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Research Article

Formulation of value added chicken meatballs by addition of Centella leaf (*Centella asiatica*) extracts

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Abstract

The study was conducted to find out the effect of different levels of Centella (Thankuni) leaf (*Centella asiatica*) extracts on chicken meatballs. Chicken meatballs sample were divided into four different treatments viz. 0, 1, 2 and 3% Centella leaf extracts group as T_0, T_1, T_2 and T_3, respectively. Days of intervals were 0, 15, 30 and 45 days. A 4×4 factorial experiment in completely randomized design having three replications per treatment was used for data analyses. Samples were preserved at -20˚C for 45 days. Sensory, proximate, physicochemical, biochemical and microbiological analyses were determined. Color, flavor, tenderness, Juiciness and overall acceptability were increased at different treatment levels significantly (p<0.001). DM content decreased (51.19 to 47.78%) significantly (p<0.001) at different treatment levels. On the contrary, DM content increased (47.39 to 51.53%) significantly (p<0.001) with the days of intervals. The EE decreased (10.75 to 9.09%) significantly (p<0.001) at different treatment level. The CP (19.05 to 20.46%) and Ash content (2.07 to 2.18%) at different treatment levels increased significantly (p<0.05). Ultimate pH (6.03 to 6.12) was increased at different treatment levels significantly (p<0.001). The cooking loss (26.30 to 23.62%) was decreased significantly (p<0.001) with the advancement of days of intervals. The FFA (0.36 to 0.28%), POV (3.33 to 2.76) and TBARS values (0.29 to 0.23) were decreased significantly (p<0.001) at different treatment levels. The TVC (5.05 to 4.39), TCC (1.10 to 1.01), and TYMC (1.34 to 1.10) decreased significantly (p<0.05) at different treatment levels. On the basis of sensory attributes, proximate, physicochemical traits, biochemical and microbial analysis showed that 3% Centella leaf extracts can be recommended for formulation of value added chicken meatballs.

Introduction

Chicken meat occupies a unique place in human diet by virtue of its specific nutritional characteristics. It is recognized as a highly nutritious food, being and excellent source of high quality protein, dietary vitamins and minerals. In fact, chicken meat supplies high protein and low fat (Bonoli et al., 2007). It has the distinction of being the most preferred meat in the world, especially as it is free from any social and religious restrictions. Chicken meat is lean and healthier contains more unsaturated fatty acids than other red meat. Therefore, the consumer's demand goes to chicken meat and meat products for overall acceptability and health friendly (Islam et al., 2018; Jamaly et al., 2017; Rima et al., 2019). It is particularly suited for processing due to its bland flavor, which can be enhanced by condiments. In recent years, the consumption of chicken meat has risen drastically. To ensure the continued growth and competitiveness of this industry, it is essential that the quality and safety of chicken meat products are maintained during processing. Different meat products such as meatballs, nuggets, sausage, and salami are also enriched source of meat protein and chicken meatballs are very popular meat products that have important nutritional contribution to human diet. Recently, chicken meatballs have gained more popularity as a fast food item in Bangladesh compared to other meat products (Ali et al., 2022; Boby et al., 2021; Bithi et al., 2020; Disha et al., 2020, Hossain et al., 2021). The transformation in the meat eating habits, lack of time for food processing at home, fast moving world, changes in the preferences for variety and taste of meat foods has lead to a shift from hot meat consumption to convenience and ready to eat meat products such as meatballs, sausages, nuggets, patties, loaves etc. They are gaining higher degree of importance due to its demand, urbanization and changing lifestyles. Among these meat products, meatball is one of the tasty and popular foods in our country.

Meatball is a foodstuff made up of minced meat combined with other ingredients, typically rolled and shaped by hands (Bruno, 2015). Meatballs are common meat products processed from lower-value trimmed red meat to produce a high-value meat product (Dzudie et al., 2004). Many non-meat ingredients are added to meatballs to increase their nutritional and functional value. However, during production, processing, distribution and storage, food undergoes deterioration from chemical and microbial processes. As chicken meat is relatively rich in unsaturated fatty acids (Valsta et al., 2005), it is more vulnerable to lipid oxidation, which affects the physicochemical parameters flavor, color, and texture, and it is also responsible for the degradation of lipid soluble vitamins and essential fatty acids (Adams, 1999).

Lipid oxidation is the main cause of quality deterioration in meat and meat products. It is not only generates unacceptable off flavors but also limits shelf-life and commercial stability (Disha et al., 2020; Sarker et al., 2021). In contrast to raw meat in which lipid oxidation occurs over days or weeks, these reactions proceed rapidly in cooked (fried) meats that oxidized flavors are detectable within hours of cooking. In particular, thermal processes promote lipid oxidation by disrupting cell membranes and releasing pro-oxidants (Sampaio et al., 2012). It is a rather complex process whereby the unsaturated fatty acid fraction of membrane phospholipids is oxidized, and hydroperoxides are formed which are further susceptible to oxidation or decomposition to secondary oxidation products, such as short-chain aldehydes, ketones, and other oxidized compounds that may adversely affect the overall quality and acceptability of meat and meat products. To prevent the autoxidation process, antioxidants have been utilized for many years in meat and meat products (Lahucky et al., 2010). Antioxidants have an ability to prevent or reduce the oxidative damage of a tissue indirectly by enhancing natural defenses of cell or directly scavenging the free radical species (Verma et al., 2012). The synthetic antioxidants like butyrated hydrox anisole, beta hydroxyl toluene etc currently being used in meat products have been found to exhibit various health affects especially mutagenic and carcinogenic agents (Boby et al., 2021). The use of these antioxidants has been questionable since they have been discovered to possess toxic, pathogenic and carcinogenic effects to humans and animals (Hayes et al., 2011). Recently, interest has considerably increased in finding naturally occurring antioxidant for usage in foods or medicinal materials in order to replace the synthetic antioxidants, which are being restricted legitimately due to their side effects (Bithi et al., 2020; Rahman et al., 2017).

