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Evaluation of shelf-life of Bengal gram flour based Japanese quail meat nuggets

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Abstract
The present study was undertaken with a view to develop the quail meat nuggets using bengal gram flour with 10% concentrations. In which the boneless meat of japanese quail was used, while the skin, subcutaneous fat, tendon separable connective tissue were trimmed off. The shelf-life of japanese quail meat nugget prepared with bengal gram flour was assessed at refrigeration temperature 4±1ºC. During refrigerated storage, the scores for all the sensory attributes, moisture, protein and fat declined but ash content inclined with the progress of storage period. Similarly, pH, TBA number, tyrosine value and microbial counts increased considerably throughout the storage period but were within the spoilage limit up to 20 days.

Keywords: Nuggets, quail meat, Bengal gram flour and Shelf-life

Introduction
Quail is a small avian species having comparatively more acceptable meat than other because of its flavour, ease of digestion, low fat content, high ratio of unsaturated fatty acids and also an excellent source of protein and its contain omega 3-fatty acid. The processed meat based products, prepared from quail are accepted without religious taboos and personal aestheticism. Nuggets are more acceptable worldwide and occupy a predominated place due to its characteristic flavour and pronounced chewy texture. Nugget is a cooked and fried product suitable as a snack food as well as an adjunct to the routine meals. It is a ready to eat food with reasonably good shelf life under refrigerated and frozen storage conditions. It would be one of the better choices to cater the need to commercial lines. Some of the binders of vegetable protein origin are best known for substituting the meat portion of nuggets upto a certain level, there by adding value to the product. Bengal gram flour is a good source of carbohydrates protein and all the essential amino acids except sulfur containing types. It is a good source of important vitamins such as riboflavin, niacin, thiamine, folate and the vitamin A precursor, β-carotene. It can be used to develop nutritious value added products and hence products can also be used as nutritious food for low income group in developing countries and for patients suffering with life style diseases (Hirdyani, 2014) [1].

2. Materials and Methods
Quails procured from Department of Poultry Science were dressed and connective tissue, tendon, fat *etc.* were separated and boneless meat were packed in low density polyethylene (LDPE) bags and stored overnight at 4±1 ºC. After adequate thawing at room temperature it was cut into small chunks and minced in the meat mincer. Minced meat added with salt, sodium tripolyphosphate, ice flakes was chopped in bowl chopper for the desired duration with the addition of vegetable oil, bengal gram flour, condiments and spices mix so as to get a uniform emulsion. Japanese quail meat nuggets were prepared as per the method described by Ghogare (2009) [2] with slight modification the samples were drawn at intervals of four days (0, 4, 8, 12, 16 and 20 days) and analyzed for physico-chemical characteristics, proximate composition, microbial counts and organoleptic evaluation. The experiment was repeated three times

Table 1: Basic formulation of Japanese quail meat nuggets using Bengal gram Flour

Sr. No.	Ingredients (gms)	Control	Bengal gram flour
			10% level
1	Mince meat	80	70
2	Vegetable oil	05	05
3	Salt	1.5	1.5
4	Ice flakes	09	09
5	Bengal gram flour	00	10
6	Spices	02	02
7	Condiments	2.1	2.1
8	STPP	0.4	0.4
	Total	100	100

2.1 Physico-chemical characteristics
The pH of developed quail meat nuggets was determined by the method of AOAC (1995) [3]. TBA and tyrosine value was determined as per the method described by Strange *et al.* (1977) [4] with slight modifications.

2.2 Proximate composition
The moisture, fat, protein and ash content of quail meat nuggets were determined by following the method of AOAC (1995) [3].

2.3 Microbiological quality
The microbiological quality of nuggets was assessed as per the method of APHA-American Public Health Association (1992) [5] for total plate count (TPC), psychrophilic count and yeast and mould count during storage.

2.4 Sensory evaluation
The semi trained sensory panelists assessed the quality of quail meat nuggets on the basis of sensory attributes viz., appearance, flavour, juiciness, texture and overall acceptability using 8 point descriptive scale (Keeton, 1983) [6] where '1' denoted extremely poor and '8' denoted extremely desirable.

2.5 Statistical Analysis
The data generated were analyzed by Analysis of Variance technique following standard procedure (Snedecor and Cochran, 1989) [7].

