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EFFECT OF LONG CORIANDER LEAF (*Eryngium foetidum*) EXTRACT AS A NATURAL ANTIOXIDANT ON CHICKEN MEATBALLS DURING AT FREEZING TEMPERATURE

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ABSTRACT

The study was envisaged to evaluate the effect of different levels of long coriander (*Eryngium foetidum L.*) leaf extract on the quality attributes of chicken meatballs. The chicken meat sample was collected from local market of Mymensingh. The sample was quickly shifted to "Animal Science Laboratory" and carried out for laboratory analyses after refrigerated at -20º C up to 90 days. Chicken meatball samples were divided into four treatment groups viz. control group (T_0), 0.01% beta hydroxyl toluene (BHT) (T_1), 0.5% long coriander leaves extract (T_2), and 1% long coriander leaves extract (T_3). Days of intervals were 0, 30 and 90 days. An ANOVA of a 4×3 factorial experiment in completely randomized design having three replications per treatment was used for data analyses. Sensory, proximate, physicochemical, biochemical and microbiological analyses were determined. Color, flavor, Juiciness, tenderness and overall acceptability increased significantly ($p<0.05$) in T_2 and T_3 treatments but decreased at different days of intervals. Dry matter (DM), crude protein (CP), ether extract (EE) and ash content decreased significantly ($p<0.05$) in T_2 and T_3 treatments and increased with days of intervals. Raw pH and cooking loss were decreased significantly ($p<0.05$) in T_2 and T_3 treatments and decreased with increased days of intervals. Free fatty acid (FFA), peroxide value (POV) were decreased significantly ($p<0.05$) in T_2 and T_3 treatments and increased with days of intervals. Thiobarbituric acid reactive substances (TBARS) were significantly ($p<0.05$) constant in T_0, T_2 and T_3 treatments. Total viable count (TVC), total coliform count (TCC) and total yeast-mold count (TYMC) decreased significantly ($p<0.05$) in T_2 and T_3 treatments. Hence, sensory, physicochemical, biochemical and microbial properties indicate that 1% long coriander leaves extract was the best among all treatment groups. So, 1% long coriander leaves extract may be recommended for chicken meatballs as enriched natural antioxidant.

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INTRODUCTION

Meat is an important food ingredient that acts as a contributor of high quality protein. Meat protein also plays an important physiological role in human body. It promotes iron absorption and prevents calcium losses (Akhter et al., 2009). Red meat contains high saturated fat that is not suitable for aged people or those who are prone to cardiovascular diseases or suffers from overweight. Chicken meat is lean and healthier as it contains more unsaturated fatty acids than other red meat. Therefore, the consumer’s demand goes to chicken meat products for overall acceptability and health friendly (Islam et al., 2018; Jamaly et al., 2017; Rima et al., 2019; Verma et al., 2012). 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. The breast meat of a chicken contains less than 3 g fat/100 g of meat, whereas red meat contains about on an average 5-7 g fat/100 g (Bithi et al., 2020). It also contains all essential amino acids, minerals, vitamins and other micro nutrients which are helpful for human life (Akhter et al., 2009). Fat is an important constituent of human nutrition and contribute to the flavor, tenderness, juiciness, appearance, texture and shelf life of meat products. Lipid oxidation is a complex process occurring in aerobic cells and reflects the interaction between molecular oxygen and polyunsaturated fatty acids (Bithi et al., 2020; Verma et al., 2009). It enhances the production of rancid flavors and odors as well as reduces shelf-life, nutritional quality, and safety of food products (Rahman et al., 2017). Thus, the challenge for meat industry is to develop low-fat meat products without compromising sensory and texture characteristics (Bithi et al., 2020). To prevent or delay the autoxidation process, antioxidants have been utilized for many years in meat and meat products (Siddiqua et al., 2018). For this reason, there has been growing interest for natural antioxidant. Naturally occurring antioxidant compounds have been preferably used in meats because of their potential health benefits, high consumer acceptance and safety compared with synthetic preservatives (Siddiqua et al., 2018). The antioxidant properties of natural antioxidants of plant origin are mainly attributed to their phenolic contents, and their antioxidant action is similar to synthetic phenolic antioxidants. The incorporation of natural antioxidant in meat products improves the yield, texture, fiber contents, oxidative stability, nutritional value and reduced production cost besides their inherent functional properties (Siddiqua et al., 2018). Long coriander (*Eryngium foetidum*) leaf is naturally occurring antioxidants that have many functions as artificial antioxidants like butyrated hydroxyl anisole (BHA), beta hydroxyl toluene (BHT) etc (Bithi et al., 2020). It can increase shelf-life of stored meat products such as meatballs without affecting qualities. The incorporation of long coriander leaf as a natural antioxidant in processed meat products is the possible solution. Consumers' recent demand of low fat and high fiber meat products for their natural antioxidant activity, fiber and nutrients contents (Disha et al., 2020). Long coriander leaf has beneficial effects on human health owing to its functional properties such as regulating the activity of the large intestine. Recently consumers have started to focus on healthy foods, because of increase in diabetes, cancer, cardiovascular diseases and obesity. Long coriander leaf is employed in the treatment of diabetes, rheumatism, several anti-inflammatory, respiratory (cold, asthma, cough, sinusitis) and stomach disorders (Jaramillo et al., 2011). The use of long coriander leaf in chicken meatball can solve these types of disease problem. Long coriander leaf having antioxidant activity has the ability to act against the free radicals with meatball (Singh et al., 2013). There is evidence of studies about such properties of long coriander leaf and it is an aromatic and medicinal herb used in ethno-medicine as a traditional spice for foods. There are many well-known phytochemicals like the flavonoids, phenolic acids, isoflavones, curcumin, isothiocyanates, and carotenoids which improve the shelf life of meat and meat products (Dhama et al., 2014). Any herbal extracts may be included upto 10% in meat and meat products prior to it‘s acceptable level of consumers to mitigate unpleasant flavor. It is evident that maximum literature found of 1% herbal extracts used to increase the shelf life of meat and meat products. From this point of view, 0.01, 0.05 and 1% level of herbal extracts were selected for the present study. Hence, the experiment was conducted to examine sensory, proximate, physicochemical, biochemical and microbiological properties of chicken meatballs after addition of long coriander leaf extract and find out its appropriate level.

