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Development and quality evaluation of bhujia incorporated with spent hen meat powder

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Abstract
A study was conducted to investigate the feasibility of incorporation of spent hen meat powder in traditional bhujia formulation to enrich the nutritional and sensory quality of product. Four treatment combinations i.e. Treatment-A (0% meat powder), Treatment-B (10% meat powder), Treatment-C (15% meat powder) and Treatment-D (20% meat powder) were prepared and analyzed for its physico-chemical, nutritional, microbiological, sensory and storage stability for a period of 60 days. The cooking yield, water requirement for dough preparation and oil uptake increased with the increase level of incorporation of meat powder in treated groups. On the other hand fracturability and pH of treatments decreased with increase level of incorporation of meat powder. There was also significant and gradual increase of pH in subsequent storage period. A significant (P<0.05) increasing trend of TBARS was observed with an increase in level of incorporation of meat powder. The moisture content increased significantly (P<0.05) with storage period of 0 to 60 days in all treatments. The crude protein, crude fat, total ash and calorific value content showed an increasing trend with increase level of incorporation of meat powder while carbohydrate content showed a significantly (P<0.05) decreasing trend. Treatment C showed a significantly higher value (P<0.05) than other treatments with respect to flavour, crispiness, taste and overall acceptability. In general, sensory attributes showed significant decreasing trend during the whole of the storage period irrespective of the treatments. Total Plate Count, Yeast & Mould, *E. coli* and *Staphylococcus spp.* indicates absence of microbial load during the whole storage period. The study indicates that the spent hen meat powder to the extent of 15% could successfully be incorporated in traditional bhujia to improve its nutritional and sensory qualities. It was also found that the bhujia was suitable to be aerobically stored in LDPE pouches (150µm thickness) at ambient for 60 days without any deterioration in its quality and acceptability.

Keywords: Bhujia, spent hen meat powder, fracturability, storage stability, sensory attributes

Introduction
India being a mixture of varied cultures and cuisine is also rich in variety of foods other than meals, of which most popular are snacks. Young generation is highly cherished by snacks due to its convenience nature and overwhelming taste and flavor. Sweet and salty snacks have faced stiff competition in recent years, as meat has established a firm foothold in the snacking sector. Due to high nutritive value and superior sensory qualities, a broad range of snacks from plant and animal origins like bhujia are still consumed today and sold under various geographical indications. It has been noticed that there is a rise in the demand for innovative foods based on traditional Indian recipes across different states in India and abroad [1]. Meat is incorporated in different non vegetarian snack formulations in the form of dried chunks, minced mix or powder. Spent hen meat obtained from old and culled chicken as a by-product of egg industry, is high in fat and cholesterol content, tough, less juicy and poor in functional characteristics resulting in poor acceptability and thus lowers remunerative prices as compared to broiler meat. Meat consumers and processors can be benefited from the development of efficient and economical technology for processing of undervalued meat such as spent hen meat into value-added meat product that are palatable and reasonable in cost [2]. Therefore, utilization of nutritious, easily available and economically viable spent hen meat in traditional snack formulation can overcome the problem of improper utilization of spent hens and will also improve nutritional value of the snacks.
Good snacks should be convenient to consume, inexpensive, nutritious, low in fat, and have a long shelf life [3]. In India, Bhujia is one of the popular snacks consumed in maximum households. Bhujia is gram flour based, deep fried, shelf stable ready to eat salted snack and

incorporation of meat powder in its formulation will not only upgrade the nutritional value but will also improve the taste and flavour of the product. It is prepared by deep fat frying process and thus can be stored at ambient temperature for longer period. However, high fat content may create the problem of off odor and oxidation and thereby rancid taste development. To overcome the problem of oxidative rancidity, natural antioxidants in the form of spices and condiments are added in the bhujia formulation to enhance the shelf life of the products without affecting its nutritional and sensory qualities. Natural antioxidants extracted from herbs and spices exhibit various degree of efficiency when used in different food application [4]. In this experiment, thus the recipe has been formulated by incorporating different spices and ingredients so as to enrich the nutritional quality of the product as well as to improve its storage stability.

With these observations, the objective of the present study was to investigate feasibility of incorporation of spent hen meat powder in traditional bhujia formulation and characterization of physico-chemical, nutritional, sensory and microbiological property.

