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FORMULATION OF VALUE ADDED CHICKEN NUGGETS USING CARROT AND GINGER AS A SOURCE OF DIETARY FIBER AND NATURAL ANTIOXIDANT

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ABSTRACT

The study was aimed to evaluate the effect of different levels of carrot with ginger on the quality attributes of chicken nuggets. For this purpose, chicken meat samples were divided into four treatment groups *viz.* T_0 (Control), T_1 (1% ginger and 4% carrot), T_2 (1% ginger and 8% carrot) and T_3 (1% ginger and 12% carrot). Days of intervals were 0, 15, 30 and 45th days. Samples were preserved at -20º C for 45 days. An ANOVA of a 4×4 factorial experiment in completely randomized design having three replications per treatment was used for analyses of data. Sensory, proximate, physicochemical, biochemical and microbiological analyses were determined. Color, flavor, juiciness, tenderness and overall acceptability increased significantly ($p<0.05$) among the different treatment groups but decreased at different days of intervals. Dry matter (DM) content decreased significantly ($p<0.05$) with different treatment levels and increased with days of intervals. Crude protein (CP), Ether extract (EE) and ash content of all treatments were decreased significantly ($p<0.05$) among different treatment groups. Free fatty acids (FFAs), peroxide value (POV) and thiobarbituric acid reactive substances (TBARS) values were decreased significantly ($p<0.05$) with different treatment levels and increased with days of intervals. Total viable count (TVC), total coliform count (TCC) and total yeast mold count (TYMC) decreased significantly ($p<0.05$) at different treatments. On the basis of sensory, physicochemical, biochemical and microbial properties indicate that T_3 was the best among treatment groups. Hence, 12% carrots with 1% ginger extracts may be recommended for formulation of value added chicken nuggets as enriched dietary fiber and natural antioxidant.

Keywords: Chicken nugget, Carrot, Dietary fiber, Ginger, Natural antioxidant, Value addition.

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INTRODUCTION

Value added meat products are becoming popular recently in a geometrical rate (Bithi et al., 2020). Now a day's consumers are concerned of the quality and safety of processed meat products. Meat and meat products are important sources of proteins, fats, essential amino acids, minerals, vitamins and other nutrients (Akhter et al., 2009). The high saturated fatty acids content of such products results in a restriction of consumption for those who are prone to cardiovascular diseases and/or suffer from over weight (Wyness et al., 2011). Yet, fat is an important constituent of human nutrition and contribute to the flavor, tenderness, juiciness, appearance, texture and shelf life of meat products. The challenge for meat industry is to develop low-fat meat products without compromising sensory and texture characteristics (Bithi et al., 2020). In recent years, poultry meat has gained much popularity among consumers. Health conscious consumers demand lower fat and higher dietary fiber in meat products. The incorporation of vegetables in comminuted meat products improves the yield, texture, fiber contents, oxidative stability, nutritional value and reduced production cost besides their inherent functional properties (Viuda-Martos et al., 2010). Antioxidants have an ability to prevent or reduce oxidative damage of a tissue indirectly by enhancing natural defense of cell and/or directly by scavenging free radical species (Islam, et al., 2018; Jahan et al., 2018). Chicken nuggets are very popular to consumers. Nugget has high protein content, but poor of dietary fiber and vitamins. Various health problems such as colon cancer, obesity and cardiovascular disease can be caused by low fiber intake. Inclusion of carrot and ginger is a new concept in the products may solve the current fiber deficit to the consumers. Many vegetable fiber sources have been utilized in the development of fiber fortified meat products; however, frugal information is available on the utilization of carrot as a source of dietary fiber in development of meat products. Dietary fiber is one of the essential vital foods ingredients for human health in various aspects (Boby et al., 2021). Many non-meat ingredients are also added to meatball to increase their nutritional and functional value (Saba et al. 2018). Carrot (*Daucus carota*) is a rich source of vitamin A (β- carotene) and dietary fiber. The β-carotene present in carrot acts as a strong anti carcinogenic agent to prevent heart attack, ulcers, colitis and stroke. It regulates sugar level and has laxative, antiseptic and vermicidal action (Kaur et al., 2015). Flavonoids are effective antioxidants because of their scavenging properties against free oxygen radicals, metal chelators and lipid peroxidation process (Rahman et al., 2017). Dietary fiber has beneficial effects on human health owing to its functional properties such as regulating the activity of large intestine. In recent years, consumers have started to focus on healthy foods, because of increasing in diabetes, cancer, cardiovascular diseases and obesity. For this reason, meat processing industries are manufacturing value added products by incorporating fibers in order to reduce calorie intake (Santhi and Kalaikannan, 2014). The use of non-meat ingredients such as fiber in chicken meat products can improve their functional properties, such as water holding capacity (WHC) and antioxidant characteristics. Ginger (*Zingiber* *officinale*) is one of the most popular spices in oriental cuisine. Gingerol, gingerdiol, gingerdione and other compounds are responsible for antioxidant activities of ginger (Rababah et al., 2004). Current recommendations for dietary fiber intake are 25 g/d for women and 38 g/d for men in the United States and 20 g/d for women and 25 g/d for men in Korea (Jamaly et al., 2017). Ginger extract increases the appearance, flavor, tenderness and overall acceptability of food products (Naveena et al., 2001). Nugget is small cube chopped or ground meat which cooked various seasons that often mixed with bread crumbs and spices. Nugget is one kind of ready-to-eat food product which is gaining popularity day by day for higher consumers' demands. Keeping in mind the above perspectives, the current research was carried out to examine the effect of carrot and ginger on sensory, proximate, physicochemical, biochemical, and microbiological properties of nuggets to find out the appropriate level of carrot and ginger extracts.