MATERIALS AND METHODS

The study was conducted during the period of January 2019 to June 2019 in the Department of Animal Science, Bangladesh Agricultural University, Mymensingh (BAU). The chicken meat sample was collected from local market of Mymensingh which was around one year of age. The meat sample was quickly shifted to the "Animal Science Laboratory" and carried out for sensory, proximate, physicochemical, biochemical and microbial analyses and refrigerated at (-20º C). 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, long coriander leaves extract, salt and sauces. There were four treatment groups, like T_0 = (Control group), T_1 = (0.01% BHT), T_2 = (0.5% long coriander leaves extract), T_3 = (1% long coriander leaves extract). When internal temperature of meat reached at 71º C then cooking was finished and it was checked by a food grade thermometer (Rahman et al., 2020). Samples were evaluated after cooking. Sensory qualities (Color, flavor, tenderness, juiciness and overall acceptability) were evaluated by a trained 6-members panel. 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; Nasrin et al., 2016). All samples were served in petri dishes. Sensory evaluation was accomplished at 0 day and repeated at 30 and 90 days. The DM, EE, CP and ash of meatballs were determined according to AOAC (2005). The pH of raw and cooked of meatballs was determined using a digital pH meter. The cooking loss of meatballs was also determined by a weighing balance and a hot water bath at 71° C for 30 minutes. The FFA, POV and TBARS value were determined by Sharma et al. (2012). The TVC, TCC and TYMC were determined according to Ikhlas et al. (2011). All determination was done in triplicate and mean value was reported.

Statistical analysis

Data were analyzed using 4x3 factorial experiment in completely randomized design (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 treatment means at values ($p<0.05$).

RESULTS AND DISCUSSION

Sensory evaluation

The ranges for colors, flavor, tenderness, juiciness and overall acceptability for all groups and days of interval are presented in Table 1. The most preferable color, flavor, tenderness, juiciness and acceptability was observed from $T_{0,}$ $T_{2,}$ and $T_{3;}$ T_2 and $T_{3;}$ T_2 and $T_{3;}$ T_2 and T_3 and T_2 and T_3 groups, respectively. These parameters were significantly ($p<0.05$) differed in all treatments. The most preferable color, flavor, tenderness, juiciness and overall acceptability were observed from 0 and 30; 0; 0; 0 and 0 days, respectively which were significantly ($p<0.05$) differed. Data show that the lowest score was reduced to 4.00 at 90 days of storage irrespective of treatment groups. Color of meat products decrease with increasing storage period were reported by Disha et al. (2020) as a result quality was deteriorated with increasing of storage period. Deterioration of flavor during storage might be due to microbial growth, formation of FFA and oxidative rancidity. Similar results were reported by Islam et al. (2018). Flavor is one of the major causes of quality deterioration because it can negatively affect sensory attributes such as color, texture, odor and flavor as well as the nutritional quality of the product (Nunez and Boleman, 2008). When meatballs were frozen, ice crystals form inside the cells of muscle tissue and puncture cell walls. Tenderness is interrelated to DM content of meatballs. With the increasing of storage period DM was increased consequently tenderness was decreased with days of intervals. The present study was related to the findings of Disha et al. (2020). Saba et al. (2018) also reported a decline rate in the juiciness scores of beet meatball during refrigerated storage. Overall acceptability decreased during storage because of decline in the sensory score of other parameters like appearance, flavor, and taste. Jahan et al. (2018) reported that overall acceptability decreased significantly during storage period. There was found positive and significant interaction between treatment and days of interval for color, flavor, tenderness, juiciness and overall acceptability (Table 1).

