannin, trigalloyl, polyphenol, flavonoids, ellagic acid and phyllembic acid (Anilakumar et al. 2004). It had been reported that gooseberry possessed antifungal, antibacterial and antiviral activities (Dutta et al. 1998; Rani and Khullar, 2004). Gooseberry is commonly consumed in India as such in the form of fruit, fruit juices and fruit powder, and added also in the cuisines in the preparation of food items. Studies had been carried out incorporating various forms of gooseberry in different meat products (Kumaresan et al. 2019; Goswami *et al*. 2020 and Kumaresan *et al*. 2020). Since gooseberry is a familiar food component, its addition to meat products will not be a concern for consumers in terms of acceptance.

Hence, the present study was carried out with the objective of assessing the antioxidant potential of the Indian gooseberry paste as a natural preservative in chicken meatballs.

MATERIALS AND METHODS

Raw materials

***Chicken meat*:** Dressed broiler carcasses were procured from the Department of Livestock Products Technology (Meat Science), Veterinary College and Research Institute, Namakkal, India. The carcasses were hygienically deboned and trimmed of all visible adipose and connective tissues manually. The deboned meat was minced through an 8-mm plate using meat mincer (PRIMUS MEW 713 – 22 MADO, Germany), packaged in low-density polyethylene (LDPE) pouches (50µm thickness), and stored at -18±1°C in the laboratory freezer until further use.

Ingredients for the preparation of chicken meatballs: Commercially available food-grade spices, salt, and green condiments.

Preparation of green condiments: Freshly procured ginger, garlic, and onion were peeled off, washed, and ground in a mixer grinder to make a paste for incorporation in meatballs.

Preparation of fresh paste of Indian gooseberry: Fresh Indian gooseberrywas procured from the market and washed thoroughly. Then they were deseeded, sliced, and blended in a mixer-grinder for about 1 to 2 min. The resultant homogenate was used as the fresh paste.

Chemicals and media: Analytical grade chemicals (Merck) were procured through the authorized dealer and used in the study.

Preparation of chicken meatballs: The chicken meatballs were prepared with the formulation given in Table 1. The frozen minced meat was thawed at 4°C by keeping in the refrigerator overnight.

Table 1. Chicken meatball formulations with fresh paste (GBP) of Indian gooseberry

Ingredients (g)	C	GBP12	GBP15	GBP18
Lean meat	1000	1000	1000	1000
Salt	20	20	20	20
Vegetable oil	50	50	50	50
Ginger	20	20	20	20
Garlic	20	20	20	20
Onion	20	20	20	20
Spice mix	20	20	20	20
Gooseberry paste	-	120	150	180

In the treatment gooseberry paste at 12%, 15%, and 18% were added, over and above quantity of meat. During the preparation of the emulsion, the Gooseberry paste was added after the addition of vegetable oil. The ingredients were chopped to make a batter in a bowl chopper. The emulsion was prepared by adding tempered minced meat and the other ingredients in sequential order at a specified time interval, as shown in the flow chart.

Addition of minced meat to bowl chopper

↓ (chopping for 1 min)

Addition of salt

↓ (chopping for 1 min)

Addition of vegetable oil

↓ (chopping for 1 min)

Addition of gooseberry paste

↓ (chopping for 1 min)

Addition of green condiments (garlic, ginger, and onion paste)

↓ (chopping for 1 min)

Addition of spice mix

↓ (chopping for 1 min)

Emulsion

Meatballs of 10 g weight each were formed manually from the prepared emulsion and added in a cooking vessel with preheated water at 50°C. Then the meatballs were cooked to reach an internal core temperature of 82°C. After cooking, the meatballs were allowed to cool to room temperature. The product was then packaged in LDPE bags (50µm thickness) aerobically for further analysis of quality characteristics. A total of six trials were conducted.

Analysis of the product: The physicochemical quality characteristics such as emulsion pH, emulsion stability, product pH, product yield and DPPH scavenging activity, and the sensory quality characteristics such as appearance and color, flavour, texture, juiciness, mouth coating, and overall acceptability were analysed.

Physicochemical properties: Emulsion weight before cooking and product weight after cooking were recorded. The product yield was calculated by the weight of meatballs after cooking/ Raw emulsion weight × 100.The pH of the chicken meatball was recorded by immersing a combined glass electrode and temperature probe of the digital pH meter (Model 361, Systronics, India).For calculating the emulsion stability, 15 g of meat sample was weighed, packed in polyethylene bags, and heated by placing in water at 80°C for 20 minutes over a temperature-controlled induction stove. Then, the fluid released was drained and the meat sample was weighed. Thewas calculated by the formula Es (%)=(Weight after heating)/(Raw emulsion weight) × 100.