Materials and Methods

Raw materials

Spent hens of commercial layer birds were obtained from Regional Poultry Breeding Farm, Kyrdemkulai, Ri Bhoi District, Meghalaya, India. Following ante-mortem examination, spent hens were slaughtered, dressed and deboned manually following proper hygienic conditions in the laboratory of AICRP on PHET, Department of LPT, C. V. Sc., AAU, Khanapara, Assam, India. Post-mortem examination of the spent hens was also performed to detect any kind of abnormalities. All visible fat, fascia and connective tissue were separated and trimmed off and the meat was minced twice through 6 mm sieve in a meat mincer and packed in low density polyethylene (150 µm thickness) bags and then kept at -18±2 °C till further use. Refined salt (Tata Chemicals Ltd., Mumbai), refined oil, gram flour, potato starch powder, rice flour, chat masala and asafoetida (hing) were procured from local market of Guwahati. Red chili powder, black pepper powder, garlic powder and cardamom powder was prepared in the laboratory. The spent hen meat powder was prepared by following the procedure as given in figure 1.

Four combinations of bhujia (Table 1) were prepared as described in the protocol (Figure 2) and then aerobic packaging was done with low density polyethylene (150 µm thickness) for storage and further evaluation. For shelf life study products were stored up to two months at room temperature for physicochemical, microbiological and sensory evaluation.

Physico-chemical parameters

Cooking yield

Cooking yield was calculated and expressed as percentage by the following formula,

$$\text{Cooking yield (\%)} = \frac{\text{Wt. of cooked bhujia}}{\text{Wt. of raw dough}} \times 100$$

Water requirement for dough preparation

Requirement of water for dough preparation was calculated and expressed as percentage by the following formula,

$$\text{Requirement of water (\%)} = \frac{\text{Wt. of dough - Wt. of dried mix formulation of bhujia}}{\text{Wt. of dried mix formulation of bhujia}} \times 100$$

Oil uptake

Oil uptake was calculated and expressed as percentage by the following formula,

$$\text{Oil uptake (\%)} = \frac{\text{Wt. of fried bhujia - Wt. of dried mix formulation of bhujia}}{\text{Wt. of dried mix formulation of bhujia}} \times 100$$

Water activity

Fried bhujia was placed in the sample container up to 1/2 to 3/4th level and kept inside the sample chamber and water activity was recorded by a water activity meter of Aqua Lab (Dew point water activity meter 4TE).

pH

The pH was measured as per the procedure of AOAC [5]. 10 grams of fried bhujia was homogenized with 50 ml of distilled water in a laboratory blender (POLYTRON, PT 300) for 1 min and the pH [6] was recorded by using a digital pH meter (Make: Metrohm, Switzerland; Model: 780).

Thiobarbituric Acid Reactive Substance (TBARS) value

The TBA value was determined as per the standard method [7].

Proximate composition

Moisture, crude fat, crude protein and total ash percentage of bhujia of all treated groups were estimated as per the standard procedure [8].

Calorific value

The energy content was determined by multiplying the percent values of crude protein, crude fat and carbohydrate by the factor of 4, 9 and 4 respectively and summing up these values [9].

Microbiological examinations

Total plate count, Staphylococcus count, *E coli* count and yeast and mold count in the samples were determined following the standard methods [10].

Total plate count

Enumeration of total viable plate count of samples were done in every 15 days in standard plate count agar medium, pH 7.0±0.1 by following pour plate technique [10]. Plates were incubated at 37 °C for up to 72 hrs for enumeration of total viable aerobic count. Counting was done by using a bacteriological colony counter and all those plates yielding >25 and <250 bacterial colonies were taken into account.

Total Staphylococcus count

Enumeration of staphylococcus counts of samples were done in every 15 days in Mannitol Salt Agar (MSA) medium, pH 7.4 ± 0.2 by following pour plate technique [10]. Counting was done by using a bacteriological colony counter and all those plates yielding >25 and <250 bacterial colonies were taken into account.

Escherichia coli

Enumeration of *E. coli* counts of samples were done in every 15 days in EMB Agar (Eosin Methylene Blue Agar) by following pour plate technique [10]. Counting was done by

using a bacteriological colony counter and all those plates yielding >25 and <250 bacterial colonies were taken into account.

Yeast and mould counts

Yeasts and moulds counts of samples were made at similar time intervals as that of the total viable plate count by inoculating the appropriate dilution of the sample on Rose Bengal Agar Base, pH 7.2±0.1 and on incubating at 25 °C up to 72 hrs [10]. Counting was done by using a bacteriological colony counter.

Sensory evaluation

Bhujia was served at ambient temperature to the semi-trained panelists of 7- member panel. All the samples were evaluated for appearance, colour, flavour, crispiness, taste and overall acceptability by using a 7 point hedonic scale score card [11].