3 Results and Discussion
3.1 Physico-chemical properties
The observation on storage related changes in physico-chemical properties of quail meat nuggets at refrigeration temperature (4±1 ºC) are presented in Table 2. The observations revealed that the pH of quail meat nuggets differ significantly (P<0.05) throughout storage period. However, increase in pH was non-significant up to 4th day of storage. The pH values of quail meat nuggets did not revealed any significant difference between 8th and 12th day of refrigeration storage. The subsequent storage of quail meat nuggets resulted in significantly (P<0.05) increase in pH till the end of 20th day of the refrigeration storage. Control quail meat nuggets recorded highest pH during storage as compare to quail meat nuggets incorporated with bengal gram flour at 10% level. Present findings are corroborated with the results of Reddy (2008) [8] who reported increase in pH of spent hen nuggets extended with bengal gram flour during refrigeration storage and Dhond (2013) [9] for quail meat balls.

During storage, TBA values of control quail meat nuggets was observed to be significantly (P<0.05) higher as compare to 10% bengal gram flour incorporated quail meat nuggets. The increase in TBA values particularly at the end of storage is indicative of oxidative rancidity but the value on 20th day was within the spoilage limit of 0.60 mg/kg where the off flavor was generally detected in the product (Greene and Cumuze, 1982) [10]. The increase in TBA values may be attributed to aerobic packaging, oxygen permeability packaging material that leads to faster lipid oxidation of product (Brewer *et al.*, 1992) [11]. Similar finding were recorded by Dhond (2013) [9] for quail meat balls.

Inclining trend was recorded in tyrosine values during entire refrigeration storage of quail meat nuggets. The tyrosine values were significantly (P<0.05) higher in control product which might be due to initial higher tyrosine in fresh product. The increase in tyrosine values may be attributed to aerobic packaging of product and oxygen permeability of packaging material (Brewer *et al.*, 1992) [11] that led to faster lipid oxidation. Similar results were recorded by Suradkar, (2008) [12] and Mundhe, (2010) [13] for preparation of chicken nuggets and chicken patties respectively.

Table 2: Storage related change in physico-chemical characteristics of japanese quail meat nuggets during refrigerated storage (4±1°C)

Type of Product	Storage Period (Days)						Treatment mean
	0	4	8	12	16	20	
pH							
Control	6.24±0.01	6.25±0.00	6.26±0.01	6.27±0.00	6.30±0.01	6.33±0.00	6.27^{a}±0.04
10%	6.20±0.01	6.22±0.01	6.24±0.01	6.26±0.01	6.27±0.00	6.30±0.01	6.24^{b}±0.04
Storage Period Mean	6.22^{a}	6.23^{a}	6.25^{ab}	6.26^{ab}	6.28^{b}	6.31^{b}	
TBA(mg malonaldehyde /Kg)							
Control	0.24±0.01	0.27±0.01	0.28±0.00	0.35±0.00	0.44±0.02	0.56±0.01	0.35^{a}±0.03
10%	0.21±0.01	0.23±0.01	0.25±0.00	0.32±0.01	0.41±0.01	0.52±0.00	0.32^{b}±0.03
Storage Period Mean	0.22^{a}	0.25^{ab}	0.26^{ab}	0.33^{b}	0.42^{c}	0.53^{d}	
Tyrosine (mg/g)							
Control	17.1±0.01	17.2±0.00	17.3±0.05	17.4±0.01	17.5±0.01	17.7±0.03	17.4^{a}±0.01
10%	15.5±0.05	15.7±0.09	16.0±0.05	16.0±0.01	16.0±0.01	16.4±0.01	15.9^{b}±0.01
Storage Period Mean	16.36^{a}	16.51^{b}	16.70^{c}	16.75^{c}	16.80^{d}	17.07^{e}	

Proximate composition

The observations with respects to changes in proximate composition in quail meat nuggets (control) and with incorporation of 10% bengal gram flour are presented in Table 3. The moisture content of 10% bengal gram flour incorporated quail meat nuggets were significantly (P<0.05) higher than control quail meat nuggets indicating the increase in hydration ability of extenders during entire storage period. Variations in moisture content might be due to loss of some moisture upon storage of products. Biswas *et al.* (2011) [14]

who reported that significant decrease in moisture content of duck patties and also Dhond (2013) [9] reported similar declining pattern in quail meat balls during storage. The fat content 10% bengal gram flour incorporated quail meat nuggets was significantly higher as compare to quail meat nuggets (control). This might be due to better fat retention and increased opportunity for fat protein interaction during storage (Lucca and Tepper, 1994) [15]. Similar findings were reported by Ahmed *et al.* (2007) [16] for enrobed buffalo meat cutlet during refrigeration storage and Dhond (2013) [9] for quail meat balls during storage.