Value added meat is the process of taking raw meat and changing its form to produce a high quality meat product. Nowadays, there is an increasing interest in the biochemical functions of natural antioxidant extracts from vegetables, fruits, and medicinal plants, which can become candidates to prevent oxidative damage, promoting health. In view of the fact that natural spices are widely used in a variety of food products, it is important to know the effects on the keeping qualities of such products. It has also been reported that these natural antioxidants, especially of plant source, have greater application potential for consumer's acceptability, palatability, stability and shelf life of meat products (Saba et al., 2018). One such plant with a potential to be used as an antioxidant is Centella leaf extracts (*Centella asiatica*). *Centella asiatica*, Family: Umbelliferae, also popularly known as Brahmi, is an herb used since ancient times as a memory enhancer. It is also known as Gota kola or Mandukparni in Indian subcontinent. It is a perennial herb that has been used for centuries in *Ayurvedic* medicine to treat several disorders, such as insanity, asthma, leprosy, ulcers and eczema, and for wound healing (Kumar and Tanwar, 2011). *Centella asiatica* contains triterpene glycosides such ascentellas-aponin, asiaticoside, madecassoside and sceffoleoside (Matsuda et al., 2001). There are many kind of herbal extracts which may be included upto 10% in meat and meat products prior to it's acceptance level of consumers to maintain unpleasant flavor. It is evident that maximum literature found of 1 to 3% herbal extracts used to increase the shelf life of meat and meat products. From this point of view, 1, 2 and 3% level of herbal extracts were used for the present study. *C. asiatica* is very rich in terpenoides, a compound which plays a very active role in wound healing and helps to reduce diastolic blood pressure and lowers the sugar level in blood (Hawkins and Ehrlich, 2006). There are no studies yet been done in Bangladesh on meatballs with Centella leaf extracts. The aim of the present study is to investigate the effect of Centella leaf extract on chicken meatballs. Hence, the experiment was conducted to examine sensory, proximate, physicochemical, biochemical and microbiological properties on chicken meatballs after addition of *Centella asiatica* leaf extracts and find out its suitable doses.

Materials And Methods

The study was conducted during the period of June 2020 to December 2020 in the Department of Animal science, Bangladesh Agricultural University, Mymensingh. The chicken meat sample was collected from K.R. Market of Mymensingh. Chicken meatballs were prepared using fresh chicken meat, garlic pest, onion pest, ginger pest, meat spices, garam masala (spices), egg, biscuit crumbs, soybean oil, ice flakes, refined vegetable oil, refined wheat flower, Centella leaf extracts, salt and sauces. There were four treatment groups, viz. T_0 = (Control), T_1 = (1% Centella leaf extracts), T_2 = (2% Centella leaf extracts), T_3 = (2% Centella leaf extracts). Sensory qualities (Color, flavor, tenderness, juiciness and overall acceptability) were evaluated by a trained 6-member panel. Samples were evaluated after cooking. When internal temperature of meat reached at 71º C for 30 minutes then cooking was finished and it was checked by a food grade thermometer (Rahman et al., 2020). After meat sample was used for sensory evaluation using a 5-point scoring method that ranks the panelist`s sense of qualities. Sensory scores were 5 for excellent, 4 for very good, 3 for good, 2 for fair and 1 for poor (Siddiqua et al., 2018; Jahan et al., 2018). All samples were supplied in petri dishes. Sensory evaluation was accomplished at 0 day and repeated at 15, 30 and 45 days. The DM, EE, CP and ash of meatballs were measured according to AOAC (2005). The pH of raw and cooked of meatballs was determined using a digital pH meter (Hanna HI 99163). The cooking loss of meatballs was determined by a weighing balance and a hot water bath internal temperature of meat reached at 71º C for 30 minutes. The FFA, POV and TBARS value were carried out by Sharma et al. (2012). The TVC, TCC and TYMC were determined according to the procedure of Ikhlas et al. (2011). All determination was done in triplicate and mean value was taken.

Statistical analysis

The proposed model for the planned experiment was factorial experiment with two factors A *(Treatments)* and *B (Days of Intervals)* is:

$Yijk = \mu + Ai + Bj + (AB)ij + \varepsilon ijk \quad i = 1,\ldots,a;\ j = 1,\ldots,b;\ k = 1,\ldots,n$

Where:

Yijk= observation *k* in level *i* of factor *A* and level *j* of factor *B*

μ = the overall mean

Ai = the effect of level *i* of factor *A*

Bj= the effect of level *j* of factor *B*

Data were analyzed using 4×4 factorial experiment in CRD replicated three times per cell using SAS 9.1.3 version Statistical Discovery software, NC, USA. Duncan's Multiple Range Test (DMRT) was used to determine the significance of differences among treatments means at values ($p<0.05$).