Results and Discussion

The results for physico-chemical properties of bhujia are presented in Table 2 & 3. Significant differences could be observed (P<0.05) within the treatment groups as regards to cooking yield, water requirement for dough preparation and oil uptake. The cooking yield, water requirement for dough preparation and oil uptake are correlated in that all the three parameters increased with the increase in the level of spent hen meat powder in the treated groups. A gradual increase in the cooking yield from Treatment A to Treatment D was noted which might be due high oil uptake during frying of the products. Water requirement for dough preparation increased with increasing the level of spent hen meat powder incorporation which might be due to the emulsifying capacity of spent hen meat powder.

Significant difference in the fracturability of the samples was noticed (P<0.05) within treatment groups. The fracturability decreased with increased level of incorporation of spent hen meat powder in the treated samples. Lowest fracturability was found in the sample with 20% spent hen meat powder (Treatment D) which might be due to high fat percentage in the final product. Similar finding was reported who noticed that negative correlation exists between fat and fracturability in commercially available frankfurters [12]. As fat content decreased resistance to force from mechanical stress also decreased.

No significant difference could be seen as regards to water activity (a_w) of the treated bhujias. Highest a_w was noticed in Treatment D and it was also seen that a_w increased with increase of storage period of all treatment groups.

The results of pH of the treatment groups decreased with increase level of incorporation of spent hen meat powder. Significant difference (P<0.05) could be noticed within the treatment groups which is due to high pH of gram flour. The significant and gradual increase of pH in subsequent storage periods might be attributed due to ammonia production during the protein denaturation. Similar findings were reported during the quality assessment of vacuum packaged chicken snacks stored at room temperature [13]. The trend of gradual increase of pH with advancement of the storage time is also very well agreed for different meat products [14, 15].

Thiobarbituric acid reactive substance (TBARS) followed a significant (P<0.05) increasing trend with an increase in the level of incorporation of meat powder which may be due to increase oil uptake during frying process. However, in the present study TBARS values were much lower than threshold value of 1mg/kg [16]. It was also observed that TBARS values increased significantly with storage period of 0 to 60 days in all treatments. Similar findings of gradual increase in TBARS value during storage period was also recorded in shelf stable buffalo meat chunks [17]; chicken chips [18]; freeze dried beef [19]; dehydrated chicken pulav [20]; dehydrated chicken kebab mix [21]; hurdle treated sausages [22] and dehydrated spent hen meat mince [23]. Increase in TBARS values on storage might be attributed to available oxygen in LDPE package that led to lipid oxidation [24]. It is also reported that gradual increase of TBARS values occurs in beef and chicken snacks stored at ambient temperature [13].

No significant difference could be observed within treatment groups as regards to the moisture content. However, the moisture content increased significantly (P<0.05) with storage period of 0 to 60 days in all treatments. The gradual increase in moisture content might be due to moisture absorption by the product from the environment that gradually permeated through packaging materials and also from the respiration of the growing microorganisms [25]. A similar increase in moisture content of dehydrated chicken kebab mix packaged in metalized polyester pouches was also observed during ambient temperature storage [21].

The crude protein, crude fat and total ash content showed an increasing trend with increased level of incorporation of spent hen meat powder. Significant difference was observed among the treatment groups which may be due to high protein content of meat powder compared to gram flour. Crude fat percentage also increased significantly with increase in the level of spent hen meat powder in the treated groups which might be due to presence of fat in the meat powder and higher oil uptake during frying process. The total ash percentage also increased significantly (P<0.05) with increase level of incorporation of spent hen meat powder. The above findings might be due to the partial replacement of gram flour (22% Crude Protein, 6% Crude fat and 1.5% Total ash) in treatments B, C & D with meat powder (70% Crude Protein, 10% Crude Fat and 11% Total Ash). Meat is specifically a good source of omega-3-fatty acids, protein and highly bio-available iron [26]. The carbohydrate content of the treated products incorporated with spent hen meat powder showed a significantly (P<0.05) decreasing trend with increase level of incorporation which might be due to the fact that meat powder (5.5%) contains less carbohydrate than gram flour (58%). The calorific value of the products showed a significant (P<0.05) increasing trend with increase level of incorporation of spent hen meat powder in the *bhujias* which might be due to increase crude fat content in the samples from Treatment A to D respectively.

In general, sensory attributes i.e., appearance, colour, flavour, crispiness, taste and overall acceptability showed significant decreasing trend during storage period irrespective of the treatments. The mean value of all sensory parameter was highest in Treatment C which might be due to incorporation of spent hen meat powder in appropriate level. Treatment C showed a significantly higher value (P<0.05) than other treatments (Treatment A, B & D) in respect to flavour, crispiness, taste and overall acceptability. Treatment B &C showed a significantly higher value (P<0.05) than treatment A &D in respect to appearance and colour.