Table 1. Effect of long coriander leaf extract on sensory parameters in chicken meatballs

Parameters	DI	Treatments				Mean	Level of significance		
		T_0	T_1	T_2	T_3		Treat.	DI	T*DI
Color	0	5.00±0.00	5.00±0.00	5.00±0.00	5.00±0.00	5.00^a±0.00	p<0.0001	p<0.0001	p<0.0001
	30	5.00±0.00	4.00±0.00	5.00±0.00	5.00±0.00	5.00^a±0.00			
	90	4.00±0.00	4.00±0.00	4.00±0.00	4.00±0.00	4.00^b±0.00			
	Mean	4.67^a±0.00	4.33^b±0.00	4.67^a±0.00	4.67^a±0.00				
Flavor	0	5.00±0.00	5.00±0.00	5.00±0.00	5.00±0.00	5.00^a±0.00	p<0.0001	p<0.0001	p<0.0001
	30	4.00±0.00	4.00±0.00	5.00±0.00	5.00±0.00	4.50^b±0.00			
	90	3.00±0.00	3.00±0.00	4.00±0.00	4.00±0.00	3.50^c±0.00			
	Mean	4.00^b±0.00	4.00^b±0.00	4.67^a±0.00	4.67^a±0.00				
Tenderness	0	5.00±0.00	5.00±0.00	5.00±0.00	5.00±0.00	5.00^a±0.00	p<0.0001	p<0.0001	p<0.0001
	30	4.00±0.00	4.00±0.00	5.00±0.00	4.00±0.00	4.00^b±0.00			
	90	3.00±0.00	3.00±0.00	4.00±0.00	4.00±0.00	3.50^c±0.00			
	Mean	4.00^b±0.00	4.00^b±0.00	4.33^a±0.00	4.33^a±0.00				
Juiciness	0	5.00±0.00	5.00±0.00	5.00±0.00	5.00±0.00	5.00^a±0.00	p<0.0001	p<0.0001	p<0.0001
	30	4.00±0.00	4.00±0.00	4.00±0.00	4.00±0.00	4.00^b±0.00			
	90	3.00±0.00	3.00±0.00	4.00±0.00	4.00±0.00	3.50^c±0.00			
	Mean	4.00^b±0.00	4.00^b±0.00	4.33^a±0.00	4.33^a±0.00				
Overall acceptability	0	5.00±0.00	5.00±0.00	5.00±0.00	5.00±0.00	5.00^a±0.00	p<0.0001	p<0.0001	p<0.0001
	30	4.00±0.00	4.33±0.00	5.00±0.00	5.00±0.00	4.50^b±0.00			
	90	4.00±0.00	4.00±0.00	4.00±0.00	4.00±0.00	4.00^c±0.00			
	Mean	4.33^b±0.00	4.33^b±0.00	4.67^a±0.00	4.67^a±0.00				

T_0 = control group, T_1 = 0.01% BHT, T_2 = 0.5% long coriander leaves extract, T_3 = 1% long coriander leaves extract, DI=Day of intervals, Treat= Treatment, T*DI=Interaction of treatment and days of intervals. Same superscripts in different treatment groups and days of interval did not differ significantly (p>0.05), whereas different superscripts in different treatment groups and days of interval differ significantly (p<0.05)