The protein content of 10% bengal gram flour incorporated quail meat nuggets was significantly (P<0.05) higher than that of quail meat nuggets (control). During storage, the protein content though decline significantly but upto 4th day of storage the difference was non-significant. Afterwards, it declined significantly throughout the entire storage period. The significant (P<0.05) decrease of protein content in quail meat nuggets with increase in refrigeration storage time could be due to denaturation of protein during refrigeration storage, freezing rate (slow and fast) affects the quality of frozen meat significantly. Fast freezing produce better quality meat than slow freezing. During slow freezing formation of large ice crystals damages the cell and result in protein denaturation. Concentration of enzymes and presence of other compounds govern the process of protein denaturation (Rahman, 1999 and Rahelic 1985) [17, 18].The ash content of 10% bengal gram flour incorporated quail meat nuggets was significantly (P<0.05) higher than that of quail meat nuggets. During storage, the ash content inclined significantly throughout the entire storage period. The results are corroborated with Reddy (2008) [8] for development of spent chicken meat nuggets with different extenders.

Table 3: Storage related change in proximate composition of japanese quail meat nuggets during refrigerated storage (4±1°C)

Type of Product	Storage Period (Days)						
	0	4	8	12	16	20	Treatment mean
Moisture (%)							
Control	57.5±0.03	57.2±0.05	56.6±0.05	56.0±0.00	55.4±0.44	54.5±0.22	56.2^{b}±0.09
10%	58.6±0.11	58.2±0.06	58.1±0.05	57.5±0.33	56.4±0.33	55.7±0.11	57.4^{a}±0.09
Storage Period Mean	58.08^{a}	57.74^{ab}	57.39^{b}	56.75^{b}	55.91^{c}	55.10^{d}	
Fat (%)							
Control	12.2±0.01	12.1±0.03	11.7±0.10	11.3±0.10	10.7±0.06	10.2±0.05	11.4^{b}±0.03
10%	12.8±0.15	12.5±0.05	12.3±0.01	12.1±0.10	11.5±0.15	11.1±0.05	12.0^{a}±0.03
Storage Period Mean	12.53^{a}	12.36^{a}	12.03^{b}	11.71^{c}	11.14^{d}	10.69^{e}	
Protein (%)							
Control	22.8±0.04	22.5±0.05	21.5±0.05	21.4±0.09	21.3±0.05	20.7±0.11	21.7^{b}±0.06
10%	23.8±0.05	23.7±0.04	23.5±0.05	23.1±0.10	22.8±0.04	22.7±0.1	23.3^{a}±0.06
Storage Period Mean	23.37^{a}	23.17^{a}	22.53^{b}	22.29^{b}	22.08^{bc}	21.73^{c}	
Ash (%)							
Control	2.52±0.00	2.58±0.00	2.64±0.01	2.70±0.01	2.75±0.0	2.81±0.00	2.66^{b}±0.01
10%	2.66±0.01	2.81±0.05	2.90±0.04	2.93±0.04	3.04±0.00	3.16±0.01	2.91^{a}±0.01
Storage Period Mean	2.58^{a}	2.69^{b}	2.77^{c}	2.81^{c}	2.89^{c}	2.98^{d}	