The microbiological quality of treatment groups (Treatment A, B, C & D) in respect to total plate count, yeast & mould, *E. coli* and *Staphylococcus spp.* indicates absence of microbial load during the whole storage period which might be due to

the lower moisture content during storage in the products as well as the lower water activity might not favoured microbial growth.

Shelf-life study of the products included a_w, pH, moisture content, TBARS value, microbiological qualities and sensory evaluation revealed that *bhujia* could be suitably stored under aerobic packaging in LDPE pouches (150µm) at ambient for 60 days without any deterioration in its quality and acceptability.

Table 1: Formulation of bhujia (in percentage)

S. No.	Ingredients	Treatment A	Treatment B	Treatment C	Treatment D
1	Gram flour	60	50	45	40
2	Spent hen meat powder	0	10	15	20
3	Potato starch powder	20	20	20	20
4	Rice flour	10	10	10	10
5	Red chili powder	1	1	1	1
6	Black pepper powder	1	1	1	1
7	Garlic powder	1	1	1	1
8	Chat masala	2	2	2	2
9	Cardamom powder	0.25	0.25	0.25	0.25
10	Asafoetida (*Hing*)	0.25	0.25	0.25	0.25
11	Salt	2	2	2	2
12	Refined Oil	2.5	2.5	2.5	2.5
Total		100	100	100	100

Table 2: Physico-chemical properties of chicken bhujia (Mean±SE)*

Parameter	Treatment-A	Treatment-B	Treatment-C	Treatment-D
Yield (%)	84.04 ± 0.35^{D}	87.36 ± 0.36^{C}	91.64 ± 0.35^{B}	95.37 ± 0.33^{A}
Water requirement for dough preparation (%)	42.9 ± 0.68^{D}	49.04 ± 0.4^{C}	51.9 ± 0.68^{B}	55.1 ± 0.4^{A}
Oil uptake (%)	20.17 ± 0.7^{D}	24.84 ± 0.90^{C}	29.57 ± 1.54^{B}	34.98 ± 1.71^{A}
Fracturability (N)	0.206 ± 0.01^{A}	0.200 ± 0.01^{A}	0.196 ± 0.01^{AB}	0.182 ± 0.01^{B}

Mean with different superscripts in the same row indicate significant difference ($P<0.05$)
Number of observation: n=5

Table 3: Effect of ambient storage on water activity, pH, TBARS value and moisture content of aerobically packaged bhujia (Mean±S.E.)*

Parameter	Storage	Treatment-A	Treatment-B	Treatment-C	Treatment-D
Water Activity (a_w)	0 day	0.2191±0.03	0.2241±0.02	0.2286±0.02	0.2327±0.02
	15 day	0.2279±0.03	0.2318±0.02	0.2346±0.02	0.2377±0.02
	30 day	0.2309±0.03	0.2347±0.02	0.2375±0.02	0.2407±0.02
	45 day	0.2340±0.03	0.2377±0.02	0.2403±0.02	0.2437±0.02
	60 day	0.2361±0.03	0.2396±0.02	0.2421±0.02	0.2457±0.02
pH	0 day	$_{d}6.36\pm0.02^{A}$	$_{d}6.29\pm0.01^{B}$	$_{d}6.25\pm0.01^{BC}$	$_{c}6.22\pm0.01^{C}$
	15 day	$_{cd}6.40\pm0.03^{A}$	$_{cd}6.33\pm0.01^{B}$	$_{cd}6.29\pm0.01^{BC}$	$_{c}6.26\pm0.01^{C}$
	30 day	$_{bc}6.44\pm0.02^{A}$	$_{bc}6.37\pm0.02^{B}$	$_{bc}6.33\pm0.01^{BC}$	$_{b}6.31\pm0.01^{C}$
	45 day	$_{ab}6.48\pm0.03^{A}$	$_{ab}6.41\pm0.01^{B}$	$_{ab}6.37\pm0.01^{BC}$	$_{a}b6.35\pm0.01^{C}$
	60 day	$_{a}6.52\pm0.03^{A}$	$_{a}6.45\pm0.02^{B}$	$_{a}6.41\pm0.02^{BC}$	$_{a}6.38\pm0.01^{C}$
TBARS	0 day	$_{d}0.060\pm0.00^{B}$	$_{d}0.073\pm0.00^{AB}$	$_{c}0.085\pm0.01^{A}$	$_{d}0.097\pm0.01^{A}$
	15 day	$_{d}0.076\pm0.00^{C}$	$_{d}0.092\pm0.00^{BC}$	$_{c}0.105\pm0.01^{AB}$	$_{d}0.119\pm0.01^{A}$
	30 day	$_{c}0.102\pm0.01^{C}$	$_{c}0.121\pm0.01^{BC}$	$_{b}0.136\pm0.01^{AB}$	$_{c}0.151\pm0.01^{A}$
	45 day	$_{b}0.143\pm0.01^{C}$	$_{b}0.162\pm0.01^{BC}$	$_{a}0.180\pm0.01^{AB}$	$_{b}0.197\pm0.01^{A}$
	60 day	$_{a}0.213\pm0.01^{C}$	$_{a}0.233\pm0.01^{BC}$	$_{a}0.256\pm0.01^{AB}$	$_{a}0.276\pm0.01^{A}$
Moisture	0 day	$_{c}2.27\pm0.28$	$_{c}2.35\pm0.22$	$_{c}2.38\pm0.33$	$_{c}2.39\pm0.32$
	15 day	$_{b}2.94\pm0.25$	$_{b}2.95\pm0.19$	$_{b}2.98\pm0.26$	$_{b}3.00\pm0.24$
	30 day	$_{a}3.72\pm0.15$	$_{a}3.72\pm0.09$	$_{a}3.74\pm0.15$	$_{a}3.74\pm0.15$
	45 day	$_{a}4.00\pm0.15$	$_{a}4.02\pm0.09$	$_{a}4.02\pm0.16$	$_{a}4.03\pm0.15$
	60 day	$_{a}4.11\pm0.15$	$_{a}4.12\pm0.09$	$_{a}4.12\pm0.16$	$_{a}4.13\pm0.15$

