DR-2051
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RESEARCH ARTICLE Asian Journal of Dairy and Food Research

Development of Ready-to-Cook Meatballs from Broiler Chicken (*Gallus gallus domesticus*)

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10.18805/ajdfr.DR-2051

ABSTRACT

Background: Meat is a rich source of protein, especially broiler chicken, which is greatly preferred by consumers compared to other meat varieties because of its low cost and religious acceptance. The main objective of the present study was aimed to develop ready-to-cook meatballs from broiler chicken (*Gallus gallus domesticus*) stored in a refrigerator (4°C) and deep freezer (-18°C) for up to 21 days.

Methods: The ready-to-cook chicken meatballs were analyzed for biochemical, physicochemical and sensory properties for a period of up to 21 days.

Result: The biochemical parameters of ready-to-cook chicken meatballs were analyzed and the results showed that the moisture, protein, fat and ash contents were decreased and there was no significant difference during refrigerated and frozen conditions for the period up to 21 days. The microbial parameters were observed in ready-to-cook chicken meatballs. The total plate count was within the spoilage limit and other microbes such as Escherichia coli, yeast and moulds were absent in all the samples. The sensory evaluation of ready-to-cook chicken meatballs was good during refrigerated and frozen conditions for a period of up to 21st days.

Key words: Broiler chicken, Convenient food, Meatballs, Ready to cook, Shelf-life.

INTRODUCTION

Global poultry meat production is estimated at 131 million metric tons and its consumption is estimated at 131 million metric tons (FAO, 2021). The global meat production in 2020 is estimated at 328 million metric tons and its consumption is about 324 million metric tons. The consumption of poultry meat in India was about 4 million metric tons which are higher than other meat sources because of its versatility, palatability and digestibility (FAO, 2021). In addition, consumption is greatly influenced by rapid urbanization and changing lifestyles which creates demand for convenient meat products (Sinhamahapatra *et al*., 2013; FAO, 2021).

Among the different convenient meat products, meatballs are one of the most popular food items. Meatballs are small balls of crushed or ground meat mixed with spices and other ingredients (Islam *et al*., 2018). The sensory quality of low-fat-comminuted meat products can be increased by plant starches and/or flours which are commonly utilized as binders and/or fillers (Bogler *et al*., 2017). Bengal gram flour is a good source of proteins, carbohydrates and vitamins (Choudhary *et al*., 2021) and it acts as a good binding and thickening agent by improving the texture and extending the shelf life of the meatballs.

The chicken meatball substituted with corn flour has a low cooking loss, it improves the taste of the meatballs (Mamun *et al*., 2017). Corn starch increases the texture and water-binding ability of sausages (Berry and Wergin, 1993). Tapioca flours are a gluten-free substitute for wheat flour and have a wide range of properties. The tapioca flour can be used as a thickener, filler, binder or stabilizer in meat products. In addition, tapioca flour has increased the texture of cooked chicken breast meat patties (Chatterjee *et al*., 2019).

Packaging techniques such as vacuum packaging, controlled atmosphere packaging, modified atmosphere

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How to cite this article: Keerthi, G., Jerish, M., Metha, M.S.M., Hema, K., Brimapureeswaran, R. and Antony, U. (2023). Development of Ready-to-Cook Meatballs from Broiler Chicken (*Gallus gallus domesticus*). Asian Journal of Dairy and Food Research. DOI: 10.18805/ajdfr.DR-2051.

Submitted: 01-12-2022 **Accepted:** 26-05-2023 **Online:** 06-10-2023

packaging and active packaging have been applied in the meat industry to prevent the deterioration of meat products (Scetar *et al*., 2010). Vacuum packaging involves removal of the air from the package prior to sealing, to minimize the contact with oxygen and water vapor in the surrounding environment. This method increased the shelf life of chicken meatballs (Sinhamahapatra *et al*., 2013). The shelf life of meatballs can be further increased by storing the meat at low-temperature storage conditions. Sinhamahapatra *et al*. (2013) found that chicken meatballs kept in a deep freezer have an extended shelf life than refrigerated storage.