3.2 Microbial quality

Storage related changes in microbial quality of quail meat nuggets (control) and with the incorporation of 10% bengal gram flour in respect of TPC, psychrophilic count and yeast and mould count during refrigeration storage are presented in Table 4. It was observed that the total plate count increased significantly (P<0.05) with the progress of refrigeration storage of 20 days. There was a steady increase in TPC count up to 8th day of the storage, but afterwards the count increase considerable. The comparable count for 0 and 8th day might be attributed to the fact that bacteria need a lag phase before rapid multiplication. The TPC for quail meat nuggets incorporated with 10% bengal gram flour were significantly higher than those of the control, which might be caused by an easy availability of carbohydrate in the bengal gram flour incorporated quail meat nuggets to favor microbial growth at the end of storage. The total plate count was far below the inefficient spoilage level of 6.70 log cfu/gm (Vonhally and Hollzafel, 1991) [19]. This might be due to the permissive temperature and relative availability of moisture and nutrients for the growth of mesophilic bacteria. These results are in accordance with Nagamallika (2003) [20] in spent hen meat patties who observed increase in total plate count with increased storage period. Present findings are in close agreement with the observation of Reddy (2008) [8] for the development of spent chicken meat nuggets with different extenders. Irrespective of the type of quail meat nuggets, growth of psychrophils could not be seen in nuggets incorporated with 10% bengal gram flour at refrigerated (4±1 ºC) storage even upto a period of 20 days. This might be attributed to the temperature variance for growth of psychrophilic bacteria during refrigerated storage. Devaki (2006) [21] noticed psychrophilic bacterial growth during refrigerated (4±1 ºC) storage in spent chicken nuggets extended with whey protein concentrates and egg white.

It was observed that the yeast and mould increased significantly (P<0.05) with the progress of refrigeration storage of 20 days. The yeast and mould for quail meat nuggets incorporated with 10% bengal gram flour were significantly higher than those of the control. This might be due to the relative availability of conducive temperature and moisture for the growth of yeast and moulds. The present findings are consonance with Anandh *et al.* (2008) [22] who reported increasing yeast and mould counts with storage days in refrigerated buffalo rolls and also by Luckose *et al.* (2015) [23] for chicken nuggets.

Table 4: Storage related change in microbiological quality of japanese quail meat nuggets during refrigerated storage (4±1°C)

Type of Product	Storage Period (Days)						
	0	4	8	12	16	20	Treatment mean
Total plate count (log cfu / g)							
Control	1.25±0.02	1.77±0.05	2.06±0.01	2.66±0.04	2.89±0.05	3.28±0.00	2.31^{b}±0.01
10%	1.54±0.01	1.96±0.01	2.39±0.03	2.79±0.07	3.04±0.02	3.36±0.03	2.51^{a}±0.01
Storage Period Mean	1.39^{a}	1.86^{b}	2.22^{c}	2.72^{d}	2.96^{e}	3.31^{f}	
Psychrophilic count (log cfu/g)							
Control	ND	ND	ND	ND	ND	ND	ND
10%	ND	ND	ND	ND	ND	ND	ND
Storage Period Mean	ND	ND	ND	ND	ND	ND	ND
Yeast and mould count (log cfu/g)							
Control	1.34±0.02	1.61±0.04	2.13±0.04	2.44±0.1	2.70±0.04	2.94±0.01	2.19^{b}±0.03
10%	1.22±0.01	1.52±0.00	1.93±0.00	2.82±0.01	2.91±0.00	3.23±0.00	2.27^{a}±0.03
Storage Period Mean	1.28^{a}	1.56^{b}	2.03^{c}	2.63^{d}	2.80^{e}	3.05^{f}	