Mean with different superscripts in the same row indicate significant difference ($P<0.05$)
Mean with different subscripts in the same column indicate significant difference ($P<0.05$)
Number of observation: n=5

Table 4: Proximate composition of chicken bhujia (Mean±SE)* on day of production

Parameter	Treatment-A	Treatment-B	Treatment-C	Treatment-D
Moisture (%)	2.27±0.28	2.35±0.22	2.38±0.33	2.39±0.32
Crude protein (%)	15.18 ± 0.12^{D}	19.01 ± 0.04^{C}	21.15 ± 0.14^{B}	22.65 ± 0.34^{A}
Crude fat (%)	23.69 ± 0.63^{D}	26.51 ± 0.06^{C}	29.23 ± 0.44^{B}	32.20 ± 0.42^{A}
Total ash (%)	3.77 ± 0.15^{C}	5.48 ± 0.14^{B}	6.22 ± 0.14^{A}	6.40 ± 0.14^{A}
Carbohydrate (%)	55.09 ± 0.71^{A}	46.65 ± 0.28^{B}	41.03 ± 0.23^{C}	36.37 ± 0.37^{D}
Calorific value (Kcal/100g)	494.27 ± 2.47^{D}	501.20 ± 1.59^{C}	511.77 ± 3.76^{B}	525.84 ± 3.44^{A}

Mean with different superscripts in the same row indicate significant difference ($P<0.05$)
Number of observation: n=5

Table 5: Effect of ambient storage on sensory parameters of aerobically packaged bhujia (Mean±S.E.)*