Results And Discussion

Sensory attributes

The score ranges for color, flavor, tenderness, juiciness and overall acceptability at different treatments were 3.58 to 4.75, 3.67 to 4.75, 3.50 to 4.50, 3.42 to 4.50 and 3.33 to 4.58, respectively and days of interval were 3.50 to 4.67, 3.50 to 4.67, 3.33 to 4.67, 3.33 to 4.67 and 3.41 to 4.58, respectively (Table 1). Color, flavo, tenderness, juiciness and overall acceptability had significantly ($p<0.001$) increased with different treatment but storage period had significantly ($p<0.001$) decreased. Similar results were found by Siddiqua et al. (2018) and Boby et al. (2021). The sensory evaluation revealed that among different herbs and cardamon was highly preferred in burfi followed by ginger, clove, curry leaves and *tulsi* (Prasad et al., 2017). These results were in accordance with the present study where 3% Centella leaf extracts was significantly affected at different sensory attributes. Most preferable color, flavor, tenderness, juiciness, tenderness and overall acceptability was found from T_3 and less preferred value was found in T_0 treatment. Most preferable color, flavor, tenderness, juiciness and overall acceptability were found from 0 day and less was 45th day. Gradual decline in appearance and color, flavor, tenderness, juiciness and overall acceptability scores of chicken meatballs at refrigeration conditions -20º C might be due to pigment and lipid oxidation resulting in non-enzymatic browning between lipids and amino acids. A similar result was reported by Kumar and Tanwar (2011) in ground mustard incorporated with chicken nuggets. It was observed that the quality was deteriorated with increasing storage period. Flavor is one of the major causes of quality deterioration because it could be negatively affected the sensory attributes viz. color, texture, odor and flavor as well as the nutritional quality of the product (Nunez and Boleman, 2008). Similar results were found by Irshad et al. (2016) where they showed that deterioration of flavor during storage period was reflected due to the growth of microbes, formation of FFA and oxidative rancidity. Tenderness is interrelated to DM content of the meatballs. With the increasing of storage period DM was increased consequently and tenderness was decreased with day's intervals.

Table 1. Effect of Centella leaf extracts on sensory attributes in chicken meatballs

Parameters	DI	Treatments				Mean	Level of significance		
		T_0	T_1	T_2	T_3		Treat.	DI	T×DI
Color	0	4.33±0.33	4.67±0.33	4.67±0.33	5.00±0.00	4.67^a±0.24			
	15	4.00±0.00	4.33±0.33	4.67±0.33	5.00±0.00	4.50^a±0.16			
	30	3.33±0.33	3.37±0.33	4.33±0.33	4.67±0.33	4.00^b±0.33	<.0001	<.0001	0.8781
	45	2.67±0.33	3.33±0.33	3.67±0.33	4.33±0.33	3.50^c±0.33			
	Mean	3.58^c±0.24	3.93^{bc}±0.33	4.34^{ab}±0.33	4.75^a±0.17				
Flavor	0	4.33±0.33	4.67±0.33	4.67±0.33	5.00±0.00	4.67^a±0.24			
	15	4.33±0.33	4.67±0.33	4.67±0.33	5.00±0.00	4.67^a±0..24			
	30	3.33±0.33	4.00±0.00	3.67±0.33	4.67±0.33	3.91^a±0.24	0.0002	<.0001	0.7678
	45	2.67±0.58	3.33±0.33	3.67±0.33	4.33±0.33	3.50^b±0.33			
	Mean	3.67^b±0.39	4.17^b±0.24	4.17^b±0.33	4.75^a±0.17				
Tenderness	0	4.33±0.33	4.33±0.33	4.67±0.33	5.00±0.00	4.67^a±0.25			
	15	4.00±0.00	4.33±0.33	4.67±0.33	4.67±0.33	4.33^a±0.33			
	30	3.33±0.33	3.67±0.33	3.67±0.33	4.33±0.33	3.75^b±0.33	0.0003	<.0001	0.8038
	45	2.33±0.33	3.33±0.33	3.67±0.33	4.00±0.00	3.33^b±0.24			
	Mean	3.50^c±0.25	3.91^{bc}±0.33	4.17^{ab}±0.33	4.50^a±0.17				
Juiciness	0	4.33±0.33	4.67±0.33	4.67±0.33	5.00±0.00	4.67^a±0.25			
	15	4.67±0.33	4.33±0.33	4.67±0.33	4.67±0.33	4.33^a±0.33			
	30	3.33±0.33	3.67±.33	3.67±0.33	4.33±0.33	3.75^b±0.33	0.0003	<.0001	0.8038
	45	2.33±0.33	3.33±0.33	3.67±0.33	4.00±0.00	3.33^b±0.25			
	Mean	3.42^c±0.33	4.00^b±0.33	4.17^{ab}±0.33	4.50^a±0.17				
Overall acceptability	0	4.00±0.00	4.67±0.33	4.67±0.33	5.00±0.00	4.58^a±0.16	<.0001	<.0001	0.7933
	15	3.67±0.33	4.00±0.00	4.33±0.33	4.67±0.33	4.17^b±0.25			
	30	3.33±0.33	3.67±0.33	4.00±0.00	4.33±0.33	3.83^b±0.25			
	45	2.33±0.33	3.33±0.33	3.67±0.33	4.33±0.33	3.41^c±0.33			
	Mean	3.33^c±0.25	3.92^b±0.25	4.17^b±0.25	4.58^a±0.25				