3.3 Sensory attributes

Storage related changes in sensory attributes of quail meat nuggets during refrigerated storage are presented in Table 5. The sensory scores for appearance of quail meat nuggets with 10% bengal gram flour and without bengal gram flour (control) decline significantly (P<0.05) during storage which might be due to pigment breakdown and lipid oxidation resulting in non-enzymatic browning. Similar findings of decreasing scores during refrigerated storage were also noticed by Devaki (2006) [21] in spent hen meat nuggets and also observed by Suradkar (2008) [12] in chicken nuggets. The flavour scores of quail meat nuggets with 10% bengal gram flour and without bengal gram flour (control) decline significantly (P<0.05) during storage. Irrespective of storage, quail meat nuggets (control) recorded significantly higher scores for flavor over quail meat nuggets with 10% bengal gram flour. In all the products, there was no any detectable off flavor throughout the storage period. The decline in flavour score in quail meat nuggets could be attributed to fat loss as fat content of meat product has greater role in development of flavour as reported by Pearson and Gillet, (1997) [24]. However, product without bengal gram flour had significantly higher flavour score than quail meat nuggets without bengal gram flour which might be due to lack of meaty flavour with proportionate replacement of meat by 10% level. Similar reduction in flavour score during storage of cooked chicken sausages was reported by Rindhe (2008) [25] and by Dhond (2013) [9] for quail meat balls using extenders. Irrespective of the type of quail meat nuggets, the juiciness scores were significantly (P<0.05) affected by storage periods. The reduction in juiciness scores of quail meat nuggets with or without bengal gram flour (control) might be due to loss of moisture from the product during storage. Among the treatments 10% bengal gram flour incorporated quail meat nuggets recorded significantly (P<0.05) higher scores than that of control. Similar findings were reported by Reddy (2008) for spent hen nuggets and Suradkar (2008) [12] for chicken nuggets upon refrigerated storage (4±1 ºC). The sensory score for texture decline significantly (P<0.05) during refrigeration storage at 20th day. Irrespective of storage, quail meat nuggets (control) recorded significantly lower scores for texture over quail meat nuggets with incorporation of 10% bengal gram flour. Significant reduction in texture scores particularly at the later part of storage (20th day) may be attributed to the increased loss of moisture leading to hardening of product and also due to the breakdown of fat and protein. Present findings are corroborated with that of Suradkar (2008) [12] for chicken nuggets upon refrigerated storage (4±1 ºC). Significant difference (P<0.05) in overall palatability scores of quail meat nuggets (control) and with bengal gram flour incorporated quail meat nuggets was noticed during the refrigerated storage (4±1°C). Quail meat nuggets incorporated with 10% bengal gram flour registered superior overall acceptability scores than control throughout the storage period. The decreased overall palatability scores might be due to the lowering scores of appearance, juiciness and texture scores. Similar types of a decrease in overall palatability scores were noticed by Nagamallika (2003) [20] in spent hen meat patties stored under refrigerated (7± 1°C) storage.

Table 5: Storage related change in sensory attributes of japanese quail meat nuggets during refrigerated storage (4±1°C)

Type of Product	Storage Period (days)						Treatment
	0	4	8	12	16	20	
Appearance							
Control	7.45±0.1	7.23±0.03	6.96±0.01	6.77±0.07	6.45±0.05	5.98±0.01	6.80^{b}±0.02
10%	7.65±0.05	7.37±0.05	7.20±0.02	6.89±0.10	6.56±0.12	5.87±0.01	6.92^{a}±0.02
Storage Period Mean	7.55^{a}	7.29^{b}	7.08^{c}	6.83^{d}	6.50^{e}	5.92^{f}	
Flavour							
Control	7.43±0.10	7.34±0.05	6.93±0.01	6.51±0.04	6.12±0.00	5.90±0.00	6.70^{a}±0.02
10%	7.29±0.05	7.00±0.00	6.88±0.04	6.47±0.05	6.11±0.05	5.88±0.01	6.60^{b} ±0.02
Storage Period Mean	7.36^{a}	7.17^{b}	6.90^{c}	6.49^{d}	6.11^{e}	5.89^{f}	
Juiciness							
Control	7.00±0.00	6.81±0.00	6.52±0.04	6.15±0.01	5.85±0.05	5.53±0.00	6.31^{b}±0.02
10%	7.46±0.05	7.08±0.06	6.92±0.05	6.55±0.10	6.07±0.05	5.84±0.16	6.65^{a}±0.02
Storage Period Mean	7.23^{a}	6.94^{b}	6.71^{c}	6.35^{d}	5.95^{e}	5.68^{f}	
Texture							
Control	7.17±0.04	6.93±0.00	6.52±0.04	6.07±0.06	5.74±0.11	5.57±0.00	6.33^{b}±0.02
10%	7.33±0.05	7.03±0.11	6.53±0.05	6.03±0.05	5.89±0.05	5.64±0.13	6.40^{a}±0.02

Storage Period Mean	7.25[a]	6.97[b]	6.52[c]	6.05[d]	5.81[e]	5.60[f]	
Overall Palatability							
Control	7.28±0.03	6.86±0.01	6.23±0.05	5.99±0.01	5.77±0.05	5.62±0.05	6.29[b]±0.02
10%	7.72±0.02	7.21±0.05	6.88±0.05	6.45±0.05	6.00±0.00	5.82±0.09	6.68[a]±0.02
Storage Period Mean	7.50[a]	7.03[b]	6.55[c]	6.22[d]	5.88[e]	5.72[f]	

Means with common superscripts did not differ significantly (P<0.05)

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