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Functional Chicken Meatballs with Carrot Pomace Powder

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ABSTRACT

This study was conducted to fortify low-fat chicken meatballs with dried carrot pomace as dietary fibre (DF) source and to assess the physicochemical and sensory properties. Carrot pomace was dried and made into powder. Emulsion-based low-fat chicken meatballs were prepared with the addition of carrot pomace powder (CPP) at levels of 1%, 2%, and 3%, over and above the amount of meat along with a control. In the physicochemical properties, there was no significant difference in the emulsion pH, product pH, and emulsion stability among the treatments. Product yield significantly ($p \leq 0.01$) increased with the addition of CPP at 2% and 3%. In sensory evaluation, the appearance score was significantly ($p \leq 0.01$) lowest for the 3% level. Juiciness, texture, and tenderness scores decreased with the addition of CPP where 3% level had the lowest scores. The flavour and overall acceptability scores significantly ($p \leq 0.01$) decreased with the addition of CPP where 1% and 2% had scores more the 'moderately acceptable' level and 3% had the lowest score which was only 'slightly acceptable'. It is concluded that emulsion-based low-fat chicken meatballs could be fortified with dietary fibre content by the inclusion of carrot pomace powder up to a level of 2% without significantly affecting the sensory qualities.

Key words: *Carrot pomace powder, Chicken meatballs, Dietary fibre, Physico-chemical properties, Sensory Properties*

INTRODUCTION

The importance of vegetables in the regular diet is well-known for their nutritional contents, especially, the dietary fibre content. The benefits of soluble and insoluble dietary fibres are improved digestive health, lowering risk of type 2 diabetes and common gastro-intestinal cancers. Dietary fibre is considered to be an important element of heart healthy diet. Globally, dietary fibre intake is highly recommended in the regular diet. Many types of meat foods are enriched with various types of natural dietary fibres (Santhi and Kalaikannan, 2014; Kasthuri *et al*. 2016; Uikey and Nayak, 2019; Zinina *et al.* 2019; Santhi *et al*. 2020). Carrot is one of the vegetables rich in dietary fibre. It is a

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common ingredient that finds place in the cuisine almost worldwide.

Carrot pomace is one of the potential dietary fibre sources which is a byproduct obtained in the preparation of carrot juice. During commercial juice processing, 30–50 percent of carrot remained as pomace containing 37–48 percent total dietary fibre (on a dry weight basis) which was a good source of dietary fibre (Bao and Chang, 1994). Hernández-Ortega *et al.* (2013) estimated the total dietary fibre content of carrot pomace as 64.35 % dry sample suggesting that carrot pomace could be used as raw material to produce foodstuff high in fibre.

The dietary fibre content of carrot pomace had been studied by many researchers. Nawirska and Kwasniewska (2005) depicted the composition of dietary fibre constituents in the fresh carrot on dry weight basis as pectin (7.41 %), hemi-cellulose (9.14 %), cellulose (80.94 %), and lignin (2.48 %) and in carrot pomace (on a dry weight basis) as pectin (3.88 %), hemi-cellulose (12.3 %), cellulose (51.6 %) and lignin (32.1%). Chau *et al.* (2004) isolated fibre-rich fractions (FRFs) including insoluble dietary fibre, alcohol-insoluble solid, and water-insoluble solid from carrot pomace and found that carrot pomace was rich in insoluble FRFs (50.1–67.4%), which mainly composed of pectic polysaccharides, hemicellulose and cellulose.

The carrot pomace being a perishable item, it may be converted to a dry powder form which has a longer shelf-life. Shyamala and Jamuna (2010) prepared carrot pomace powder (CPP) and beetroot pomace powder (BPP) by drying and grinding the pulp left after juice extraction and estimated the insoluble dietary fibre (%) as 32.00 and 39.53 in CPP and BPP and soluble dietary fibre (%) as 13.53 and 21.33 in CPP and BPP, respectively. While preparing high dietary fibre powder from carrot peels at different drying temperatures after blanching, Chantaro *et al.* (2008) estimated the total dietary fibre (% dry weight) of the powders ranged between 69.72 to 73.32.