Sensory scores were 5 for excellent, 4 for very good, 3 for good, 2 for fair, and 1 for poor. Mean in each row having different superscript varies significantly at values $p<0.05$, T_0=control group, T_1=1% centella leaf extract, T_2 =2% centella leaf extract and T_3 =3% centella leaf extract, DI=Day Intervals, Treat= Treatment, T×DI=Interaction of Treatment and Day Intervals

Proximate components

The ranges for DM, CP, EE and ash at different treatments were 47.78 to 51.19, 19.05 to 20.46, 9.09 to 10.75 and 2.07 to 2.18, respectively and days of interval were 47.39 to 51.53, 19.00 to 20.31, 9.49 to 10.25 and 1.85 to 2.41, respectively (Table 2). The DM and EE values showed significantly decreased ($p<0.001$). The CP and ash values were significantly increased ($p<0.001$) in all treatments. The days of interval for DM and CP were observed significantly increased ($p<0.001$) but EE and ash values were found significantly increased $p<0.001$). These results were not in agreement with the findings of Disha et al. (2020), Rima et al. (2019) and Sidiqua et al. (2018). Most preferable DM was found in T_3 treatment group. The lowest DM indicated that the product was most suitable for consumers. The DM was increased due to increase of storage period resulting moisture loss was decreased of increasing storage period. Similar results were found by Rahman et al. (2017). The Most preferable CP content was observed at T_3 and less preferable CP content at T_0 treatments. The highestt EE content was observed from T_0 and lowest in T_3 treatments. The lowest amount of EE content indicates this product is most preferable for consumers' health. This result was almost similar to Boby et al. (2021). The EE was increased due to increase of storage period which was not similar to Disha et al. (2020). The highest ash content was observed from T_3 group and lowest from T_1. The lowest amount of ash content indicates this product is most preferable for consumers' health. Data showed that ash gradually increased with increasing of storage period.

This result was in accordace with Bithi et al. (2020). Zargar et al. (2017) reported that ash content of the products was observed significantly decreased ($p<0.05$) with increasing levels of incorporation carrot in chicken sausages which was similar to the present study. Bhosale et al. (2011) also found that ash content decreased for ground carrot and mashed sweet potato incorporated with chicken nuggets. The positive and significant interaction was found between treatments and days of interval for DM, CP and EE except ash (Table 2).

Table 2. Effect of Centella leaf extract on proximate components in chicken meatballs

Parameters	DI	Treatments				Mean	Level of significance		
		T_0	T_1	T_2	T_3		Treat.	DI	T×DI
DM(%)	0	48.66±.02	47.89±0.03	46.96±0.03	46.04±0.07	47.39^d±0.03	<.0001	<.0001	<.0001
	15	50.51±.1	48.63±0..03	47.92±0.03	46.85±0.03	48.48^c±0.04			
	30	52.05±0.04	49.93±0.02	49.11±0.03	48.30±0.04	49.84^b±0.03			
	45	53.53±0.03	51.69±0.02	50.96±0.04	49.93±0.04	51.53^a±0.03			
	Mean	51.19^a±0.04	49.54^b±0.02	48.74^c±0.03	47.78^d±0.05				
CP(%)	0	19.82±0.08	20.07±0.02	20.42±0.03	20.91±0.02	20.31^a±0.03	<.0001	<.0001	<.0001
	15	19.31±0.06	19.84±0.03	19.96±0.03	20.71±0.03	19.96^b±0.03			
	30	18.92±0.03	19.25±0.04	19.63±0.05	20.35±0.04	19.54^c±0.04			
	45	18.14±0.05	18.79±0.06	19.24±0.04	19.85±0.03	19.00^d±0.04			
	Mean	19.05^d±0.05	19.49^c±0.03	19.81^b±0.03	20.46^a±0.03				
EE(%)	0	10.22±0.04	9.82±0.02	9.11±0.04	8.82±0.04	9.49^d±0.03	<.0001	<.0001	<.0001
	15	10.76±0.02	10.02±0.03	9.32±0.02	9.03±0.03	9.78^c±0.02			
	30	10.91±0.03	10.22±0.02	9.79±0.02	9.22±0.04	10.03^b±0.02			
	45	11.13±0.03	10.60±0.02	9.98±0.02	9.30±0.02	10.25^a±0.02			
	Mean	10.75^a±0.03	10.16^b±0.02	9.55^c±0.02	9.09^d±0.03				
Ash(%)	0	1.82±0.03	1.79±0.03	1.85±0.02	1.91±0.02	1.85^d±0.02	<.0001	<.0001	0.1139
	15	1.93±0.04	1.78±0.02	1.93±0.02	1.98±0.02	1.91^c±0.02			
	30	2.13±0.03	2.18±0.01	2.27±0.03	2.35±0.02	2.23^b±0.02			
	45	2.39±0.05	2.35±0.02	2.42±0.03	2.48±0.01	2.41^a±0.03			
	Mean	2.07^{cc}±.03	2.02^c±0.02	2.12^b±0.02	2.18^a±0.01				

Mean in each row having different superscript varies significantly at values $p<0.05$, T_0=control group, T_1=1% centella leaf extract, T_2 =2% centella leaf extract and T_3 =3% centella leaf extract, DI=Day Intervals, Treat= Treatment, T×DI=Interaction of Treatment and Day Intervals.

