Full Length Article

EFFECT OF OAT FLOUR AND CABBAGE ON TECHNOLOGICAL PROPERTIES OF CHICKEN MEATBALLS

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ABSTRACT

In recent years, investigations have been carried out to improve the functional value of meat products through the introduction of dietary fibre (DF). The addition of dietary fibre in meat products contributes to the fabrication of products that enhance physiological functions. The present study was conducted to fortify chicken meatballs with Oats (Avena sativa) and Cabbage (Brassica oleracea) as a source of dietary fibre. Oat flour and cabbage were incorporated at the levels of 1.5 %, 2.5 % and 3.5 % (w/w) for the preparation of meatballs. Moisture content, product pH, emulsion stability and technological properties like cooking yield, water absorption capacity and oil absorption capacity of the final product were studied. The results revealed that cooking yield increased on the addition of oat flour and cabbage ($p \leq 0.05$). There was no significant change in product pH, and in sensory attributes at the level of 2.5 % incorporation. Overall technological properties and sensorial analysis of these products were found to be higher than control. Thus, the inclusion of oat flour and cabbage at the level of 2.5 % to chicken meatballs had significantly increased the crude fibre from control 4.053+0.021 to 4.727±0.015% in T2, representing a l6.62% increase in fibre content, that also showed higher desirability in sensorial analysis.

Key words: Dietary fibre, oats, cabbage, chicken meatballs, technological properties

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INTRODUCTION

Meat is a highly nutritious food which consists of a high quantity of proteins, B-complex vitamins and minerals especially iron and zinc with a high level of bio-availability. Meatballs are one of the most popular meat products in India and available in various types such as chicken meatball, beef

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meatball, fish meatball and prawn meatball (Augustynska – Prejsnar *et al.,* 2022). The fibre content of meat is very low; therefore, developing fibre enriched ready-to-eat chicken products would be beneficial and convenient for the consumers. Intake of fibre reduces the risk of cardiovascular diseases, colon cancer, obesity including diabetes mellitus (Paudel *et al.,* 2021).

The insoluble fraction of dietary fibre has been related to intestinal regulation whereas soluble fibre is associated with decrease in cholesterol level and absorption of intestinal glucose. For adults, the recommended acceptable intakes of dietary fibre are 28-36 g/day, 70-80 % of which must be insoluble fibre (Mehta *et al.,* 2015). Hence intake of dietary fibre in daily diet is highly recommended.

Oats (*Avena sativa*) is one of the most popular cereals which can be used as a functional ingredient. It contains β-glucans, which lowers the blood serum cholesterol levels and controls lipoprotein metabolism. It helps in prevention of gut related problems, cardiovascular diseases, type 2 diabetes, cancer and obesity. Meat is generally lacking in such potential ingredient, which could be incorporated during processing of comminuted products to make them more healthful (Diaz *et al.,* 2022). Cabbage is a good source of the vitamins (such as K, A, C, B_6, folate, thiamine and riboflavin), minerals (calcium, potassium and magnesium) and tryptophan amino acid, vitamin C, polyphenols, flavonoids and glucosinolates (Ashfaq *et al.,* 2020). The study has presented objectives of enrichment of chicken meatballs with oat flour and cabbage as dietary fibre sources and analysis of the functional and physico-chemical properties of chicken meatballs incorporated with fibre sources.

MATERIALS AND METHODS

Preparation of ingredients

Minced chicken meat - Deboned broiler chicken meat was purchased from local market. All visible adipose and connective tissues were trimmed. The deboned meat was minced through a 8-mm plate using a meat mincer.

Oats - Oat flakes was powdered and sieved to the mesh size of 60.

Cabbage - Cabbage was cleaned and diced, cooked (10 min at 95ºC), cooled and grounded to fine paste.

Spice mix – predetermined level of chilly, turmeric, clove, cinnamon, cumin, fennel, cinnamon, aniseed and curry leaf powder was prepared and stored until usage.

Preparation of Chicken Meatballs

The frozen meat was tempered to 4°C for 2 hours in the refrigerator. The chicken meatballs were prepared according the procedure of Golge *et al.* (2018). The minced meat was mixed with predetermined level of salt, refined oil, spice mix and condiments. Oats (1.5, 2.5, 3.5 % (w/w)) and Cabbage ((1.5, 2.5, 3.5 %(w/w)) were added replacing the lean meat as given in Table 1. Spices, condiments and maida were added subsequently and blended for 5 minutes in a bowl chopper and chopped for 5 minutes. The mixture was made into balls of each 10 g. The meatballs were cooked in hot water in a pressure cooker till the internal temperature reached 120°C to ensure microbial safety. Then the meatballs were vacuum packed in LDPE bags and stored at refrigerated temperature.