DPPH scavenging activity: DPPH (2, 2' diphenylpicrylhydrazyl) was determined following the procedure of Wu *et al.* (2003) with slight modifications. 1 g of Indian Gooseberry paste added chicken meatball was homogenized with 10 ml of ethanol. From that solution, 1 ml was taken, mixed with 5 ml of 0.1 mM DPPH solution, dissolved in 95% ethanol, incubated in darkness for 30 minutes and the absorbance at 517 nm was measured. DPPH scavenging activity was calculated by using the following formula

DPPH scavenging activity was calculated by using the following formula

$$\text{DPPH scvenging activiy}(\%) = \frac{Ac - As}{Ac} \times 100$$

where,

Ac is the absorbance of the control (DPPH solution without sample)

As is the absorbance of the sample

Sensory evaluation: Trained sensory panel consisting of students and teaching faculty of the college evaluated the products. Samples were evaluated for appearance and colour, flavour, texture, juiciness, mouth coating, and overall palatability using an 8-point hedonic scale (Keeton, 1983).

Statistical analysis: The data generated in the present study were subjected to statistical analysis (Snedecor and Cochran, 1995) for analysis of variance, critical difference, and Duncan's multiple range tests for comparing the means to find the effect of treatment, storage period, and their interactions. Then the data were tabulated and the significance of the difference were marked.

RESULTS AND DISCUSSION

Physicochemical quality characteristics: Emulsion pH (EpH) and product pH were significantly (P<0.01) lowered in gooseberry paste added to chicken meatballs whereas emulsion stability (ES) was not affected (Table 2). Gooseberry paste caused a significant (P<0.01) drop in pH of all the samples. Product yield (PY) was not affected in the 12% treatment, but significantly lower in the other treatments compared to control. The product pH was lowest in 18%of treatments and all the treatments differed significantly from each other.

The DPPH scavenging activity was sequentially improved with the corresponding increase in the levels of gooseberry paste (Fig 1). The remarkable increase in antioxidant activity was due to more total phenols and tannins infusion into the meatballs.

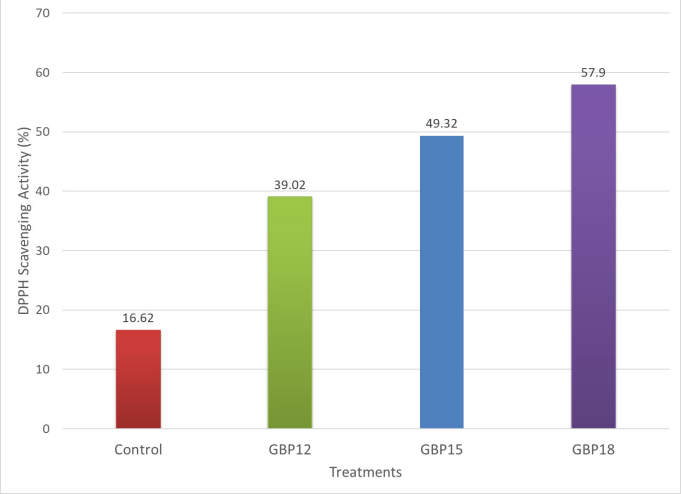

Fig. 1. Effect of inclusion of gooseberry paste on the physicochemical qualities of chicken meatballs

Bariya et al. (2018) analysed the DPPH radical scavenging activity of Amla (gooseberry) fruit to be 21.18 **µmol** TE/g and the total phenolic content to be 1164.83 mg GAE /100 g and found that incorporation of 10% amla fruit extract in goat meat patties significantly increased its total phenolic content and decreased the pH. The drop in pH was due to the presence of ascorbic acid and phenolic substances in gooseberry (Barthakur and Arnold 1991). Goraya and Bajwa (2015) developed gooseberry pulp added to ice cream and reported that the addition of phenolic-rich substances present in gooseberry, like elagic acid and gallic acid decreased thepH and increased the DPPH radical scavenging activity of ice cream. Kumaresan *et al.* (2019) observed a significant reduction in the pH of the spent hen meat pickle by partial replacement of acetic acid added pickle with up to 3% gooseberry powder and there were no significant changes in the pH during storage up to 60 days at room temperature (Kumaresan *et al.* 2020).Similar results were evidenced with the use of other forms of gooseberry such as extract and powder in certain meat products where the pH was significantly lowered and the antioxidant potential was increased (Najeeb *et al.* 2015; Bariya *et al.* 2016; Kumar and Langoo 2016). Mahajan et al. (2017) added amla fruit juice powder to spent meat nuggets and observed improvement in cooking yield and emulsion stability. Similarly, Argade *et al.* (2020) noticed an improvement in the cooking yield and emulsion stability of mutton rolls incorporated with various forms of gooseberry such as powder, aqueous extract, and ethanolic extract. In this study, the disagreement of the results might be due to the different forms and the level of gooseberry used in the products.

Sensory quality characteristics: Sensory quality scores of all the attributes of the chicken meatballs incorporated with 12% gooseberry paste were similar to that control whereas the other two treatments had significantly (P<0.01) lower scores.