Chicken meat-based snacks have become popular in recent days since they are fast and convenient food. There are many varieties of chicken products depending upon the local demand such as meatballs, nuggets, cutlets, samosa, popcorn, etc. The chicken product consumption is more in urban areas where the industrial working group population is high and its demand is increasing day by day since it has now become a common item of consumption among all classes of people. Since meat is deficient in dietary fibre, developing fibre enriched ready-to-eat chicken product would be beneficial and convenient for the consumers, as most of them do not consume enough amount of fibre-rich foods due to lack of time and access. Carrot pomace had been used as a dietary fibre source in many meat products and found to be acceptable (Khan and Ahmad 2015; Singh *et al.* 2015; Ktari *et al.* 2016; Kilincceker and Kurt 2018; Yadav *et al.* 2018, Santhi *et al.* 2020, Reddy *et al.* 2020). Hence this study was conducted to fortify low-fat chicken meatballs with dried carrot pomace dietary fibre source and to assess the physicochemical and sensory properties of the product.

MATERIALS AND METHODS

Source of Raw Materials

Broiler meat: Dressed broiler carcasses were purchased from the retail outlets of Namakkal town, packed in fresh polyethylene bags, and transported in thermo cool box to the Department of Livestock Products Technology (Meat Science), Veterinary College and Research Institute, Namakkal. The carcasses were hygienically deboned and trimmed of all visible adipose and connective tissues at the department laboratory. The deboned meat was minced through an 8-mm plate using a meat mincer (Junior MEW 510, MADO, Germany) packaged in low-density polyethylene (LDPE) and stored in the laboratory freezer at -18±2°C for subsequent use in the experiments.

Carrot pomace powder (CPP): Fresh carrots (*Daucus carota* ssp. *sativa*) were purchased from the market and processed in the laboratory. The carrots were washed thoroughly to remove the adhering soil particles, peeled off, and crushed in a juice extractor to obtain the juice and the pomace. The pomace was then dried in a hot air oven by placing on a drying tray at 60°C for 16 hours, ground to flour, and stored at room temperature for use in the experiment.

Spice mix formulation: The spices were dried, weighed, and ground to a fine powder as per the following composition expressed in percent (Coriander-40, Cumin seeds-5, Fennel seeds-10, Black pepper-10, Poppy seeds-2, Cinnamon-1, Cloves-1.5, Cardamom-0.5, Nutmeg-0.5, Star anise-0.1, Bay leaf-0.4, Turmeric-0.5, Red chilli-20, Mace-0.5, Dried ginger-8.0). This spice mix was stored for subsequent use.

Green condiments: Freshly procured ginger, garlic, and onion were peeled off, cut into pieces, made into a paste in a mixer, and used as condiments in the meatball formulation.

Other ingredients: Commercially available food-grade ingredients available in the local market namely refined sunflower oil, refined wheat flour (RWF), dried spices, salt, ginger, garlic, and onion were used in the present study.

Chemicals used for analyses: Standard chemicals procured from authorized dealers were used in the present study for various analyses.

Preparation of chicken meatballs

Preparation of meat emulsion: The frozen minced meat was tempered to 4°C by keeping in the refrigerator overnight and used for the preparation of emulsion. The emulsion was prepared in a bowl chopper (TC11 Bowl Cutter Scharfen, Germany) by adding minced meat and the other ingredients of the formulation (Table 1) in sequential order at a specified time interval. During chopping, the temperature of the emulsion was maintained at 10-12°C by the addition of slush ice. CPP was added at levels of 0% (C), 1% (CPP1), 2% (CPP2), and 3% (CPP3) over and above the control formulation and processed as described above.