Sensory attributes	Days	Treatment-A	Treatment-B	Treatment-C	Treatment-D
Appearance	0 day	$_{a}5.87\pm0.13^{B}$	$_{a}6.11\pm0.10^{A}$	$_{a}6.34\pm0.06^{A}$	$_{a}5.26\pm0.17^{C}$
	15 day	$_{ab}5.64\pm0.09^{B}$	$_{ab}5.94\pm0.10^{A}$	$_{ab}6.17\pm0.06^{A}$	$_{a}5.23\pm0.07^{C}$
	30 day	$_{bc}5.49\pm0.09^{B}$	$_{bc}5.80\pm0.10^{A}$	$_{bc}6.02\pm0.06^{A}$	$_{ab}5.09\pm0.07^{C}$
	45 day	$_{c}5.31\pm0.07^{B}$	$_{cd}5.69\pm0.08^{A}$	$_{cd}5.89\pm0.05^{A}$	$_{b}4.97\pm0.05^{C}$
	60 day	$_{d}5.03\pm0.07^{B}$	$_{d}5.51\pm0.09^{A}$	$_{d}5.74\pm0.05^{A}$	$_{b}4.86\pm0.05^{C}$
Colour	0 day	$_{a}5.98\pm0.14^{B}$	$_{a}6.19\pm0.12^{AB}$	$_{a}6.37\pm0.04^{A}$	$_{a}5.54\pm0.11^{C}$
	15 day	$_{ab}5.75\pm0.11^{B}$	$_{ab}6.04\pm0.10^{A}$	$_{ab}6.25\pm0.03^{A}$	$_{ab}5.37\pm0.11^{C}$
	30 day	$_{bc}5.61\pm0.11^{B}$	$_{bc}6.04\pm0.10^{A}$	$_{bc}6.25\pm0.03^{A}$	$_{bc}5.37\pm0.11^{C}$
	45 day	$_{c}5.49\pm 0.12^{B}$	$_{cd}5.77\pm0.10^{A}$	$_{cd}5.97\pm0.03^{A}$	$_{cd}5.11\pm0.08^{C}$
	60 day	$_{d}5.11\pm0.12^{B}$	$_{d}5.63\pm0.10^{A}$	$_{d}5.80\pm0.03^{A}$	$_{d}4.86\pm0.05^{B}$
Flavour	0 day	$_{a}5.45\pm0.07^{C}$	$_{a}5.89\pm0.06^{B}$	$_{a}6.29\pm0.06^{A}$	$_{a}5.70\pm0.22^{B}$
	15 day	$_{ab}5.31\pm0.07^{C}$	$_{ab}5.74\pm0.06^{B}$	$_{ab}6.15\pm0.06^{A}$	$_{ab}5.57\pm0.21^{BC}$
	30 day	$_{abc}5.17\pm0.07^{C}$	$_{abc}5.61\pm0.06^{B}$	$_{abc}6.00\pm0.06^{A}$	$_{ab}5.43\pm0.21^{BC}$
	45 day	$_{bc}5.04\pm0.07^{C}$	$_{bc}5.49\pm0.07^{AB}$	$_{bc}5.87\pm0.06^{A}$	$_{b}5.27\pm0.19^{BC}$
	60 day	$_{c}4.87\pm0.07^{C}$	$_{c}5.34\pm0.07^{B}$	$_{c}5.73\pm0.06^{A}$	$_{c}4.87\pm0.11^{C}$
Crispiness	0 day	$_{a}5.93\pm0.11^{B}$	$_{a}6.37\pm0.04^{A}$	$_{a}6.52\pm0.05^{A}$	$_{a}5.91\pm0.09^{B}$
	15 day	$_{ab}5.76\pm0.12^{C}$	$_{b}6.11\pm0.06^{B}$	$_{ab}6.35\pm0.06^{A}$	$_{ab}5.74\pm0.08^{C}$
	30 day	$_{bc}5.61\pm0.12^{C}$	$_{bc}5.97\pm0.06^{B}$	$_{bc}6.21\pm0.06^{A}$	$_{bc}5.60\pm0.08^{C}$
	45 day	$_{cd}5.46\pm0.12^{C}$	$_{cd}5.84\pm0.06^{B}$	$_{cd}6.08\pm0.06^{A}$	$_{cd}5.47\pm0.09^{C}$
	60 day	$_{d}5.24\pm0.10^{C}$	$_{d}5.63\pm0.09^{B}$	$_{d}5.91\pm0.07^{A}$	$_{d}5.30\pm0.08^{C}$
Taste	0 day	$_{a}5.57\pm0.08^{C}$	$_{a}5.91\pm0.11^{B}$	$_{a}6.46\pm0.05^{A}$	$_{a}5.93\pm0.04^{B}$
	15 day	$_{ab}5.51\pm0.06^{C}$	$_{ab}5.80\pm0.09^{B}$	$_{ab}6.33\pm0.04^{A}$	$_{ab}5.79\pm0.05^{B}$
	30 day	$_{bc}5.37\pm0.06^{C}$	$_{bc}5.66\pm0.09^{B}$	$_{bc}6.19\pm0.04^{A}$	$_{bc}5.65\pm0.05^{B}$
	45 day	$_{c}5.24\pm0.07^{C}$	$_{c}5.53\pm0.10^{B}$	$_{c}6.07\pm0.03^{A}$	$_{c}5.52\pm0.06^{B}$
	60 day	$_{d}4.97\pm0.03^{C}$	$_{d}5.26\pm0.05^{B}$	$_{d}5.87\pm0.03^{A}$	$_{d}5.21\pm0.06^{B}$
Overall acceptability	0 day	$_{a}5.89\pm0.11^{C}$	$_{a}6.21\pm0.04^{B}$	$_{a}6.51\pm0.05^{A}$	$_{a}5.89\pm0.06^{C}$
	15 day	$_{b}5.70\pm0.07^{C}$	$_{b}5.95\pm0.01^{B}$	$_{ab}6.37\pm0.02^{A}$	$_{b}5.69\pm0.04^{C}$
	30 day	$_{b}5.56\pm0.07^{C}$	$_{b}5.82\pm0.02^{B}$	$_{b}6.23\pm0.02^{A}$	$_{c}5.54\pm0.05^{C}$
	45 day	$_{c}5.41\pm0.09^{C}$	$_{c}5.67\pm0.03^{B}$	$_{c}6.08\pm0.02^{A}$	$_{d}5.37\pm0.06^{C}$
	60 day	$_{d}5.01\pm0.05^{C}$	$_{d}5.37\pm0.06^{B}$	$_{d}5.89\pm0.03^{A}$	$_{e}5.04\pm0.05^{C}$