Physicochemical traits

The ranges for ultimate pH, cooked pH and cooking loss at different treatments were 6.03 to 6.12, 6.13 to 6.25 and 24.45 to 25.56, respectively and days of interval were 6.02 to 6.13, 6.03 to 6.25, and 23.62 to 26.30, respectively (Table 3). Ultimate pH and cooked pH at different teatments were found increased in which ultimate pH had significant ($p<0.001$) and cooked pH was not statistically significant ($p>0.05$). Cooking loss was significantly ($p<0.001$) decreased as increasing the doses of Centella leaf extracts. Ultimate pH, cooked pH and cooking loss were found decreased at different days of interval in which ultimate pH and cooking loss were statistically significant ($p<0.001$) and cooked pH was ($p<0.05$). Similar results were found by Boby et al. (2021) and Bithi et al. (2020) but disagreed with the findings of Disha et al. (2020). The decrease in ultimate pH with incorporation of carrot may be attributed to low pH of minced carrot which is rich in bioactive compounds. Verma et al. (2012) observed a decrease in pH of chicken nuggets incorporated with bottle gourd. Cooking loss was decreased due to increased of treatnment level and decreased of storage period which was similar to the results of Disha et al. (2020). Cooking loss was found positve and significant inteaction between treatment and days of interval (Table 3).

Table 3. Effect of Centella leaf extract on physiochemical traits in chicken meatballs

Parameters	DI	Treatments				Mean	Level of significance		
		T_0	T_1	T_2	T_3		Treat.	DI	T×DI
Ultimate PH	0	6.11±0.08	6.13±0.08	6.14±0.05	6.17±0.08	6.13^a±0.07	<.0001	<.0001	0.1136
	15	6.04±0.08	6.09±0.05	6.10±0.08	6.13±0.01	6.09^b±0.07			
	30	6.02±0.08	6.07±0.06	6.06±0.05	6.10±0.01	6.06^c±0.07			
	45	5.95±0.01	6.02±0.02	6.10±0.01	6.09±0.01	6.02^d±0.01			
	Mean	6.03^c±0.09	6.08^b±.09	6.08^b±0.07	6.12^a±0.09				
Cooked PH	0	6.19 ±0.05	6.23±0.01	6.28±0.03	6.31±0.05	6.25^a±0.05	0.12	0.0028	0.3866
	15	6.16±0.01	6.18±0.02	6.24±0.01	6.30±0.03	6.22^a±0.01			
	30	6.11±0.01	6.13±0.02	6.20±0.08	6.24±0.01	6.17^a±0.01			
	45	6.06±0.01	6.09±0.08	5.80±0.03	6.17±0.08	6.03^b±0.01			
	Mean	6.13^a±0.08	6.16^a±.01	6.13^a±0.03	6.25^a±0.06				
Cooking loss (%)	0	27.32±0.1	26.12±0.05	25.94±0.02	25.87±0.06	26.30^a±0.04	<.0001	<.0001	<.0001
	15	26.08±0.04	25.14±0.07	25.02±0.02	24.74±0.02	25.24^b±0.03			
	30	24.95±0.09	24.45±0.05	24.18±0.03	23.87±0.05	24.36^c±0.05			
	45	23.89±0.06	23.75±0.03	23.5±0.01	23.35±0.03	23.62^d±0.03			
	Mean	25.56^a±0.07	24.86^b±0.05	24.66^c±0.02	24.45^d±0.02				

Mean in each row having different superscript varies significantly at values $p<0.05$, T_0=control group, T_1=1% centella leaf extract, T_2 =2% centella leaf extract and T_3 =3% centella leaf extract, DI=Day Intervals, Treat= Treatment, T×DI=Interaction of Treatment and Day Intervals.

Biochemical properties

The ranges for FFA, POV and TBARS at different treatments were 0.28 to 0.36, 2.76 to 3.33 and 0.23 to 0.29, respectively and days of interval were 0.28 to 0.37, 2.71 to 3.42, and 0.21 to 0.32, respectively (Table 4). The FFA, POV and TBARS values of all treatments significantly decreased ($p<0.001$) and for days of interval significantly increased ($p<0.001$). The most preferable FFA, POV and TBARS values were found in T_3 and 0 day of interval. These results were supported to the findings of Jahan et al. (2018). The FFA content significantly ($p<0.05$) increased in the products during storage period might be as per growth of lipolytic microorganisms (Das et al., 2008). The FFAs are the product of enzymatic/microbial degradation of lipids. It gives us the information of fat stabilty during storage period. The lowest POV gives us information that this product is most suitable for consumer's health. During storage period, POV increased in all treatments. The antioxidant with treatments could minimize POV value in food item during compared to control group. Disha et al. (2020) reported that POV in chicken meatballs with three treatment (0.01% BHA, 0.05 and 1% lemon ectract) showed lower values than that of control group which was similar to the present study. The most TBARS value was found in T_3 group. The lowest TBARS value indicates the product is most preferable to consumer's health. The TBARS values significantly ($p<0.001$) increased during storage period. Yadav et al. (2018) reported a significant increased in TBARS value of control and fiber enriched sausage with an increase in storage period. There was found positve and significant interaction between treatment and days of interval for FFA and TBARS except POV (Table 4).