Table 2. Effect of inclusion of gooseberry paste on the physicochemical qualities of chicken meatballs

Quality characteristics	Treatments				
	C	GBP12	GBP15	GBP18	Significance
Emulsion pH	5.99±0.08^{a}	5.65±0.13^{b}	5.35±0.05^{c}	5.19±0.06^{c}	**
Product pH	6.10±0.04^{a}	5.78±0.03^{b}	5.32±0.08^{c}	4.79±0.07^{d}	**
Emulsion stability (%)	97.32± 0.33	96.90± 0.07	96.58±0.42	96.03±0.20	NS
Product Yield (%)	92.39±1.06^{a}	89.43±0.76^{ab}	88.52±1.07^{b}	86.70±0.68^{b}	**
DPPH Scavenging Activity (%)	16.62±0.61^{d}	39.02±1.16^{c}	49.32±0.50^{b}	57.90±0.86^{a}	**

Means within a row with different superscripts are significantly different ** - Highly significant (P≤0.01), NS - Not significant, C-Control, GBP12-Gooseberry paste 12%, GBP15-Gooseberry paste 15%, and GBP18-Gooseberry paste 18%

Table 3. Effect of inclusion of gooseberry paste on the sensory qualities of chicken meatballs

Quality characteristics	Treatments				
	C	GBP12	GBP15	GBP18	Significance
Appearance and colour score	6.64±0.13[a]	6.53±0.11[a]	5.61±0.12[b]	5.19±0.15[c]	**
Flavour score	6.83±0.14[a]	6.58±0.12[a]	5.56±0.11[b]	5.06±0.14[c]	**
Texture score	6.69±0.15[a]	6.67±0.09[a]	5.42±0.17[b]	4.81±0.10[c]	**
Juiciness score	6.50±0.19[a]	6.56±0.13[a]	5.44±0.13[b]	4.94±0.12[c]	**
Mouth coating score	6.42±0.19[a]	6.50±0.11[a]	5.44±0.16[b]	4.89±0.13[c]	**
Overall acceptability score	6.72±0.17[a]	6.75±0.08[a]	5.56±0.10[b]	5.19±0.13[c]	**

Means within a row with different superscripts are significantly different ** - Highly significant (P≤0.01); C-Control, GBP12-Gooseberry paste 12%, GBP15-Gooseberry paste 15%, and GBP18-Gooseberry paste 18%

It was observed by the sensory panelists, that the flavour of the chicken meatballs was unacceptable beyond the 12% level of the gooseberry paste, and also the sour taste was not palatable. The sour taste was due to the low pH and inherent taste present in the solid portion imparted by the gooseberry addition. The texture of the product was altered to a greater extent at 15% and 18% levels which was evidenced by the poor binding of the product. This might be due to the low pH and the presence of considerable crude fibre content of gooseberry (Mishra and Mahanta 2014; Goraya and Bajwa 2015) that hinders product binding wherein no binding agent was added to the product. However, the control and 12% treatment had acceptable texture. In agreement with the present results, it was observed that chevon meat patties prepared with 10% gooseberry extract were sensorially acceptable which had flavour score, juiciness score, and overall acceptability score comparable with control without gooseberry (Bariya *et al*. 2016, Bariya *et al*. 2018). In another study, Giriprasad *et al*. (2015) formulated functional restructured buffalo meat steaks fortified with 0.5% level of gooseberry powder which had sensory scores equivalent to that of the control product. The addition of gooseberry powders up to 3% in spent hen meat pickle retained its sensory attributes (Kumaresan *et al*. 2019). Mahajan et al. (2017) observed that amla fruit juice powder added to spent meat nuggets up to 1.5% did not significantly affect the sensory scores and it was attributed to the fact that very small quantity was added in the formulation. Other products containing gooseberry as one of the functional ingredients such as ready to serve beverages (Chandan *et al*. 2010), ready to serve drink, squash and nectar with 25% gooseberry (Singh *et al*. 2012) and gooseberry enriched fruit bar with 25% gooseberry (Deepika and Panja 2017) and pasta fortified with 3% gooseberry powder (Mishra and Bhatt2016) were sensorially acceptable.

CONCLUSION

From this study, it was observed that the antioxidant activity of the chicken meatballs incorporated with Indian gooseberry paste increased significantly as indicated by the DPPH scavenging activity. The sensory characteristics of chicken meatballs incorporated with 12% Gooseberry paste were not significantly affected compared to the control samples. However, at 15% and 18% levels, a significant reduction in all the sensory scores were observed. In conclusion, based on the physicochemical and sensory evaluations, Indian gooseberry paste could be added as a potential antioxidant in the chicken meatballs up to a level of 12% without affecting the sensory qualities of the product.

COMPETING INTERESTS

The authors do not have any competing interests among themselves or others related to this research work.

ETHICS STATEMENT

Not applicable.

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