Mean with different superscripts in the same row indicate significant difference (P<0.05)
Mean with different subscripts in the same column indicate significant difference (P<0.05)
Number of observation: n=5

Table 6: Effect of ambient storage on the microbiology of aerobically packaged bhujia (Mean±S.E.)*

Parameters	Days	Treatment-A	Treatment-B	Treatment-C	Treatment-D
Total Plate Count (cfu/g)	0 day	ND	ND	ND	ND
	15 day				
	30 day				
	45 day				
	60 day				
Yeast & Mould (cfu/g)	0 day	ND	ND	ND	ND
	15 day				
	30 day				
	45 day				
	60 day				
E. coli (cfu/g)	0 day	ND	ND	ND	ND
	15 day				
	30 day				
	45 day				
	60 day				
Staphylococcus spp. (cfu/g)	0 day	ND	ND	ND	ND
	15 day				
	30 day				
	45 day				
	60 day				

ND: Not Detected

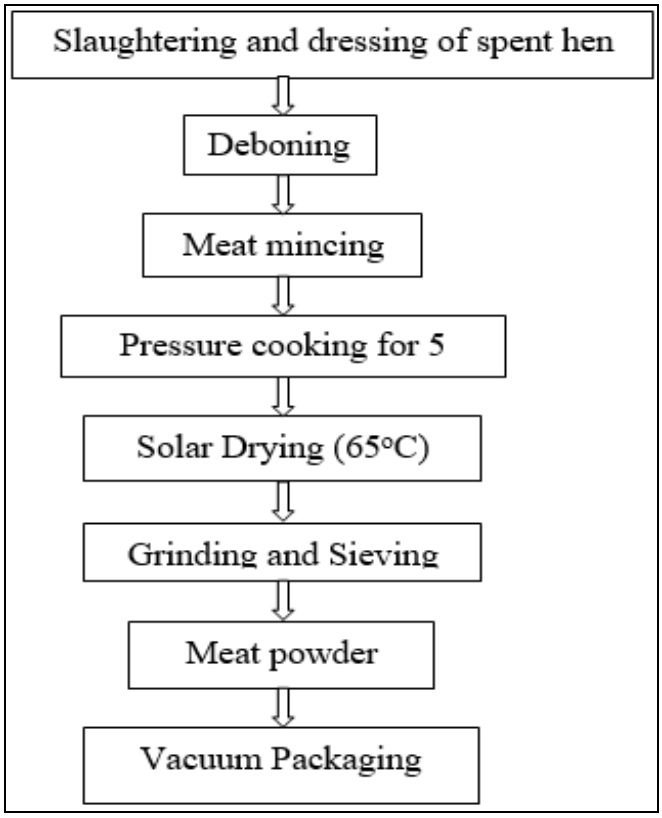