Table 1. Formulation of chicken meatballs with the inclusion of carrot pomace powder

Ingredients (g)	**Treatments**			
	C	CPP1	**CPP2**	**CPP3**
CPP%	**0**	**1**	**2**	**3**
Lean meat	1000	1000	1000	1000
Vegetable oil	50	50	50	50
Refined wheat flour	40	40	40	40
Carrot pomace powder	-	10	20	30
Salt	20	20.20	20.40	21.60
Ginger	25	25.25	25.50	25.75
Garlic	25	25.25	25.50	25.75
Onion	25	25.25	25.50	25.75
Spice mix	20	20.20	20.40	21.60
Added water	100	105	110	115

Forming, cooking, and packaging of meatballs: Meatballs of approximately 10 g weight each were formed manually and placed on stainless steel trays. Water was preheated to 50°C in a cooking vessel and the meatballs were put into the water and cooked to reach an internal core temperature of 82°C which was measured by a digital probe thermometer. After cooking, the meatballs were allowed to cool at room temperature, weighed, and used for analysis.

Analytical procedures: Physicochemical (emulsion pH, product pH, emulsion stability, product yield) and sensory evaluations were conducted for all the trials to optimize the level of inclusion of carrot pomace in the chicken meat balls.

Physicochemical evaluation

***pH*:** The pH of chicken meat was determined by adopting the method of AOAC (1995).

***Emulsion stability (ES)*:** A method of Baliga and Madaiah (1971) as modified by Kondaiah *et al.* (1985) was followed for the estimation of ES. The ES calculated by the formula

$$Es\,(\%) = \frac{\text{(Weight after heating)}}{\text{(Raw emulsion weight)}} \times 100$$

Product yield: Weights of meat balls before and after cooking were recorded. The product yield was calculated as below

$$Product\ yield(\%) = \frac{\text{Weight of chicken meat balls after cooking}}{\text{Raw emulsion weight}} \times 100$$

Sensory evaluation: Experienced sensory panel consisting of students and teaching faculty of the college evaluated the products. Samples were evaluated for appearance and colour, flavour, juiciness, texture, tenderness and overall acceptability using an 8- point hedonic scale (Keeton, 1983) as given in the score sheet.

Statistical Analysis: The data generated in the present study were subjected to statistical analysis (Snedecor and Cochran 1994) for analysis of variance, critical difference and Duncan's multiple range test was done for comparing the means to find the effect of treatment at 5% level of significance, using the statistical software SPSS for windows. Average of six replicates was used in calculations.

RESULTS AND DISCUSSION

The addition of CPP in chicken meatballs did not affect the Emulsion pH (EpH), Product pH (PpH) and ES. The PY (product yield) was significantly ($p \leq 0.01$) high in 2 percent and 3 percent inclusion levels which could be due to the fact that insoluble fibre increases cooking yield by improved moisture and fat absorption (Table 2). Similar to our observations, Eim *et al.* (2008) observed no differences in PpH by addition of carrot dietary fibre (prepared by dehydration of fresh carrots) in dry fermented pork sausage (sobrassada) and suggested an inclusion level up to 3 percent level based on the overall sensory acceptability and the ripening characteristics.

Table 2. Effect of inclusion of carrot pomace powder on the physicochemical quality of chicken meatballs

Quality attributes	Treatments				Significance
	C	CPP1	**CPP2**	**CPP3**	
Emulsion pH	6.17±0.01	6.15±0.01	6.12±0.01	6.17±0.02	NS
Product pH	6.33±0.02	6.36±0.01	6.35±0.01	6.35±0.01	NS
Emulsion stability (%)	94.95±0.35	95.74±0.42	94.85±0.37	95.07±0.44	NS
Product Yield (%)	91.87^{b}±0.29	91.62^{b}±0.59	93.51^{a}±0.25	94.08^{a}±0.31	**

C - Control, CPP1 - 1% CPP, CPP2 - 2% CPP, CPP3 - 3% CPP
Means in a row with different superscripts are significantly different
** - Highly significant (P≤0.01)
NS - Not Significant

Table 3. Effect of inclusion of carrot pomace powder on the sensory quality of chicken meatballs