MATERIALS AND METHODS

The study was conducted from the period of June 2019 to December 2019 in the Department of Animal Science, Bangladesh Agricultural University, Mymensingh. The chicken meat sample was collected from the local market of Mymensingh. Chicken nuggets 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, carrots and ginger extracts, salt and sausage. There were four treatment groups, such as T_0 = (Control group), T_1 = (4% Carrot + 1% Ginger), T_2 = (8% Carrot + 1% Ginger), T_3 = (12% Carrot + 1% Ginger). Sensory qualities (Color, flavor, tenderness, juiciness and overall acceptability) were evaluated by a trained 6-members panel. Samples were evaluated after cooking. When internal temperature of meat reached at 71ºC then cooking was completed and the preparation 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). All samples were served 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 nuggets were determined according to AOAC (2005). The pH of raw and cooked nuggets was determined using a digital pH meter. The cooking loss of nuggets was also determined by a weighing balance and a hot water bath. The FFAs, POV and TBARS values were determined by Sharma et al. (2012). The TVC, TCC and TYMC were determined according to standard protocol (Ikhlas et al., 2011). All determination was done in triplicate and mean values were reported.

Statistical analysis

Data were analyzed using 4x4 factorial experiment in completely randomized design 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.

RESULTS AND DISCUSSION

Sensory evaluation

The score ranges for color, flavor, tenderness, juiciness, and overall acceptability at different treatments were 3.50 to 4.42, 3.83 to 4.42, 3.50 to 4.25, 3.33 to 4.08 and 3.50 to 4.33, respectively and days of interval were 3.17 to 4.67, 3.42 to 4.67, 2.83 to 4.67, 2.58 to 4.67 and 3.00 to 4.67, respectively (Table 1). Color, tenderness, juiciness and overall acceptability significantly ($p<0.05$) increased with increasing levels of carrot extracts. Nevertheless, storage period negatively influenced to those parameters. Similar observations were reported by earlier researchers (Siddiqua et al., 2018). Among different the herbs, cardamon is highly preferred in burfi followed by ginger, clove, curry leaves and *tulsi* (Prasad et al., 2017). Evidently, the current research revealed significant alteration of sensory attributes of meat products with the application of 12% carrot and 1% ginger extracts. Most preferable color, flavor, tenderness, juiciness, and overall acceptability were noticed in $T_{3,}$ while less preferred score was found in $T_{0,}$ except T_2 for tenderness attribute. Most preferable color, flavor, tenderness, juiciness, and overall acceptability were found from 0 and 15th day and less was on 45th day. Gradual decline in appearance and color scores of nuggets stored at refrigeration conditions (-20ºC) 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 can 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). Irshad et al. (2016) reported that the flavor deterioration during storage was responsible due to microbial growth, formation of FFAs and oxidative rancidity. Tenderness is interrelated to DM content of the nuggets. With the increasing of storage period, the DM was increased consequently and tenderness was decreased with days of intervals.