Fig 1: Flow chart for preparation of spent hen meat powder

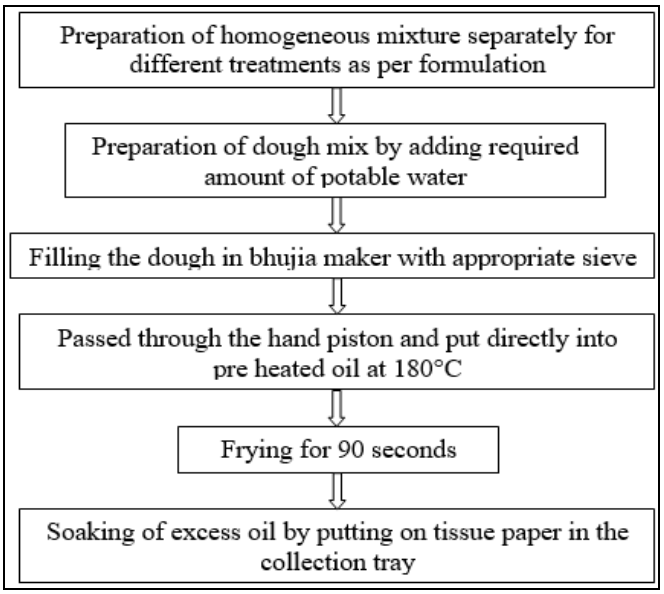

Fig 2: Flow chart for preparation of chicken bhujia

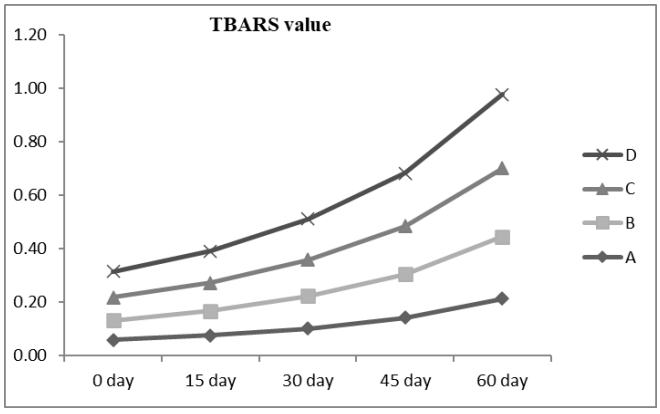

Fig 3: TBARS values of treatments during storage

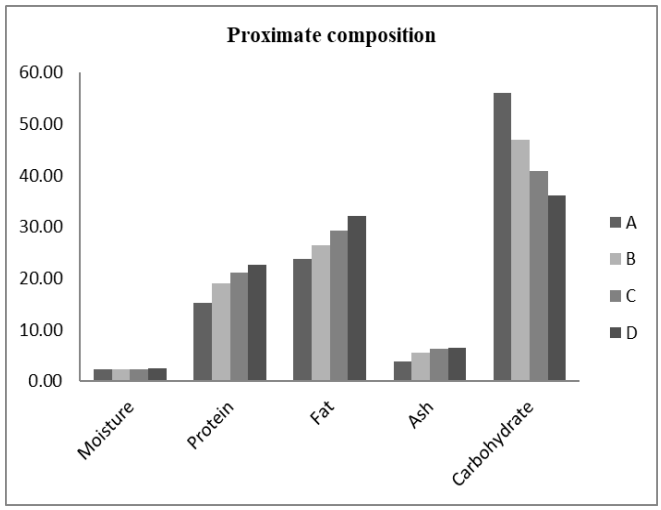

Fig 4: Proximate composition of treatments

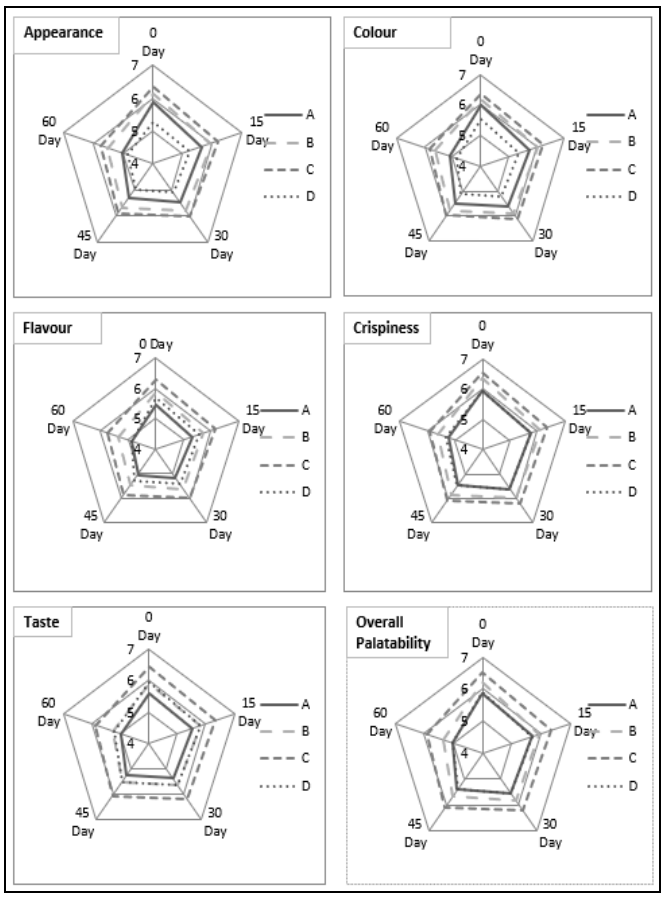

Fig 5: Radar chart depicting sensory parameters of treatments

Conclusion

Spent hen meat powder can be successfully incorporated in traditional bhujia up to 15% to improve its physicochemical, nutritional and sensory qualities. Bhujia can be suitably stored under aerobic packaging in LDPE pouches (150µm) at ambient conditions for 60 days without any deterioration in its quality and acceptability.

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