Physico-chemical analysis of oats and cabbage incorporated chicken meatballs

The moisture (oven drying method),), protein (Kjeldahl distillation, N×6.25), crude fibre (Fibrotron extraction and muffle furnace), fat (Soxhlet extraction and ash (muffle furnace) and of oats and cabbage incorporated chicken meatballs were estimated as per the standard procedures of Association of Official Analytical Chemists (AOAC and Horwitz, 2003).

Technological properties of oats and cabbage incorporated chicken meatballs

Cooking yield

The cooking yield was calculated before and after cooking, the weight of each product was recorded. A formula was used to compute the cooking yield, which was then expressed as a percentage as the following equation.

$$\text{Cooking yield (\%)} = \frac{\text{Weight of cooked product}}{\text{weight of the raw product}} \times 100$$

Water absorption capacity

1.20 g of chicken meatballs samples was mixed with 10 ml distilled water and vortexed for 30 mins with regular intervals and centrifuged (Laboratory centrifuge, ATICO) at 3000 g for 20 minutes. The supernatant was drained and kept undisturbed for 30 mins, the precipitates collected in the bottom was removed and given as gram of water or oil bound per gram of chicken meatballs (Summo *et al.,* 2019).

Oil absorption capacity

0.75g of chicken meatballs samples was mixed with 9 ml refined oil and vortexed for 30 mins and centrifuged at 3000 g for 20 minutes. The supernatant and suspended oil layer was drained and the precipitates were weighed and the results were given as gram of water or oil bound per gram of chicken meatballs (Summo *et al.,* 2019).

Emulsion stability

Emulsion stability was carried out by adopting methods of Mounika and Sahityarani (2021) with some modifications. 10 g of chicken meatballs emulsion was placed in low density polyethylene (LDPE) bags and placed in a water bath and cooked at 80ºC for 20 minutes. The bags were removed from the water bath, cut open and the fluid drained off and the cooked samples were weighed. Emulsion stability was calculated as percent by dividing final weight with initial emulsion weight.

Sensorial analysis

The sensory panellists (10 semi trained) were academic staff and students of the College of Food and Dairy Technology,

Table 1. Ingredients used in formulation of Chicken meatballs

Ingredients % (w/w)	Treatments			
	Control	T1	T2	T3
Lean meat % (w/w)	70	67	65	63
Oats powder % (w/w)	0	1.5	2.5	3.5
Cabbage paste % (w/w)	0	1.5	2.5	3.5
Salt % (w/w)	3	3	3	3
Oil % (w/v)	8	8	8	8
Spice mix % (w/w)	3	3	3	3
Condiments % (w/w)	3	3	3	3
Binder % (w/w)	3	3	3	3
Ice % (w/w)	10	10	10	10

Table 2. Sensory score of oats powder and cabbage incorporated chicken meatballs

Samples	Colour and Appearance	Flavor	Texture	Tenderness	Overall acceptability
Control	8.13 ± 0.295^{a}	8.00 ± 0.267^{a}	8.00 ± 0.267^{a}	8.25 ± 0.250^{a}	8.38 ± 0.183^{a}
T1	7.00 ± 0.267^{b}	6.75 ± 0.313^{b}	6.63 ± 0.324^{b}	7.00 ± 0.260^{b}	7.38 ± 0.183^{b}
T2	8.13 ± 0.295^{a}	8.25 ± 0.250^{a}	7.88 ± 0.295^{a}	8.25 ± 0.250^{a}	8.50 ± 0.189^{a}
T3	6.13 ± 0.295^{c}	6.50 ± 0.189^{b}	5.63 ± 0.375^{c}	6.13 ± 0.295^{c}	6.38 ± 0.183^{c}
F value	11.322**	11.511**	12.517**	15.194**	28.880**

Means bearing various superscripts in the same column differs highly significantly ($P\leq0.01$)

** Statistically highly significant ($P\leq0.01$)

Control: Chicken meatballs without oats flour and cabbage

T1: Chicken meatballs incorporated with both oat flour and cabbage @ 1.5% (w/w)

T2: Chicken meatballs incorporated with both oat flour and cabbage @ 2.5% (w/w)

T3: Chicken meatballs incorporated with both oat flour and cabbage @ 3.5% (w/w)

Table 3. Proximate value of optimized chicken meatballs

Composition	Control	T2	t value
Moisture content %	65.790±0.374	64.456±0.459	2.250*
Protein%	27.474±0.009	27.850±0.007	7814.262**
Crude fibre %	4.053±0.021	4.727±0.015	825.21**
Fat %	2.734±0.076	5.013±0.076	2109.944*
Ash %	3.233±0.036	2.384±0.006	60.513*

** Statistically highly significant (P≤0.01)

Control: Chicken meatballs without oats flour and cabbage

T2: Chicken meatballs incorporated with both oat flour and cabbage @ 2.5% (w/w)