Proximate analysis

The ranges for DM, CP, EE and ash at different treatments were 47.91 to 52.25, 18.02 to 19.70, 8.90 to 10.66 and 1.53 to 2.19, respectively and days of interval were 46.78 to 53.16, 17.92 to 19.41, 9.28 to 10.05 and 1.57 to 2.16, respectively (Table 2). All teatment parameters showed significantly decreased ($p<0.05$). The days of interval for DM, EE and ash was observed significantly increased ($p<0.05$), but CP significantly decreased ($p<0.05$). These results were not in agreement with the findings of Disha et al. (2020), Rima et al. (2019) and Sidiqua et al. (2018). The most preferable DM was found in T_3 treatment groups. The lowest DM indicated that the product was most suitable for consumers. The DM was increased due to increase of

Table 1. Effect of carrot and ginger on sensory parameters in chicken nuggets

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	45.00±0	$4.67^{a}\pm0.25$			
	15	3.67±0.33	4.00±0.58	4.33±0.33	4.67±0.33	$4.17^{ab}\pm0.39$			
	30	3.33±0.33	3.67±0.33	4.00±0.58	4.33±0.33	$3.83^{b}\pm0.39$	$p<0.01^{**}$	$p<0.01^{**}$	p>0.10
	45	2.67±0.33	3.00±0.58	3.33±0.33	3.67±0.33	$3.17^{c}\pm0.39$			
	Mean	$3.50^{c}\pm0.33$	$3.83^{bc}\pm0.46$	$4.08^{ab}\pm0.39$	$4.42^{a}\pm0.25$				
Flavor	0	4.33±0.33	4.67±0.33	4.67±0.33	5.00±0.00	$4.67^{a}\pm0.25$			
	15	4.33±0.33	4.67±0.33	4.33±0.33	4.67±0.33	$4.50^{a}\pm0.33$			
	30	3.67±0.33	4.33±0.33	4.33±0.33	4.33±0.33	$4.17^{a}\pm0.33$	p>0.10	$p<0.01^{**}$	p>0.10
	45	3.00±0.58	3.67±0.33	3.33±0.33	3.67±0.33	$3.42^{b}\pm0.39$			
	Mean	$3.83^{b}\pm0.39$	$4.33^{ab}\pm0.33$	$4.17^{ab}\pm0.33$	$4.42^{a}\pm0.25$				
Tenderness	0	4.33±0.33	4.67±0.33	4.67±0.33	5.00±0.00	$4.67^{a}\pm0.25$			
	15	4.00±0.00	4.00±0.00	4.33±0.33	4.67±0.33	$4.25^{a}\pm0.17$			
	30	3.33±0.33	3.67±0.33	3.67±0.33	4.00±0.00	$3.67^{b}\pm0.25$	$p<0.01^{**}$	$p<0.01^{**}$	p>0.10
	45	2.33±0.33	2.67±0.33	3.00±0.58	3.33±0.33	$2.83^{c}\pm0.39$			
	Mean	$3.50^{b}\pm0.25$	$3.75^{b}\pm0.25$	$3.12^{ab}\pm0.39$	$4.25^{a}\pm0.17$				
Juiciness	0	4.33±0.33	4.67±0.33	4.67±0.33	5.00±0.00	$4.67^{a}\pm0.25$			
	15	4.67±0.33	4.33±0.33	4.00±0.58	4.33±0.33	$4.33^{a}\pm0.39$			
	30	2.33±0.33	3.00±0.00	3.33±0.33	3.67±0.33	$3.08^{b}\pm0.25$	$p<0.01^{*}$	$p<0.01^{**}$	p>0.27
	45	2.00±0.00	2.33±0.33	2.67±0.33	3.33±0.33	$2.58^{c}\pm0.25$			
	Mean	$3.33^{b}\pm0.25$	$3.58^{b}\pm0.25$	$3.67^{ab}\pm0.39$	$4.08^{a}\pm0.25$				
Overall acceptability	0	4.33±0.33	4.67±0.33	4.67±0.33	5.00±0.00	$4.67^{a}\pm0.25$			
	15	4.00±0.00	4.33±0.33	4.33±0.33	4.67±0.33	$4.33^{a}\pm0.25$			
	30	3.33±0.33	3.67±0.33	4.00±0.00	4.33±0.33	$3.83^{b}\pm0.25$	$p<0.01^{**}$	$p<0.01^{**}$	p>0.98
	45	2.33±0.33	3.00±0.00	3.33±0.33	3.33±0.33	$3.00^{c}\pm0.25$			
	Mean	$3.50^{b}\pm0.25$	$3.92^{a}\pm0.25$	$4.08^{a}\pm0.25$	$4.33^{a}\pm0.25$				