Table 4. Effect of Centella leaf extract on biochemical parameters in chicken meatballs

Parameters	DI	Treatments				Mean	Level of significance		
		T_0	T_1	T_2	T_3		Treat.	DI	T×DI
FFA (%)	0	0.32±0.04	0.29±0.07	0.28±0.05	0.22±0.07	0.28^d±0.05	<.0001	<.0001	0.0006
	15	0.34±0.02	0.32±0.08	0.29±0.03	0.25±0.04	0.30^c±0.04			
	30	0.38±0.01	0.34±0.02	0.33±0.07	0.31±0.05	0.34^b±0.03			
	45	0.40±0.06	0.38±0.05	0.36±0.04	0.34±0.03	0.37^a±0.04			
	Mean	0.36^a±0.03	0.33^b±0.05	0.31^c±0.04	0.28^d±0.04				
POV (meq/kg)	0	3.02±0.03	2.82±0.04	2.62±0.02	2.41±0.02	2.71^d±0.03	<.0001	<.0001	0.1749
	15	3.16±0.02	3.01±0.02	2.84±0.03	2.58±0.01	2.90^c±0.02			
	30	3.41±0.01	3.25±0.02	3.09±0.02	2.96±0.04	3.18^b±0.02			
	60	3.74±0.06	3.54±0.03	3.30±0.03	3.10±0.08	3.42^a±0.03			
	Mean	3.33^a±0.03	3.15^b±0.02	2.96^c±0.02	2.76^d±0.03				
TBARS (mg-MA/kg)	0	0.23±0.01	0.22±0.01	0.20±0.02	0.18±0.01	0.21^d±0.01	<.0001	<.0001	<.0001
	15	0.27±0.01	0.25±0.01	0.21±0.01	0.20±0.02	0.23^c±0.01			
	30	0.30±0.01	0.28±0.02	0.25±0.04	0.23±0.02	0.27^b±0.06			
	45	0.35±0.02	0.33±0.02	0.30±0.02	0.29±0.02	0.32^a±0.02			
	Mean	0.29^a±0.01	0.27^b±0.06	0.24^c±0.02	0.23^d±0.02				

Mean in each row having different superscript varies significantly at values $p<0.05$, T_0=control group, T_1=1% centella leaf extract, T_2 =2% centella leaf extract and T_3 =3% centella leaf extract, DI=Day Intervals0063hgk, Treat= Treatment, T×DI=Interaction of Treatment and Day Intervals.

Microbiological assessment

The ranges for TVC, TCC and TYMC at different treatments were 4.39 to 5.05, 1.01 to 1.10 and 1.10 to 1.34, respectively and days of interval were 4.63 to 4.79, 1.00 to 1.10, and 0.99 to 1.47, respectively (Table 5). The TVC, TCC and TYMC values were found significantly ($p<0.001$) decreased with the increasing level of herbal doses in all treatmenmt groups. The lowest amount of TVC value indicates the product is most preferable for consumer's health (T_3). The amount of TVC was increased with increasing storage period. The antioxidant compounds act as barrier of deteriorating of fat and assisted to prevent metabolism of fat by bacteria as resulting in bacterial growth was lower in chicken nuggets treated with antioxidants. Babatunde and Adewumi (2015) reported that garlic, ginger and roselle extract provided antioxidant and antimicrobial benefits to raw chicken patties during cold storage. Microbial load was decreased in all treatment groups than control groups. The TCC in control group (1.10 log CFU/g) was found significantly ($p<0.05$) higher than all treated groups. These reults were supported to Disha et al. (2020). Lower amount of TCC indicates the product is the most suitbale for consumer's health. Duing storage period TCC values significantly ($p<0.05$) decreased which was similar to Disha et al. (2020). Singh and Immanuel (2014) showed that the raw chicken meat emulsion incorporated with clove powder, singer and garlic paste at refrigerated storage (4±1° C). The TYMC in control group (1.34 log CFU/g) was found significantly ($p<0.001$) higher than all the treated groups. These results were in accordance with Islam et al. (2019). Same trend was found by Rima et al. (2019). The lowest TYMC value indicates the product is most preferable for consumer's health. The highest TYMC was observed at 0 day and the lowest at 45 days. There was found positive and significant inteaction between treatments and days of interval for TCC and TYMC except TVC (Table 5).

Table 5. Effect of Centella leaf extracts on different microbe's population in chicken meatballs

