



Effect of Different Fillers on the Physico-chemical and Sensory Attributes of Chicken Meat Caruncles

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ABSTRACT

The present study was undertaken to evaluate the effects of three different fillers i.e. rice flour, tapioca starch and potato starch, on the physico-chemical and sensory attributes of chicken meat caruncles, so as to find the best filler for chicken snacks. Four different batches were prepared as follows - control (35% refined wheat flour), T-1 (22.75% refined wheat flour + 12.25% rice flour), T-2 (14.00% refined wheat flour + 21.00% tapioca starch) and T-3 (35.00% potato starch). All the variants were assayed for physico-chemical, proximate composition, texture profile, colour profile and sensory attributes. The cooking yield (%) was significantly higher ($P < 0.05$) in T-2 batch than control and other treated groups. There was continued and significant ($P < 0.05$) increase in Water Absorption Index (WAI) of all the samples from control to T-3. In texture profile, hardness was significantly higher ($P < 0.05$) in T-3 batch than control, T-1 and T-2. Adhesiveness, adhesive force and stringiness remained non-significant ($P > 0.05$) in control and treated batches. L^* value increased non-significantly in all the treated samples due to addition of fillers. Moisture (%) was significantly higher ($P < 0.05$) in T-1 followed by T-2, control and T-3. Among the sensory attributes, colour/appearance, crispiness, after-taste, meat flavour intensity and overall acceptability were significantly higher ($P < 0.05$) in T-2 (tapioca starch) batch than control, T-1 and T-3 batches. Hence 60% tapioca starch could be used in place of refined wheat flour along with 65% spent hen meat for the development of good quality chicken meat caruncles.

Keywords: Chicken meat caruncles, rice flour, tapioca starch, potato starch, physico-chemical analysis

In the food pyramid, meat based snack foods are convenient, easy to carry, highly crispy, attractive, nutritionally sound, shelf-stable and satisfying for one person, working women, school age children and during travelling or to satisfy short term hunger (Singh *et al.*, 2013). Being ready-to-eat food items, meat snacks have provided a suitable option for consumers in today's busy life style (Singh *et al.*, 2014c; Singh *et al.*, 2014d). The value of world snack food market was \$66 billion USD in 2003 with baked goods, cookies and crackers, meat snacks, and popcorn accounting for about 22% of these sales (Hodgen, 2004). However, Indian snack food market has reached a value of ₹. 1530 crore and is expected to grow at 9 to 12% during the tenth five-year plan (Singh *et al.*, 2014a). Usually cereal snacks lack essential amino acids such as threonine, lysine and tryptophan (Jean *et al.*,

1996), but incorporation of animal protein such as fish, pork, beef, chicken etc, greatly enhances its nutritive value especially with respect to amino acids, flavour and taste (Singh *et al.*, 2015).

Utilization of spent hen meat for the development of meat and meat products is also a major challenge for the food industry, as the meat obtained from these birds has poor functional properties such as objectionable toughness as compared to broilers and roasters (Baker *et al.*, 1969) due to its high collagen content (Nakamura *et al.*, 1975) and cross linkages (Wenham *et al.*, 1973). However, meat from spent hens is a good source of myofibrillar proteins (Lee *et al.*, 2003), omega-3 fatty acids and there is less cholesterol content especially in breast muscle (Ajuyah *et al.*, 1992) which is good for health. Spent hen meat can be subjected to tenderization before using in meat products.

Meat based snacks are prepared by using natural ingredients or components to yield products with specified functional properties (Reid, 1998). Various flours and starches are used as non-meat ingredients to improve water binding capacity, meat batter stability, cooking yield, texture and sensory characteristics such as colour, flavour, taste and crispiness (Hedrick *et al.*, 1994). In extruded snack foods, cereal grains and starches are well known for their expansion characteristics such as expansion, hardness and density (Ibanoglu *et al.*, 2006). In addition to their textural and viscosity benefits, starches also reduce costs of established food products (Sajilata and Singhal, 2005). In lieu of that, the present study was envisaged to find out the effects of three different fillers (rice flour, tapioca starch and potato starch) on the physico-chemical and sensory attributes and thus to find the best filler among them, for the development of chicken meat caruncles (CMC).