Mean in each row having different superscripts varies significantly at values *p<0.05. T_0= control group, T_1=1% ginger and 4% carrot, T_2= 1% ginger and 8% carrot and T_3= 1% ginger and 12% carrot, DI=Days of intervals, Treat= Treatment, T*DI=Interaction of treatment and day intervals.

storage period resulting moisture loss was decreased of increasing storage period. Similar results were found by Disha et al. (2020). Most preferable CP content was observed at 0 day and less preferable to CP content at 45 days. The probable reasons for decreased protein content may be attributed to the comparatively lower protein content of the carrot (Yadav et al. 2018). The highestt EE content was observed in nuggets of T_3 group. The lowest amount of EE content indicated it was most preferable product from consumers' health. This result was almost similar to Disha et al. (2020). 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_0. The lowest amount of ash content indicates this product is most preferable for consumers' health. Data showed that ash gradually increased with increasing storage period. Unlike to earlier observations (Disha et al., 2020), the EE increased due to increase of storage period. This result was in accordance with Disha et al. (2020). Zargar et al. (2017) reported that ash content of the products was significantly decreased (p<0.05) with increasing levels of carrot extracts in chicken sausages which was similar to the present study. Bhosale et al. (2011) also found a decrease in the ash content 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, EE and ash (Table 2).