Proximate analysis

The ranges for DM, CP, EE, and ash for all treatment groups and days of interval are presented in Table 2. The most suitable DM, CP, EE and ash content was observed at T_3, control, control and T_3 groups, respectively. The most suitable DM, CP, EE and ash content was observed at 0, 0, 90 and 0 days, respectively. Lowest amount DM content indicates this product is most preferable. The DM content was increased with increasing storage period because moisture loss was decreased with increasing storage period. Data showed that highest amount of DM content was increased to 52.56 in all treatments after 90 days of storage. These results were similar to Milon et al. (2016) of value added beef meatballs with DM content. Rahman et al. (2017) also reported of increase DM content with the increase of storage period for kalogira seed extract. The CP decreased significantly ($p<0.05$) in all treatments which was not in accordance with Saba et al. (2018) where they showed increased CP with 0.1, 0.2 and 0.3% *Maringa oleifera* leaf extract mixed with beef meatball. The CP decreased significantly in wheat bran (WB) and dried carrot pomace (DCP) incorporated with chicken sausage (Yadav et al., 2018) which was similar to the present findings. The CP decreased with increased storage period which was supported to Saba et al. (2018). Lowest amount of EE content indicates this product is most preferable for consumers' health. The EE content was decreased with increasing storage period. Data showed that highest amount of EE content was decreased to 8.30 % in all treatments after 90 days of storage. Islam et al. (2018) observed that decreased EE of mutton nuggets by incorporation of guava powder. The EE content of the products showed significantly ($p<0.05$) decreasing trend with increasing levels of incorporation of pumpkin in chicken sausages reported by Zargar et al. (2014). Zargar et al. (2017) reported that ash showed significant ($p<0.05$) decreasing trend with increasing levels of incorporation of carrot in chicken sausages. Ash significantly decreased ($p<0.05$) in all treatments which was similar to Disha et al. (2020). Lowest amount of ash content indicates this product is most preferable for consumers' health. Ash content was significantly ($p<0.05$) increased with the increased storage period. These results were in agreement with Saba et al. (2018). There was found positive and significant interaction between treatments and days of interval for DM, CP, EE and ash (Table 2).

Physicochemical properties

The ranges for raw pH, cooked pH and cooking loss for all treatment groups and days of interval are presented in Table 3. The most desirable raw pH, cooked pH and cooking loss were observed at T_0, T_2 and T_3 and T_3 groups, respectively. The highest amount of raw pH indicates this product is most preferable for consumers' health than other treatment groups. Data showed a slight decrease in raw pH values for all treatment and an increase in the acidity values for all samples along with storage time during 90 days of storage as a result of increasing FFAs due to rancidity. Decreased of pH with incorporation of long coriander leaf may be attributed to the low pH of long coriander leaf extract which is rich in bioactive compounds. Similarly, decreased of pH was found by Disha et al. (2020) in chicken meatballs incorporated with lemon extract and Saba et al. (2018) in beef meatballs incorporated with bottle gourd leaf extract. Bacteria and mold have a tendency to increase with increasing storage time and they secrete components that affect the increasing raw pH. Data showed a slight increase in cooked pH values and a decrease in the acidity values for all samples along with addition of synthetic antioxidant and natural antioxidant as a

Table 2. Effect of long coriander 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	53.71±0.01	52.63±0.02	48.07±0.01	48.94±0.03	$50.84^{c}\pm0.01$	p<0.0001	p<0.0001	p<0.0001
	30	51.55±0.06	55.00±0.03	48.63±0.02	50.58±0.01	$51.44^{b}\pm0.03$			
	90	51.30±0.05	53.34±0.01	55.76±0.01	49.81±0.01	$52.56^{a}\pm0.02$			
	Mean	$53.67^{b}\pm0.01$	$52.18^{b}\pm0.04$	$50.82^{c}\pm0.01$	$49.78^{d}\pm0.01$				
CP (%)	0	21.32±0.04	22.75±0.02	20.53±0.06	20.85±0.02	$21.37^{a}\pm0.03$	p<0.0001	p<0.0001	p<0.0001
	30	21.20±0.05	22.61±0.01	20.32±0.03	19.74±0.02	$20.94^{b}\pm0.02$			
	90	21.37±0.01	21.84±0.01	19.75±0.02	19.69±0.03	$20.67^{c}\pm0.01$			
	Mean	$22.40^{a}\pm0.01$	$21.30^{b}\pm0.03$	$20.20^{c}\pm0.03$	$20.09^{d}\pm0.01$				
EE (%)	0	8.58±0.02	8.69±0.03	8.81±0.09	7.73±0.07	$8.46^{a}\pm0.05$	p<0.0001	p<0.0001	p<0.0001
	30	8.78±0.06	8.40±0.01	7.75±0.01	8.2±0.01	$8.42^{a}\pm0.02$			
	90	8.52±0.01	8.31±0.03	8.55±0.02	8.29±0.06	$8.30^{b}\pm0.03$			
	Mean	$8.63^{a}\pm0.03$	$8.47^{b}\pm0.01$	$8.37^{c}\pm0.04$	$8.09^{d}\pm0.04$				
Ash (%)	0	1.72±0.01	1.88±0.01	1.65±0.01	1.14±0.01	$1.46^{b}\pm0.01$	p<0.0001	p<0.0001	p<0.0001
	30	1.64±0.02	1.42±0.01	1.58±0.02	1.20±0.01	$1.58^{a}\pm0.01$			
	90	1.69±0.03	1.60±0.02	1.62±0.02	1.41±0.02	$1.60^{a}\pm0.02$			
	Mean	$1.69^{a}\pm0.01$	$1.64^{b}\pm0.01$	$1.62^{b}\pm0.01$	$1.26^{c}\pm0.01$				