Parameters	DI	Treatments				Mean	Level of significance		
		T_0	T_1	T_2	T_3		Treat.	D	T×DI
TVC (logCFU/g)	0	5.31±0.65	4.54±0.01	4.41±0.08	4.27±0.09	4.63^a±0.16	<.0001	0.29	0.721
	15	4.79±0.01	4.66±0.03	4.48±0.01	4.32±0.08	4.56^a±0.01			
	30	4.95±0.01	4.75±0.02	4.58±0.01	4.43±0.01	4.67^a±0.01			
	45	5.17±0.02	4.81±0.01	4.64±0.05	4.53±0.01	4.79^a±0.01			
	Mean	5.05^a±0.02	4.69^b±0.02	4.53^{bc}±0.08	4.39^c±0.09				
TCC (logCFU/g)	0	1.13±0.02	1.11±0.01	1.11±0.03	1.07±0.08	1.10^a±0.03	<.0001	<.0001	0.0016
	15	1.12±0.02	1.10±0.01	1.09±0.05	1.02±0.04	1.08^b±0.03			
	30	1.11±0.02	1.09±0.03	1.07±0.09	1.00±0.09	1.07^c±0.05			
	45	1.03±0.03	1.03±0.04	1.02±0.04	0.93±0.01	1.00^d±0.05			
	Mean	1.10^a±0.02	1.09^b±0.03	1.07^c±0.01	1.01^d±0.07				
TYMC (logCFU/g)	0	1.62±0.08	1.51±0.01	1.41±0.01	1.36±0.03	1.47^a±0.07	<.0001	<.0001	<.0001
	15	1.42±0.02	1.29±0.01	1.25±0.02	1.19±0.01	1.28^b±0.01			
	30	1.23±0.09	1.17±0.01	1.11±0.06	1.05±0.08	1.14^c±0.03			
	45	1.11±0.09	1.09±0.04	0.95±0.01	0.82±0.02	0.99^d±0.01			
	Mean	1.34^a±0.01	1.27^b±0.08	1.18^c±0.01	1.10^d±0.01				

Mean in each row having different superscript varies significantly at values $p<0.05$, T_0=control group, T_1=1% centella leaf extract, T_2 =2% centella leaf extract and T_3 =3% centella leaf extract, DI=Day Intervals, Treat= Treatment, T×DI=Interaction of Treatment and Day Intervals.

Conclusions

It is revealed from the study that chicken meatballs can be preserved for 45 days using different levels of Centella leaf extracts. Among the treatments, Centella leaf extracts dose 3% showed the best results in terms of sensory evaluation, physicochemical, biochemical and microbial assessment and the shelf life extension of value added chicken meatballs. So, it can be recommended that 3% Centella leaf extracts can be used as a source of enriched dietary fibre and natural antioxidant for the formulation of value added chicken meatballs.

Conflicts Of Interest

The authors declare that there are no potential conflicts of interests.

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References

Adams CA. 1999. Nutricines: food components in health and nutrition. Nottingham: Nottingham University Press.

Ali MS, Rahman MM, Habib M, Kabir MH, Hashem MA, Azad MAK, Rahman MM. 2022. Quality of spent hen sausages incorporated with bee honey. Meat Research. 1: Article 13.

AOAC. 2005. Association of Official Analytical Chemists, Official methods of analysis, 18th Ed. Washington, D.C.

Babatunde OA, Adewumi AO. 2015. Effects of ethanolic extract of garlic, roselle and ginger on quality attributes of chicken patties. African Journal of Biotechnology, 14(8): 688-694.

Bhosale SS, Biswas AK, Sahoo J, Chatli MK, Sharma DK. Sikka SS. 2011. Quality evaluation of functional chicken nuggets incorporated with ground carrot and mashed sweet potato. Food Science and Technology International, 17(3): 233-239.

Bithi MAA, Hossain MA, Rahman SME, Rahman MM, Hashem MA. 2020. Sensory, nutritive, antioxidant and antimicrobial activity of telakucha (*Coccnia cordifolia*) leaves extract in broiler meatballs. Journal of Meat Science and Technology, 8(2): 23-31.

Boby F, Hossain MA, Hossain MM, Rahman MM, Azad MAK, Hashem MA. 2021. Effect of long coriander leaf (eryngium foetidum) extract as a natural antioxidant on chicken meatballs during at freezing temperature. SAARC Journal of Agriculture, 19(2): 271-283. Doi: https://doi.org/10.3329/sja.v19i2.57687

Bonoli M, Caboni MF, Rodriguez-Estrada MT, Lercke G. 2007. Effect of feeding fat sources on the quality and composition of lipids of precooked ready-to-eat fried chicken patties. Food Chemistr, 10**:** 1327-1337.

Bruno M. 2015. Meatballs-The ultimate guide. https://www.murdochbooks.com.au/ browse/ books/cooking-food-rink/fooddrink/Meatballs

Das AK, Anjaneyulu ASR, Gadekar YP, Singh RP, Pragati H. 2008. Effect of full fat soya paste and textured soya granules on quality and shelf-life of goat meat nuggets in frozen storage. Meat Science, 80(1): 607-614.

Disha MNA, Hossain MA, Kamal MT, Rahman MM, Hashem MA. 2020. Effect of different levels of lemon extract on quality and shelf life of chicken meatballs during frozen storage. SAARC Journal of Agriculture, 18(2):139-156.

Dzudie T, Kouebou CP, Essia-Ngang JJ, Mbofung CMF. 2004. Lipid sources and essential oils effects on quality and stability of beef patties. Journal of Food Engineering, 65: 67-72.

Hawkins EB, Ehrlich SD. 2006. Gotu kola. University of Maryland Medical Center, Baltimore USA.

Hayes JE, Allen P, Brunton N, O'Grady MN, Kerry JP. 2011. Phenol composion of invitro antioxidant capacity of four commercial phytochemical products: olive leaf extracts (Olea europaea L), lutein, sesame oil and ellagic acid. Food Chemistry, 126: 948-955.

Hossain MA, Rahman MM, Rahman MW, Hossain MM, Hashem MA. 2021. Optimization of slaughter age of Jamuna basin lamb based on carcass traits and meat quality. SAARK J Agricultrure. 19(2): 257-270.