Table 2. Effect of carrot and ginger on proximate components in chicken nuggets

Parameters	DI	Treatments				Mean	Level of significance		
		T_0	T_1	T_2	T_3		Treat.	DI	T*DI
DM (%)	0	49.73±0.10	47.39±0.09	45.43±0.13	44.57±0.05	46.78^d±0.09			
	15	51.22±0.14	49.10±0.12	47.90±0.19	45.79±0.12	48.50^c±0.14			
	30	53.00±0.09	51.79±0.18	49.66±0.16	49.99±0.03	51.11^b±0.12	p<0.01**	p<0.01**	p<0.01**
	45	55.03±0.36	53.63±0.27	52.67±0.27	51.29±0.14	53.16^a±0.26			
	Mean	52.25^a±0.17	50.48^b±0.16	48.92^c±0.19	47.91^d±0.09				
CP (%)	0	20.75±0.12	19.54±0.14	18.92±0.12	18.42±0.18	19.41^a±0.14			
	15	20.33±0.28	18.69±0.23	18.41±0.10	18.28±0.12	18.93^b±0.18			
	30	19.21±0.20	18.10±0.08	17.97±0.04	17.88±0.11	18.29^c±0.11	p<0.01**	p<0.01**	p<0.01**
	45	18.51±0.33	17.91±0.07	17.75±0.04	17.52±0.02	17.92^d±0.12			
	Mean	19.70^a±0.23	18.56^b±0.13	18.26^c±0.07	18.02^d±0.11				
EE (%)	0	10.10±0.05	9.57±0.02	8.96±0.02	8.48±0.02	9.28^d±0.03			
	15	10.58±0.02	9.82±0.02	9.22±0.02	8.79±0.02	9.60^c±0.02			
	30	10.92±0.02	10.02±0.03	9.40±0.02	9.05±0.04	9.85^b±0.03	p<0.01**	p<0.01**	p<0.01**
	45	11.04±0.03	10.19±0.02	9.69±0.01	9.28±0.02	10.05^a±0.02			
	Mean	10.66^a±0.03	9.90^b±0.02	9.32^c±0.02	8.90^d±0.02				
Ash (%)	0	1.87±0.01	1.65±0.01	1.47±0.01	1.28±0.01	1.57^d±0.01			
	15	2.10±0.01	1.90±0.01	1.68±0.01	1.43±0.01	1.78^c±0.01			
	30	2.31±0.01	2.07±0.03	1.90±0.01	1.61±0.02	1.98^b±0.02	p<0.01**	p<0.01**	p<0.01**
	45	2.49±0.01	2.29±0.01	2.08±0.02	1.78±0.01	2.16^a±0.01			
	Mean	2.19^a±.01	1.98^b±0.01	1.79^c±0.01	1.53^d±0.01				

Physicochemical properties

The ranges for ultimate pH, cooked pH and cooking loss at different treatments were 5.97 to 6.12, 6.01 to 6.11 and 24.49 to 26.15, respectively and days of interval were 6.02 to 6.10, 5.93 to 6.18, and 24.40 to 26.24, respectively (Table 3). Ultimate pH, cooked pH and cooking loss at different teatments and days of interval were found significantly decreased (p<0.05). The present study was almost similar with the findings of Disha et al. (2020). The results showed that slight decreased in ultimate pH and cooked pH for all teatments and an increased in the acidity values for all treatments with 45 days of storage as a result of increased of FFAs due to rancidity. The decrease in 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 doses as well as increasing storage period, which was similar to the results of Disha et al. (2020). There was positve and significant interaction between treatment and days of interval for cooking loss except raw pH and cooked pH (Table 3).

Table 3. Effect of carrot and ginger on physicochemical properties in chicken nuggets

Parameters	DI	Treatments				Mean	Level of significance		
		T_0	T_1	T_2	T_3		Treat.	DI	T*DI
Ultimate pH	0	6.17 ±0.01	6.12±0.02	6.09±0.01	6.01±0.02	6.10^{a}±0.02	p<0.01**	p<0.01**	p>0.10
	15	6.13±0.02	6.10±0.01	6.05±0.02	6.00±0.02	6.07^{b}±0.02			
	30	6.11±0.01	6.07±0.02	6.03±0.01	5.95±0.03	6.04^{c}±0.02			
	45	6.08±0.01	6.06±0.02	5.99±0.02	5.93±0.03	6.02^{d}±0.02			
	Mean	6.12^{a}±0.01	6.08^{b}±.02	6.04^{c}±0.02	5.97^{d}±0.03				
Cooked pH	0	6.25 ±0.02	6.18±0.01	6.16±0.01	6.13±0.01	6.18^{a}±0.01	p<0.01**	p<0.01**	p>0.45
	15	6.14±0.01	6.14±0.02	6.10±0.02	6.08±0.02	6.12^{b}±0.02			
	30	6.06±0.02	6.05±0.02	5.97±0.02	5.95±0.01	6.01^{c}±0.02			
	45	5.97±0.02	5.94±0.02	5.92±0.03	5.88±0.02	5.93^{d}±0.02			
	Mean	6.11^{a}±0.02	6.08^{b}±.02	6.04^{c}±0.02	6.01^{d}±0.01				
Cooking loss (%)	0	27.27±0.13	26.89±0.09	25.57±0.22	25.24±0.14	26.24^{a}±0.16	p<0.01**	p<0.01**	p<0.01*
	15	26.35±0.30	25.97±0.07	24.99±0.01	24.89±.004	25.55^{b}±0.10			
	30	25.90±0.01	25.07±0.04	24.37±0.01	24.08±0.02	24.85^{c}±0.02			
	45	25.08±0.04	24.74±0.04	24.04±0.05	23.75±0.05	24.40^{d}±0.04			
	Mean	26.15^{a}±0.12	25.67^{b}±0.06	24.74^{c}±0.07	24.49^{d}±0.06				