T_0 = control group, T_1 = 0.01% beta hydroxyl toluene (BHT), T_2 = 0.5% long coriander leaves extract, T_3 = 1% long coriander leaves extract, DI=Day of intervals, Treat= Treatment, T*DI=Interaction of treatment and Days of intervals. Same superscripts in different treatment groups and days of interval did not differ significantly (p>0.05), whereas different superscripts in different treatment groups and days of interval differ significantly (p<0.05)

result of decreasing FFAs due to lower acidity. Cooked pH was decreased with increasing storage period. The highest amount of cooked pH indicated this product is most preferable for consumers' health than other treatment groups. These results were similar to Islam et al. (2018) who reported that storage time had a significant effect on pH values, which tended to decrease with storage time. Cooking loss significantly decreased (p<0.05) in all treatment groups which was similar to the findings of Disha et al. (2020). The lowest amount of cooking loss indicates this product is most preferable for consumers' choices than other treatment groups. Cooking loss was decreased with increasing storage period. Cooking loss refers to the reduction in weight of meatballs during cooking process (Saba et al., 2018) which was similar to the present study. Major components of cooking losses were thawing, dripping and evaporation. Thawing loss refers to the loss of fluid in meatballs resulting from the formation of exudates following freezing and thawing (Saba et al., 2018) which was similar to the present study. Drip loss is the loss of fluid from meatballs and water evaporation from the shrinkage of muscle proteins (actin and myosin) (Yu et al., 2005). Cooking yield is an important data that are used by the meat industry to predict the behavior of their products during processing (Disha et al., 2020). There was found positive and significant interaction between treatments and days of interval for raw pH, cooked pH and cooking loss (Table 3)

Table 3. Effect of long coriander leaf extract on physicochemical properties in chicken meatballs

Parameters	DI	Treatments				Mean	Level of significance		
		T_0	T_1	T_2	T_3		Treat.	DI	T*DI
Raw pH	0	5.95±0.01	5.89±0.01	5.91±0.01	5.91±0.01	5.92^a±0.01	p<0.0001	p<0.0001	p<0.0001
	30	5.70±0.01	5.87±0.03	5.70±0.02	5.61±0.03	5.72^b±0.02			
	90	5.87±0.03	5.65±0.05	5.70±0.01	5.51±0.01	5.68^c±0.02			
	Mean	5.84^a±0.01	5.80^b±0.03	5.78^c±0.01	5.68^d±0.01				
Cooked pH	0	6.05±0.01	6.05 ±0.01	6.04±0.01	6.05±0.01	6.05^a±0.01	p<0.0001	p<0.0001	p<0.0001
	30	6.04±0.01	6.02±0.01	6.10±0.02	6.03±0.02	6.05^a±0.01			
	90	5.86±0.01	6.06±0.01	6.01±0.02	6.06±0.01	5.99^b±0.01			
	Mean	5.98^b±.01	6.04^a±0.01	6.05^a±0.02	6.05^a±0.01				
Cooking loss (%)	0	28.02±0.04	27.20±0.01	26.32±0.02	26.04±0.02	26.90^a±0.02	p<0.0001	p<0.0001	p<0.0001
	30	27.17±0.01	26.43±0.03	26.09±0.01	22.49±0.06	25.55^c±0.02			
	90	27.02±0.02	28.16±0.03	27.05±0.01	22.03±0.02	26.07^b±0.02			
	Mean	27.41^a±0.02	27.26^b±0.02	26.49^c±0.01	23.52^d±0.02				

T_0= control group, T_1 = 0.01%betahydroxyltolune (BHT), T_2 = 0.5% long coriander leaves extract, T_3 = 1% long coriander leaves extract, DI=Days of intervals, Treat= Treatment, T*DI=Interaction of treatment and Days of intervals. Same superscripts in different treatment groups and days of interval did not differ significantly (p>0.05), whereas different superscripts in different treatment groups and days of interval differ significantly (p<0.05)