Table 4. Effect of inclusion of oats flour and cabbage on the technological properties of chicken meatballs

Quality Attributes	Control	T2	t value
Emulsion pH	5.57±0.02	5.50±0.02	5.691^{NS}
Product pH	5.74±0.01	5.66±0.01	7.455^{NS}
Emulsion stability %	94.80±0.35	95.45±0.44	45.074**
Cooking yield %	90.82±0.22	94.51±0.29	89.996**
Water Absorption Capacity %	5.217± 0.07	4.856± 0.03	21.234*
Oil binding capacity %	3.593± 0.02	2.774± 0.05	14.998**

** Statistically highly significant (P≤0.01)

Control: Chicken meatballs without oats flour and cabbage

T2: Chicken meatballs incorporated both oat flour and cabbage with 2.5% (w/w)

Koduveli. The panelists were requested to assess the quality of Oats flour and Cabbage incorporated chicken meatballs on the basis of sensory attributes such as color & appearance, flavour, texture, juiciness and overall acceptability based on 9point hedonic scale as given by Archana *et al.* (2016).

Statistical analysis

Data was analysed using software, statistical package for social sciences (SPSS) as per the standard methods. Experimental trials were replicated thrice with duplicates for analysis of proximate parameters (n=6), sensory analysis (n=30, 10 members). Data obtained was subjected to statistical analysis for analysis of variance (ANOVA) and independent t- test for comparing means at 5% level (p<0.0.05) for significance.

RESULTS AND DISCUSSION

Sensory analysis of oats and cabbage incorporated chicken meatballs

Meatballs of treatment T1 was similar to control meatballs and T3 developed a veggie taste and flavour which was dominated over chicken meat flavour. T2 had overall higher acceptability rate with slight caramelized nutty flavour due to inclusion of oats flour and succulent in texture as imparted by addition of cabbage paste and significantly differed from other samples ($p<0.05$). The results are given in table 2. From sensory evaluation it was found that meatballs with both oats powder and cabbage paste @ 2.5% were highly acceptable when compared to other treatments. So further analysis was carried out for samples T2. Incorporating dietary fibers in meat products can have a significant impact on their physicochemical, technological, and sensory properties. Kilincceker and Yilmaz (2019) found fiber addition can delay lipid oxidation, affect color, and improve moisture retention in chicken meatballs. However, the sensory properties were only positively affected up to a certain concentration.

Proximate analysis of oats and cabbage incorporated chicken meatballs

The proximate composition of 2.5 % oats and cabbage incorporated chicken meatballs were given in table 3. Notably the crude fiber content increased from 4.053±0.021(control) to 4.727±0.015 % (T2) since the raw material (oat flour 2.5g had and similar trend was observed by Mounika and Sahityarani(2021)and Talukder and Sharma (2010). This proves that oats and cabbage can be utilized as the main source of fiber.

Technological properties of oats and cabbage incorporated chicken meatballs

Highly significant difference ($p<0.05$) was observed in cooking yield, water absorption capacity and oil binding capacity in 2.5 % oats and cabbage incorporated chicken meatballs (Table 4). The results revealed that chicken meatballs incorporated with oat flour and cabbage at 2.5 % had significantly ($p\leq 0.05$) higher emulsion stability and no significant difference in product pH (Govind *et al.* 2013). The higher water binding was possibly due to the presence of increased hydration of fibre that improved texture and resisted to the mobility of water molecules and thereby increasing the cooking yield by adding bulk density to the product (Park *et al.,* 2011). Oil binding properties is one of the important health concerned factors. As the results proved that incorporation of fiber has minimized the absorption of cooking oil via water replacement and cooling phase effect, the developed product can be considered as low-fat or low-oil product (Brannan *et al.*, 2014). Similar reduction in oil binding capacity% was reported by Zhuang *et al.* (2016) in low-fat meat batter and Song *et al.* (2016) in low-fat frankfurters. Hence, incorporation of oats and cabbage can be considered for development of novel low fat or no-fat meat products.

CONCLUSION

In conclusion, the incorporation of oat flour and cabbage into chicken meatballs at2.5% (w/w) replacing lean meat content reported to absorb less oil that can be considered as beneficial and economical. Water absorption capacity of the product has been improved thereby resulting in soft texture and significant increase in cooking yield. Additionally, the use of oats flour adds a subtle nutty flavor and a tender texture, while cabbage adds moisture and a subtle sweetness. Even at incorporation level of 3% (w/w) oats flour and cabbage, the flavour was still acceptable but change in physico-chemical properties affected the final product. Modification to naturally derived fibre from oat and cabbage would bea great source for fortification of fibre into various meat products by reducing the cost of the final product. Further study on structural changes at molecular level would result in development of complete natural products without added food additives.

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