Biochemical properties

The ranges for FFAs, POV and TBARS at different treatments were 0.28 to 0.38, 2.81 to 3.29 and 0.23 to 0.29, respectively and days of interval were 0.28 to 0.38, 2.67 to 3.45, and 0.20 to 0.33, respectively (Table 4). The FFA, POV and TBARS values of all treatments decreased significantly ($p<0.05$) and for days of interval increased significantly ($p<0.05$). The most preferable FFAs, POV and TBARS values were found in T_3 treatment and 0 day of interval. These results were supported to the findings of Disha et al. (2020). The significant ($p<0.05$) increased in FFAs content of the products during storage period might be due to the growth of lipolytic microorganisms (Das et al., 2008). The FFAs are the product of enzymatic/microbial degradation of lipids. It gives 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 treatments (0.01% BHA, 0.05 and 1% lemon extract) 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. TBARS values significantly ($p<0.05$) 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 positve and significant interaction between treatment and days of interval for POV and TBARS except FFA (Table 4).

Table 4. Effect of carrot and ginger on biochemical parameters in chicken nuggets

Parameters	DI	Treatments				Mean	Level of significance		
		T_0	T_1	T_2	T_3		Treat.	DI	T*DI
FFA (%)	0	0.34±0.01	0.30±0.01	0.27±0.01	0.21±0.02	0.28^d±0.01	$p<0.01^{**}$	$p<0.01^{**}$	$p>0.06$
	15	0.36±0.02	0.31±0.01	0.31±0.01	0.24±0.02	0.31^c±0.02			
	30	0.39±0.01	0.35±0.01	0.34±0.01	0.32±0.01	0.35^b±0.01			
	45	0.42±0.02	0.38±0.01	0.36±0.01	0.35±0.01	0.38^a±0.01			
	Mean	0.38^a±0.01	0.34^b±0.01	0.32^c±0.01	0.28^d±0.01				
POV (meq/kg)	0	2.97±0.04	2.78±0.06	2.52±0.02	2.41±0.02	2.67^d±0.04	$p<0.01^{**}$	$p<0.01^{**}$	$p<0.01^{**}$
	15	3.11±0.01	3.01±0.02	2.95±0.01	2.72±0.02	2.95^c±0.02			
	30	3.36±0.02	3.29±0.04	3.10±0.02	2.79±0.06	3.18^b±0.04			
	60	3.37±0.04	3.56±0.03	3.39±0.02	3.14±0.03	3.45^a±0.03			
	Mean	3.29^a±0.03	3.16^b±0.04	2.99^c±0.02	2.81^d±0.03				
TBARS (mg-MA/kg)	0	0.23±0.001	0.20±0.002	0.20±0.001	0.19±0.003	0.20^d±0.001	$p<0.01^{**}$	$p<0.01^{**}$	$p<0.03^{*}$
	15	0.27±0.002	0.23±0.002	0.21±0.003	0.20±0.002	0.23^c±0.002			
	30	0.31±0.002	0.29±0.002	0.27±0.004	0.24±0.003	0.28^b±0.002			
	45	0.37±0.02	0.33±0.003	0.31±0.002	0.30±0.003	0.33^a±0.007			
	Mean	0.29^a±0.006	0.27^b±0.002	0.25^c±0.002	0.23^d±0.002				