Biochemical properties

The ranges for FFA, POV and TBARS for all treatment groups and days of interval are presented in Table 4. Determination of FFA gives us information about stability of fat during storage. The FFA value was increased with increasing storage period. The most expectable FFA, POV and TBARS values was observed at $T_{2;}$ T_3 and $T_{0;}$ T_2 and T_3 treatment groups, respectively. With increasing of storage period, a significant (p<0.05) increase in FFAs was reported by Disha et al. (2020) which was similar to the present study. The significant (p<0.05) increased in FFA content of the products during storage might be increased due to growth of lipolytic microorganisms (Das et al., 2008). The FFAs are products of the enzymatic or microbial degradation of lipids reported by Das et al. (2012). The lowest amount of POV indicates this product is most preferable for consumers' health. During storage, POV increased in all treatments. However, antioxidant treatments, generally, can minimize POV in the food sample during storage compared with the control. The lowest amount of TBARS value indicates the product is most preferable for consumers' health. Yadav et al. (2018) found a significant increase in TBARS value of control and fibre enriched sausage with an increasing storage period. There was positive and significant interaction between treatments and days of interval for FFA, POV and TBARS (Table 4).

Table 4. Effect of long coriander 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±0.01	0.36±0.01	0.31±0.01	0.31±0.01	0.33^c±0.01	p<0.0001	p<0.0001	p<0.0001
	30	0.33±0.01	0.38±0.01	0.31±0.01	0.34±0.01	0.34^b±0.01			
	90	0.34±0.02	0.42±0.01	0.31±0.02	0.34±0.01	0.36^a±0.01			
	Mean	0.33^b±0.01	0.39^a±0.01	0.31^c±0.01	0.33^b±0.01				
POV (meq/kg)	0	3.86±0.01	3.89±0.02	2.74±0.01	2.43±0.02	3.23^c±0.01	p<0.0001	p<0.0001	p<0.0001
	30	4.01±0.02	3.72±0.01	2.90±0.02	2.93±0.01	3.40^b±0.01			
	90	4.63±0.01	3.91±0.03	2.71±0.02	2.91±0.01	3.54a±0.01			
	Mean	4.12^a±0.01	3.85^b±0.02	2.79^c±0.01	2.76^d±0.01				
TBARS (mg-MA/kg)	0	0.09±0.01	0.13±0.01	0.11±0.01	0.11±0.01	0.11^c±0.01	p<0.0001	p<0.0001	p<0.0001
	30	0.12±0.02	0.15±0.01	0.13±0.01	0.11±0.01	0.13^b±0.01			
	90	0.12±0.01	0.22±0.01	0.10±0.02	0.11±0.01	0.14^a±0.01			
	Mean	0.11^{bc}±0.01	0.17^a±0.01	0.11^b±0.01	0.11^c±0.01				

T_0=control group, T_1=0.01% beta hydroxyl toluene (BHT), T_2=0.5% long coriander leaves extract, T_3=1% long coriander leaves extract, DI=Day intervals, Treat= Treatment, T*DI=Interaction of treatment and days of intervals. FFA = Free Fatty Acid (%), POV= Peroxide value (meq/kg), TBARS= Thiobarbituric acid value (mg-MA/kg). Same superscripts in different treatment groups and days of interval did not differ significantly (p>0.05), whereas different superscripts in different treatment groups and days of interval differ significantly (p<0.05)

Microbiological assessment

The ranges for TVC, TCC and TYMC for all treatment groups and days of interval are presented in Table 5. The plate count in T_0 group (6.52 logCFU/g) was significantly (p<0.05) higher than the treated samples. Less amount of TVC value indicates this product is most preferable for consumers' health. The amount of TVC was increased with increasing storage period. The antioxidant compounds blocked the deteriorating of fat and helped to prevent the metabolism of fat by bacteria. As a result, bacterial growth was lower in chicken meatballs treated with antioxidants. Plant-derived spices are generally used in foods as flavorings and medicinal purposes. The mixtures of cinnamon (*Cinnamomum verum*) and clove (*Syzygium aromaticum*) oil were able to suppress the growth of major spoilage microorganisms in intermediate moisture foods (Matan et al., 2006). It was reported by Babatunde and Adewumi (2015) that plant extracts like garlic, ginger and roselle provided antioxidant and antimicrobial benefits to raw chicken patties during cold storage. Microbial load was reduced in treated samples than the control. The TCC in the control sample (1.72 logCFU/g) was significantly ($p<0.05$) higher than four treatment groups. Less amount of TCC value indicates the product is most preferable for consumers' health. Similar findings were observed by Singh and Immanuel (2014) of raw chicken meat emulsion incorporated with clove powder, ginger and garlic paste at refrigerated storage (4±1º C). The antioxidant compounds blocked the deteriorating of fat and helped to prevent the metabolism of fat by bacteria. Reddy et al. (2017) observed a significantly ($p<0.05$) lower coliform count in chicken meat patties incorporated with natural antioxidant extracts i.e., rosemary (RE) and green tea (GTE). The TYMC count in the control sample (1.53logCFU/g) was significantly higher than three antioxidant groups. These results were in accordance with Disha et al. (2020). Less amount of TYMC value indicates the product is most preferable for consumers' health. During storage TYMC value was decreased which was similar to Saba et al. (2018). There was found positive and significant interaction between treatments and days of interval for TVC, TCC and TYMC (Table 5).