Quality attributes	Treatments				Significance
	C	CPP1	**CPP2**	**CPP3**	
Appearance and colour	7.42^{a}±0.15	7.25^{a}±0.13	7.17^{a}±0.11	6.58^{b}±0.15	**
Flavour	7.58^{a}±0.15	6.75^{b}±0.13	6.42^{b}±0.15	5.00^{c}±0.21	**
Juiciness	7.08^{a}±0.15	7.00^{a}±0.17	6.67^{ab}±0.14	6.42^{b}±0.15	*
Texture	7.50^{a}±0.15	7.33^{ab}±0.14	6.92^{bc}±0.15	6.58^{c}±0.15	**
Tenderness	7.33^{a}±0.14	6.83^{b}±0.17	6.42^{bc}±0.15	6.17^{c}±0.21	**
Overall acceptability	7.58^{a}±0.15	7.00^{b}±0.21	6.75^{b}±0.13	5.25^{c}±0.22	**

C - Control, CPP1 - 1% CPP, CPP2 - 2% CPP, CPP3 - 3% CPP
Means in a row with different superscripts are significantly different
*- Significant (P≤0.05)
** - Highly significant (P≤0.01)

Likewise, Khan and Ahmad (2015) found that buffalo meat sausage samples incorporated with carrot powder (including one control) had pH values in the range of 6.13 to 6.41 in fresh conditions with no significant differences among the samples.

Grossi *et al.* (2012) stated that the addition of carrot fibre to the meat emulsion increased the water binding capacity and this might be the rationale for the increased PY in the present study. Mendiratta *et al.* (2013) added carrot paste to mutton nuggets at 10 percent level and found no marked changes in pH and cooking yield. In the preparation of functional chicken nuggets, Bhosale *et al.* (2011) found that there was an improvement in the nutritional value in terms of increased dietary fibres and β-carotene by the inclusion of ground raw carrot and noticed desirable cooking yield and ES. Also, based on the sensory qualities they found that 10 percent inclusion level of raw carrot was optimum which would serve as a good source of dietary fibre. In the present study, the sensory scores were acceptable up to 2 percent level and significantly (P≤0.01) low for 3 percent level (Table 3). In earlier studies, the addition of carrot fibre at a level of 1.5 percent in low salt pork sausages (Grossi *et al.* 2012) and 1.0 percent in turkey meat sausages (Ktari *et al.*2016) had been suggested.

However, Singh *et al.* (2015) observed that overall acceptability scores of the chicken meat cutlet with 4% carrot powder were significantly (P<0.05) higher than control and other treatment products with 2% and 6% carrot powder. This difference in the recommendation of inclusion levels might be due to the variation in the product formulation and processing. Mendiratta *et al.* (2013) recorded a higher score for appearance in the sensory evaluation of mutton nuggets incorporated with 10 percent carrot paste with no difference in other sensory attributes. The addition of 10% carrot paste to turkey meat sausages improved their appearance, texture, juiciness, and overall acceptability (Reddy *et al.* 2020). The differences in the sensory scores might be attributed to the form of vegetables used (fresh or dehydrated), the type of meat used, the formulation of the product, and differences in processing methods. The potential of carrot fibre as a functional ingredient for the source of dietary fibre and other vital phytonutrients had been brought to the spotlight only during the past few years. Apart from meat foods, other types of sensorially acceptable food products also had been prepared with the inclusion of carrot dietary fibre such as wheat rolls with 3 percent carrot pomace powder (Kohajdova *et al.* 2012), wheat flour-based cookies with 6 percent carrot pomace (Kumar and Kumar, 2011) and wheat flour based buns with 2.5 percent carrot pomace. Thus, the utilization of carrot dietary fibre in meat products needs more investigation.

CONCLUSION

With the advancement in food processing technologies, consumers are at present more fascinated towards the 'easy to eat' ready-made foods, especially meat products with advantages in terms of health benefits. Hence incorporating carrot pomace as a dietary fibre source in chicken meatballs would be highly beneficial, since it is a vegetable that finds place in regular cooking. From this study, it can be concluded that carrot pomace powder can be included in chicken meatballs up to a level of 2% level without affecting the physicochemical and sensory characteristics.

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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