Microbiological assessment

The ranges for TVC, TCC and TYMC at different treatments were 4.36 to 4.94, 0.91 to 1.13 and 1.05 to 1.53, respectively and days of interval were 4.45 to 4.81, 0.86 to 1.11, and 1.09 to 1.35, respectively (Table 5). The TVC, TCC and TYMC values were found significantly ($p<0.05$) higher in T_0 than treated 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.

Table 5. Effect of carrot and ginger on different microbe's population in chicken nuggets

Parameters	DI	Treatments				Mean	Level of significance		
		T_0	T_1	T_2	T_3		Treat.	DI	T*DI
TVC (logCFU/g)	0	4.67±0.01	4.50±0.01	4.39±0.01	4.23±0.01	4.45^{d}±0.01	p<0.01**	p<0.01**	p<0.01**
	15	4.81±0.02	4.64±0.02	4.47±0.01	4.32±0.01	4.56^{c}±0.02			
	30	4.98±0.01	4.73±0.02	4.54±0.02	4.41±0.01	4.66^{b}±0.02			
	45	5.32±0.02	4.81±0.01	4.62±0.01	4.50±0.01	4.81^{a}±0.01			
	Mean	4.94^{a}±0.02	4.67^{b}±0.02	4.50^{c}±0.01	4.36^{d}±0.05				
TCC (logCFU/g)	0	1.13±0.003	1.12±0.001	1.10±0.001	1.08±0.005	1.11^{a}±0.002	p<0.01**	p<0.01**	p<0.01**
	15	1.13±0.003	1.11±0.002	1.09±0.003	1.00±0.003	1.08^{a}±0.002			
	30	1.13±0.01	1.09±0.003	1.02±0.004	0.95±0.03	1.05^{b}±0.01			
	45	1.15±0.002	0.95±0.04	0.71±0.04	0.63±0.04	0.86^{c}±0.03			
	Mean	1.13^{a}±0.004	1.06^{b}±0.01	0.98^{c}±0.01	0.91^{d}±0.02				
TYMC (logCFU/g)	0	1.51±0.01	1.39±0.01	1.30±0.01	1.20±0.004	1.35^{a}±0.01	p<0.01**	p<0.01**	p<0.01**
	15	1.53±0.003	1.28±0.01	1.20±0.01	1.10±0.001	1.28^{b}±0.01			
	30	1.54±0.003	1.16±0.01	1.11±0.003	1.07±0.01	1.22^{c}±0.01			
	45	1.55±0.002	1.09±0.001	0.93±0.03	0.81±0.03	1.09^{d}±0.02			
	Mean	1.53^{a}±0.004	1.23^{b}±0.01	1.14^{c}±0.01	1.05^{d}±0.01				

The antioxidant compounds act as barrier of deteriorating fat and assisted to prevent metabolism of fat by bacteria as a result bacterial growth was lower in chicken nuggets treated with antioxidants. Babatunde and Adewumi (2015) reported that garlic, ginger and roselle extracts 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 (1.13 log CFU/g) was found significantly ($p<0.05$) higher than 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) reported that raw chicken meat emulsion incorporated with clove powder, ginger and garlic paste at refrigerated storage (4 ±1ºC). The TYMC in control group (1.53 log CFU/g) was found significantly ($p<0.05$) higher than treated groups. These results were in accordance with Disha et al. (2020). In table 5 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 TVC, TCC and TYMC.

CONCLUSION

The current study demonstrated that the chicken nuggets could be preserved for 45 days using different levels of carrot extract in the presence of ginger extract. Based on sensory, physicochemical, biochemical and microbial properties, 12% carrot extract with 1% ginger extract ensured acceptable qualities of chicken nuggets.

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