Table 5. Effect of long coriander leaf extract on different microbe's population in chicken meatballs

Parameters	DI	Treatments				Mean	Level of significance		
		T_0	T_1	T_2	T_3		Treat.	DI	T*DI
TVC (log CFU/g)	0	6.53±0.03	5.93±0.01	5.80±0.01	6.40±0.20	6.17^b±0.06	p<0.001	p<0.001	P<0.001
	30	6.24±0.02	6.33±0.01	6.10±0.01	6.06±0.02	6.18^b±0.01			
	90	6.78±0.01	6.40±0.01	6.00±0.01	6.39±0.01	6.40^a±0.01			
	Mean	6.52^a±0.02	6.22^b±0.01	5.97^c±0.01	6.29^d±0.07				
TCC (log CFU/g)	0	1.46±0.01	1.45±0.02	1.37±0.02	1.38±0.01	1.42^a±0.01	p<0.001	p<0.001	P<0.001
	30	1.46±0.01	1.36±0.01	1.32±0.01	1.26±0.02	1.35^b±0.01			
	90	1.46±0.01	1.45±0.01	1.38±0.01	1.02±0.04	1.33^c±0.01			
	Mean	1.46^a±0.01	1.42^b±0.01	1.36^c±0.01	1.22^d±0.02				
TYMC (log CFU/g)	0	1.90±0.01	1.86±0.01	1.89±0.01	1.85±0.01	1.87^a±0.01	p<0.001	p<0.001	P<0.001
	30	1.67±0.01	1.44±0.02	1.52±0.02	1.35±0.01	1.50^b±0.01			
	90	1.57±0.03	1.51±0.01	1.24±0.02	1.01±0.01	1.33^c±0.01			
	Mean	1.72^a±0.01	1.60^b±0.01	1.55^c±0.01	1.40^d±0.01				

T_0 = control group, T_1 = 0.01% beta hydroxyl toluene (BHT), T_2 = 0.5% long coriander leaves extract, T_3 = 1% long coriander leaves extract, DI=Day Intervals, Treat= Treatment, T*DI=Interaction of Treatment and Days of Intervals. Same superscripts in different treatment groups and days of interval did not differ significantly ($p>0.05$), whereas different superscripts in different treatment groups and days of interval differ significantly ($p<0.05$).

CONCLUSION

It is revealed from the study that chicken meatballs can be preserved for 90 days using different levels of long coriander leaf extracts. On the basis of sensory, proximate, physicochemical, biochemical and microbial properties indicates that 1%

long coriander leaf extract was more acceptable. So, it may be recommended that 1% long coriander leaf extract for formulation of value added chicken meatballs was used as enriched source of natural antioxidant.

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REFERENCES

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

Akhter, S., Rahman, M., Hossain, M.M. and Hashem, M.A. (2009). Effect of drying as a preservation technique on nutrient contents of beef. *Journal of Bangladesh Agricultural University,* 7(1): 63-68.

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

Bithi, M.A.A., Hossain, M.A., Rahman, S.M.E., Rahman, M.M. and Hashem, M.A. (2020). Sensory, nutritive, antioxidant and antimicrobial activity of telakucha (*Coccinia cordifolia*) leaves extract in broiler meatballs. *Journal of Meat Science and Technology,* 8(2): 23-31.

Das, A.K., Anjaneyulu, A.S.R., Gadekar, Y.P., Singh, R.P. and Pragati, H. (2008). Effect of full-fat soy paste and textured soy granules on quality and shelf-life of goat meat nuggets in frozen storage. *Meat Science,* 80(1): 607-614.

Das, A.K., Rajkumar, V., Verma, A.K. and Swarup, D. (2012). *Maringa oleiferia* leaves extract a natural antioxidant for retarding lipid peroxidation in cooked goat meat patties. *International Journal of Food Science and Technology,* 47: 585-591.

Dhama, K., Tiwari, R., Khan, R.U., Chakraborty, S., Gopi, M., Karthik, K., Saminathan, M., Desingu, P.A. and Sunkara, L.T. (2014). Growth promoters and novel feed additives improving poultry production and health, bioactive principles and beneficial applications: the trends and advances: A review. *International Journal of Pharmacology,* 10 (3): 129-159.