The present study aimed to develop ready-to-cook chicken meatballs from broiler chicken (*Gallus gallus domesticus*) stored at (-4°C) and (-18°C) and to evaluate the physico-chemical, microbial and sensory properties of ready-to-cook chicken meat balls were stored at (-4°C) and (-18°C) for the period upto 21 days.

MATERIALS AND METHODS

Broiler chicken (*Gallus gallus domesticus*) was purchased from Poorna slaughterhouse, Ponneri and the other ingredients were purchased from the local supermarket. The fresh broiler chicken meat was washed with potable water and sliced into small pieces. The smaller meat portions were minced using a mixer grinder and the minced meat temperature was maintained at 0 to -5°C using flake ice. The ingredients such as tapioca flour, bengal gram flour, garam masala, salt and onion were quantified as mentioned in (Table 1) and for preparing traditional masala spices like cardamom, cinnamon, clove, fennel, ginger, garlic and green chili was quantified as mentioned in the (Table 2). The onions were cut into small pieces, minced and roasted in a pan along with traditional masala. The roasted onions were added to the minced meat which was roasted in a pan for 10 mins. After that, the meat was allowed to cool for 2-3 mins and then ground using a mixer to form meat emulsion. The meat emulsions were transferred to a flat surface and blended with tapioca flour, bengal gram flour, garam masala and salt to form meat dough. The dough mixture was kneaded for 3 mins. The meat dough was rolled into meatballs. The meatballs were baked at 180°C, for 6mins and packed in LDPE bags, sealed using a vacuum packaging machine. Then, analyzed for the physico chemical, microbial and sensory properties of vacuum-packed ready-to-cook chicken meatballs were evaluated at -4°C and -18°C under different storage conditions.

The proximate composition was determined in accordance with standard AOAC (2005). The pH values were determined by 5g of chicken meatball diluted in 45 ml of distilled water and measured for pH using the glass electrode of a digital pH meter as described by IS. 2168 (1971). The cooking yield or product yield was calculated by measuring the difference in sample weight before and after cooking and was determined according to Murphy *et al*. (1975).

$$\text{Product yield (\%)} = \frac{\text{Weight of cooked meat ball}}{\text{Weight of raw meat ball}} \times 100$$

The microbial analysis of ready-to-cook chicken meat balls were analyzed for total plate count, *Escherichia coli*, yeast and mould according to the standard method described by APHA (1984). The sensory analysis of ready-to-cook chicken meatballs were carried out by trained and untrained panelists using 5-point hedonic scale as prescribed by Civille and Carr, (2015).

RESULTS AND DISCUSSION

Proximate composition

The result of the proximate composition of ready-to-cook chicken meatballs were given in (Table 3). The biochemical composition of broiler chicken meat consists of 75.80% moisture, 22.60% protein, 1.60% fat and 1.27% ash. The moisture content of ready-to-cook chicken meatballs on 1st day was 58% which was comparatively lower than raw chicken meat. This might be due to dry and intense heat applied during baking which results in the evaporation of moisture (Talukder and Sharma, 2010).

The protein content of ready-to-cook chicken meatballs on 1st day was 25% which was comparatively higher than the protein content of raw chicken meat. This significant increase might be a result of the baking process (Talukder and Sharma, 2010). The protein content in chicken products was mainly linked to the quality of raw meat and the ingredients used (Babar *et al*., 2017). There was a significant decrease in the protein content during storage and it decreased to 23.93% and 24.66% on the 21st day in samples T_1 and T_2. The decrease in protein content of refrigerated samples might be due to slow freezing which is often a major

Table 1: Formulation of ready-to-cook chicken meatballs.

Ingredients	Quantity (%)
Meat	70.65
Bengal gram flour	5.4
Tapioca flour	5.4
Garam masala	0.72
Salt	0.72
Traditional masala	6.12
Onion	11

Table 2: Composition of traditional masala.