Ikhlas B, Huda N, Ismail N. 2011. Effect of Cosmos caudatus, Polygonum minus and BHT on physical properties, oxidative process, and microbiological growth of quail meatball during refrigeration storages. Journal of Food Processing and Preservation, 36(1): 55-66.

Irshad A, Sharma BD, Ahmed SR, Talukder S, Malav OP, Kumar A. 2016. Effect of incorporation of calcium lactate on physicochemical, textural, and sensory properties of restructured buffalo meat loaves. World Veterinary, 9(2): 151-159.

Islam F, Hossain MA, Rahman MF, Hashem MA, Rahman M, Azad MAK. 2018. Effect of synthetic or herbal preservatives on the quality of beef meatballs at different shelf life periods. SAARC Journal of Agriculture, 16(1): 23-34.

Jahan I, Haque MA, Hashem MA, Rima FJ, Akhter S, Hossain, MA. 2018. Formulation of value added beef meatballs with pomegranate (*Punica granatum*) extract as a source of natural antioxidant. Journal of Meat Science and Technology, 6(1):12-18.

Jamaly SI, Hashem MA, Akhter S, Hossain MA. 2017. Wheat flour as dietary fiber on fresh and preserved beef meatballs. Bangladesh Journal of Animal Science, 46(1): 35-43.

Kumar D, Tanwar VK. 2011. Effect of incorporation of ground mustard on quality attributes of chicken nuggets preparation. Journal of Food Science and Technology, 48: 59-62

Lahucky R, Nuernberg K, Kovac L, Bucko O, Nuernberg G. 2010. Assessment of the antioxidant potential of selected plant extracts - in vitro and in vivo experiments on pork. Meat Science**,** 85: 779-784.

Matsuda H, Morikawa T, Ueda H, Yoshikawa M. 2001. Medicinal foodstuffs. XXVII. Saponin constituents Gotu Kola (2): Structures of new ursane- and oleanane-type triterpeneoligoglycosides, centellasaponin B, C, and D, from *Centella asiatica* cultivated in Sri Lanka. Chemistry and Pharmacy Bulletin, 49: 1368–1371.

Nunez G, Boleman S. 2008. Microbial safety of meat in the European Union. Meat Science, 78**:** 14-18.

Prashad W, Khamrui K, Surajit M, Riche B. 2017. Anti-oxidative, physiocochemical and sensory attributes of burfi affected by incorporation of defferent herbs and its comparison with synthetc anti-oxidant (BHA). Journal of Food Science and Technology, 54(6): 1-8.

Rahman M, Kabir MH, Hossain MA, Milon M, Hossain MM, Hashem M A. 2017. Effect of kalogira (Nigella sativa) and BHA (beta hydroxyl anisole) on quality control and shelf- life of beef meatballs. International Journal of Natural and Social Sciences, 4(1): 85-94.

Rahman MF, Iqbal A, Hashem MA, Adedeji AA. 2020. Quality assessment of beef using Computer Vision Technology. Food Science of Animal Resouces, 40: 896-907.

Rima FJ, Sadakuzzaman M, Hossain MA, Ali MS, Hashem MA. 2019. Effect of gamma irradiation on shelf life and quality of broiler meat. SAARC Journal of Agriculture, 17(1): 149-159.

Saba NA, Hashem MA, Azad MAK, Hossain MA, Khan M. 2018. Effect of bottle gourd leaf (Lagenaria siceraria) extract on the quality of beef meatball. Bangladesh Journal of Animal Science, 47(2): 105-113.

Sampaio GR, Saldanha T, Soares RA, Torres EA. 2012. Effect of natural antioxidant combinations on lipid oxidation in cooked chicken meat during refrigerated storage. Food Chem. 135: 1383-1390.

Sarker MIA, Hashem MA, Azad MAK, Ali MS, Rahman MM. 2021. Food grade vinegar acts as an effective tool for short-term meat preservation. Meat Research, Vol 01, Issue 01, Article No. 5.

Sharma P, Jha AB, Dubey RS, Pessarakli M. 2012. Reactive oxygen species, oxidative damae and antioxidative degense mechanism in plants under stressful conditions. Journal of Botany, 1-26.

Siddiqua T, Hossain MA, Khan M, Hashem MA. 2018. Formulation of value added beef meatball using tulsi (Ocimum sanctum) leaf extract as a source of natural antioxidant. Journal of Bangladesh Agricultural University, 16(2): 260-265.

Singh S, Immanuel G. 2014. Extraction of antioxidants from fruits peels and its utilization in paneer. Journal of Food Processing and Technology, 5: 7. Doi:10.4172/2157-7110.1000349

Valsta LM, Tapanainen H, Mannisto S. 2005. Meat fats in nutrition. Meat Science, 70(3): 525–530.

Verma AK, Sharma BD, Banerjee R. 2012. Quality characteristics of low-fat chicken nuggets: effect of common salt replacement and added bottle gourd (*Lagenaria siceraria* L). Journal of Food Science and Agriculture, 92: 1848-1854.

Yadav S, Pathera AK, Malik AK, Sharma DP. 2018. Effect of wheat bran and dried carrot pomace addition on quality characteristics of chicken sausage. Asian-Australasian Journal of Animal Sciences, 31(5):729-737.

Zargar FA, Kumar S, Bhat ZF, Kumar P. 2017. Effect of incorporation of carrots on the quality characteristics of chicken sausages. Indian Journal of Poultry Science, 52(1): 91-95.