Disha, M.N.A., Hossain, M.A., Kamal, M.T., Rahman, M.M., and Hashem, M.A. (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.

Ikhlas, B., Huda, N. and 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.

Islam, F., Hossain, M.A., Rahman, M.F., Hashem, M.A., Rahman, M. and Azad, M.A.K. (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.

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

Jahan, I., Haque, M.A., Hashem, M.A., Rima, F.J., Akhter, S. and Hossain, M.A. (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.

Jaramillo, B.E., Duarte, E. and Martelo, I. (2011). Volatile chemical composition of the essential oil from Colombian *Eryngium foetidum L.* and determination of its antioxidant activity. *Plantas Medicinales*, 16: 140-150.

Matan, D., Rongrong, L. and Carpenter, J.A. (2006). Sensory and instrumental properties of smoked meatball made with technically separated poultry (MSP) meat and wheat protein. *Journal of Food Science*, 63: 923-929.

Milon, M., Kabir, M.H., Hossain, M.A., Rahman, M., Azad, M.A.K. and Hashem, M.A. (2016). Value added beef meatballs using turmeric (Curcuma longa) powder as a source of natural antioxidant. *International Journal of Natural and Social Sciences*, 3(4): 52-61.

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

Nasrin, S., Kabir, M.H., Hossain, M.A., Hossain, M.M. and Hashem, M.A. (2016). Formulation of value added beef meatballs using bottle gourd (*Lagenaria siceraria*) leaf extracts and wheat flour. *International Journal of Applied Research*, 2(3): 164-171.

Rima, F.J., Sadakuzzaman, M., Hossain, M.A., Ali, M.S. and Hashem, M.A. (2019). Effect of gamma irradiation on shelf life and quality of broiler meat. *SAARC Journal of Agriculture*, 17(1): 149-159.

Rahman, M.F., Iqbal, A., Hashem, M.A. and Adedeji, A.A. (2020). Quality assessment of beef using Computer Vision Technology. *Food Science of Animal Resources*, 40: 896-907.

Rahman, M., Kabir, M.H., Hossain, M.A., Milon, M., Hossain, M.M. and 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.

Reddy, D.M., Vani, S., Naveen, Z. and Rao, B.E. (2017). Comparative effect of natural and synthetic antioxidants on microbiological quality of chicken meat patties during refrigeration storage. *International Journal of Science, Environment and Technology*, 6(1): 443-448.

Singh, S., Singh, D.R., Banu, S. and Salim, K.M.M. (2013). Determination of bioactivities and antioxidant activity in *Eryngium foetidum* L.: A Traditional Culinary and Medicinal Herb. *The National Academy of Science*, 83(3): 453-60.

Siddiqua, T., Hossain, M.A., Khan, M. and Hashem, M.A. (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. and Immanuel, G. (2014). Extraction of antioxidants from fruits peels and its utilization in paneer. *Journal of Food Processing and Technology,* 5:7.

Saba, N.A., Hashem, M.A., Azad, M.A.K., Hossain, M.A. and 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.

Sharma, P., Jha, A., Dubey, R.S. and Pessarakli, M. (2012). Reactive oxygen species, oxidative damage and antioxidative defense mechanism in plants under stressful conditions. *Journal of Botany*, 2012. doi:10.1155/2012/217037.

Verma, A.K., Sharma, B.D. and 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

Verma, A.R., Vijayakumar, M., Mathela, C.S. and Rao, C.V. (2009). *In vitro* and *in vivo* antioxidant properties of different fractions of *Moringa oleifera* leaves. *Journal of Food and Chemical Toxicology,* 47: 2196-2201.

Yadav, S., Pathera, A.K., Islam, R.U.I., Malik, A.K. and Sharma, D.P. (2018). Effect of wheat bran and dried carrot pomace addition on quality characteristics of chicken sausage. *Asian-Australasian Journal of Animal Science,* 31(5): 729-737.

Yu, L.H., Lee, E.S., Jeong, J.Y., Paik, H.D., Choi, J.H. and Kim, C.J. (2005). Effect of thawing temperature on the physicochemical properties of pre-rigor frozen chicken breast and leg muscles. *Meat Science,* 71(2): 375-382.

Zargar, F.A., Kumar, S., Bhat, Z.F. and Kumar, P. (2014). Effect of pumpkin on the quality characteristics and storage quality of aerobically packaged chicken sausages. *Springer Plus,* 3(1): 39.

Zargar, F.A., Kumar, S., Bhat, Z.F. and Kumar, P. (2017). Effect of incorporation of carrot on the quality characteristics of chicken sausages. *Indian Journal of Poultry Science,* 52(1): 91-95.