Ingredients	Quantity (g)
Ginger	30
Garlic	30
Green chilli	4
Clove	1.5
Cardamom	1.5
Cinnamon	2
Fennel	40
Total	150

cause of protein denaturation (Hammad *et al*., 2019). In frozen samples, the protein denaturation might be due to the enzymatic reaction taking place during freezing (Kilinceeker *et al*., 2013). The fat content of ready-to-cook chicken meatballs on 1st day was 2.03% and there was no significant difference during the period of up to 21 days. This might be due to the antioxidant activity of spices. The ash content was 6% and it was comparatively higher than commercial meatballs which might be due to the presence of spices in the product. Generally, spices have high ash content (Mehring, 1924). It decreased to 5.67% and 5.7% on the 21st day in samples T_1 and T_2. The deterioration of ash might be attributed to protein and water hydrolysis (Hammad *et al*., 2019).

pH and cooking yield

The pH and cooking yield of ready-to-cook chicken meatballs during storage was given in (Table 4). There was a significant difference in the pH of chicken meatballs. The pH of chicken meatballs was 6.02 on 1st day and increased to 6.11 and 6.04 on the 21st day in samples T_1 and T_2. The rate of increment in pH was slower in the freezer temperature than in the refrigerator. This might be due to the effect of freezer temperature in arresting microbial growth to a larger extent (Sinhamahapatra *et al*., 2013). Increasing pH values might be the result of proteolytic effects (Kilincceker *et al*., 2013). The range of pH value was 6.07-6.22 for meatballs in which the tapioca was substituted with other kinds of flour (Ozturk and Turhan, 2020). The pH of vacuum-packed meatballs increased at a slower rate because vacuum hinders the growth of microbes for a longer time (Kim *et al*., 1996). The cooking yield of chicken meatballs was 86.70% on 1st day and it increased to 88.67% and 88.70% on the 21st day in samples T_1 and T_2. The cooking yield increased with increased storage (Islam *et al*., 2018).

Microbial analysis

The microbial count of ready-to-cook chicken meatballs in storage was given in (Table 5). The total plate count of ready-to-cook chicken meatballs increased significantly during refrigerated storage. The TPC count increased from 2.00×10^6 CFU/g to 6.7×10^6 CFU/g and 3.5×10^6 CFU/g on the 21st day in samples T_1 and T_2. The growth rate of total plate count in frozen meatballs is slower than refrigerated storage due to the reduction of the microbial cell and extension of the lag phase of the microbial growth caused by cold chain in the freezer storage (Sinhamahapatra *et al*., 2013). The meatballs were devoid of coliform, yeast and mould because yeast and moulds grow more slowly under vacuum packaging as the primary need for thriving and multiplication of the microbes became inadequate in vacuum packs (Valin and Lacourt, 1980).

Sensory evaluation

The sensory parameters of ready-to-cook chicken meatballs during storage was given in (Table 6). During refrigerated and freezer storage, colour, flavour and tenderness score of the meatballs decreased gradually. Initially, ready-to-cook chicken meatball has an appearance score of 4.55 and it decreased to 4.45 in both samples. Color values were also decreased from an initial score of 4.45 and decreased to 4.25 and 4.35 on 21st day in T_1 and T_2. The score obtained

Table 3: Proximate composition of ready-to-cook meatballs stored at 4°C and -18°C.

Parameters samples		0th day	7th day	14th day	21st day
Moisture (%)	T_1	58.01±0.01	56.57±0.40	56.73±0.73	56.33±0.32
	T_2		57.97±0.31	57.37±0.28	56.70±0.20
Protein (%)	T_1	25.00±0.01	24.97±0.08	24.66±0.20	23.93±0.49
	T_2		25.00±0.02	24.93±0.11	24.66±0.93
Fat (%)	T_1	2.03±0.02	2.03±0.01	2.03±0.04	2.03±0.07
	T_2		2.03±0.01	2.03±0.06	2.03±0.05
Ash (%)	T_1	6.00±0.05	5.72±0.00	5.69±0.13	5.67±0.04
	T_2		6.00±0.01	5.71±0.11	5.70±0.13

*Values are shown as mean±standard error of triplicates.

T_1- Refrigerated ready-to-cook chicken meatballs (4°C).

T_2- Frozen ready-to-cook chicken meatballs (-18°C).

Table 4: pH and cooking yield of ready-to-cook meatballs stored at 4°C and-18°C.

Parameters	Samples	0th day	7th day	14th day	21st day
pH	T_1	6.02±0.03	6.02±0.05	6.05±0.01	6.11±0.02
	T_2		6.02±0.03	6.02±0.03	6.02±0.0
Cooking yield (%)	T_1	86.70±0.10	88.53±0.35	89.65±0.13	89.67±0.21
	T_2		86.35±0.64	88.20±0.13	88.70±0.61

*Values are shown as mean±standard error of triplicates.

T_1- Refrigerated ready-to-cook chicken meatballs (4°C).

T_2- Frozen ready-to-cook chicken meatballs (-18°C).

Table 5: Microbiological parameters of ready-to-cook Meatballs stored at 4°C and -18°C.

Parameters	Samples	0^{th} day	7^{th} day	14^{th} day	21^{st} day
Total plate count	T_1	2.00×10^6	3.25×10^6	4.35×10^6	6.7×10^6
	T_2		2.03×10^6	3.05×10^6	3.5×10^6
Escherichia coli	T_1	Nil	Nil	Nil	Nil
	T_2		Nil	Nil	Nil
Yeast and mould	T_1	ND	ND	ND	ND
	T_2		ND	ND	ND

*Values are shown as mean±standard error of triplicates.

T_1- Refrigerated ready-to-cook chicken meatballs (4°C).

T_2- Frozen ready-to-cook chicken meatballs (-18°C).

Table 6: Sensory parameters of ready-to-cook meatballs stored at 4°C and-18°C.

Days	samples	Appearance	colour	Texture	Flavour	Taste	Overall acceptability
0	T_1	4.55±0.52	4.45±0.46	4.50±0.53	4.75±0.46	4.88±0.35	4.63±0.46
	T_2						
7	T_1	4.45±0.64	4.40±0.89	4.38±0.52	4.38±0.52	4.38±0.46	4.40±0.54
	T_2	4.55±0.71	4.40±0.92	4.50±0.52	4.70±0.46	4.80±0.53	4.59±0.56
14	T_1	4.38±0.71	4.38±0.92	4.38±0.52	4.38±0.52	4.25±0.46	4.35±0.63
	T_2	4.45±0.71	4.38±0.76	4.50±0.53	4.65±0.52	4.80±0.52	4.56±0.61
21	T_1	4.28±0.52	4.25±0.46	4.20±0.53	4.25±0.46	4.20±0.52	4.24±0.50
	T_2	4.45±0.53	4.35±0.53	4.45±0.52	4.60±0.52	4.75±0.52	4.52±0.52

*Values are shown as mean±standard error of triplicates.

T_1- Refrigerated ready-to-cook chicken meatballs (4°C).

T_2- Frozen ready-to-cook chicken meatballs (-18°C).

for texture was 4.50 on 1^{st} day and decreased to 4.38 and 4.45 on the 21^{st} day in samples T_1 and T_2. Flavour values also decreased from an initial score of 4.75 to 4.25 and 4.60 on 21^{st} day in samples T_1 and T_2. The score obtained for taste was 4.88 on 1^{st} day and decreased to 4.25 and 4.75 on 21^{st} day in samples T_1 and T_2. Refrigerated samples had an overall score of 4.2 whereas frozen samples had an overall score of 4.52 on 21^{st} day. Decrease in the colour, flavour and tenderness scores might be due to moisture loss from the product, increased lipid oxidation and proteolysis of the product (Bhoyar *et al*., 1997).

CONCLUSION

The broiler chicken meat is a rich source of protein and also has a high muscle-to-bone ratio compared with other meat varieties which makes it suitable for human consumption. The addition of tapioca flour with Bengal gram flour in the production of meatballs is a better alternative to wheat flour which is generally used in kofta making. Based on the results from the present study, the chicken meatballs were better in the deep freezer (-18°C) than refrigerator at (-4°C).

Conflict of interest: None.

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