MATERIALS AND METHODS

Source of raw materials

For Rice Flour (RF), the excellent quality rice (Brand - Dawat, Rozana Basmati rice) were dried (65°C in a hot air oven for about 2-3 hours) and then grinded in an Inalsa mixer (Inalsa Maxie plus, New Delhi, India) to get fine powder. Tapioca Starch (TS) and Potato Starch (PS) were procured from Shubham Starch Chemical Pvt. Limited, Faridabad, Haryana. Spice mix was prepared by grinding dried (45±2°C for 2 hours) ingredients in different proportions such as coriander - 15%, cumin seeds - 15%, caraway seeds - 10%, aniseed - 10%, black pepper - 10%, red chilli powder - 8%, dry ginger powder - 8%, cinnamon - 5%, clove - 5%, cardamom large - 5%, mace - 5%, nutmeg - 2% and cardamom small - 2%, to a fine ground powder using Inalsa mixer and sieved through a fine mesh. Common salt (Tata chemicals Ltd. Mumbai), cane sugar, baking powder (Ajanta Baking powder, Solan, India), refined wheat flour (RWF) and refined oil (FORTUNE Soyabean oil) were procured from the local super market of Ludhiana, Punjab. Carboxymethyl cellulose was procured from Sd fine-CHEM Ltd., Mumbai, India.

Preparation of chicken meat caruncles

The white Leghorn layer spent hens were procured from the poultry farm of Guru Angad Dev Veterinary and Animal Sciences University (GADVASU), Ludhiana

and slaughtered in the experimental slaughter house following animal welfare and ethics protocols approved by GADVASU, Animal Ethical Committee. After manual deboning, the meat chunks were tenderized by dipping these in a solution containing 0.25% papain (w/w) and 0.15 M calcium chloride (w/v) for about 36-40 hours at 4±1°C (Biswas *et al.*, 2009). Thereafter the meat chunks were washed thoroughly 2-3 times with running water and then packed in low density polyethylene bags and kept at -18±1°C for subsequent use. Frozen tenderized meat chunks were then partially thawed in a refrigerator (4±1°C), and then double minced using 6 mm and 4 mm grinder plates to get fine minced chicken meat.

Three different experiments were conducted for the selection of best level of each of RF, TS and PS by replacing RWF and on the basis of physico-chemical and sensory attributes, it was found that RF - 35% (Singh *et al.*, 2014b), TS - 60% (Singh *et al.*, 2014a) and PS - 100% were most suitable for development of chicken meat caruncles. The emulsion was prepared by blending tenderized minced chicken meat (65%) with common salt (1%) and mixed in Inalsa mixer for 1 minute, followed by mixing of sugar (1%), baking powder (0.5%), carboxymethyl cellulose (0.7%) and spice mix (2%), up to 30 seconds in the mixer. The entire emulsion was then divided into four different batches in which RWF, RF, TS and PS were added as follows - control (35% RWF), T-1 (22.75% RWF+12.25% RF), T-2 (14.00% RWF+21.00% TS) and T-3 (35.00% PS) and again mixed for 1-2 minutes. At last the soyabean oil (5%) was added slowly by the side of the mixer in all the samples and mixing was done for another 1 minute. Thereafter, with the help of a manually operated stainless steel extruder, the prepared chicken meat emulsion was extruded in the form of thin long chip like caruncles (7-8cm × 1 cm) in a microwave plate. Cooking was done in a microwave oven (2450 MHz, 230-250 volts, Inalsa microwave ovens, New Delhi, India) for 4 minutes to get the cooked CMC. The cooked CMC were kept in Pearl Polyethylene Terephthalate (PET) jars and thereafter analyzed for different physico-chemical and sensory attributes.

Physico-chemical analysis

Cooking yield (%) was calculated by dividing the recorded weights of raw and cooked CMC before and after cooking respectively, multiplied by 100.

Water activity (a_w) was determined using hand held potable digital water activity meter (Rotonix HYGRO Palm AW1 Set/40, 60146499).

For hydratability (Mittal and Lawrie, 1986), 2.5 gram sample of CMC was placed in a test tube with excess of boiling water and the tubes were immersed in a boiling water bath for 5 minutes to hydrate the sample. The hydrated sample was drained with an intermittent blotting and then weighed. Hydratability of CMC was calculated as weight of water absorbed by the CMC (gm) / weight of dry sample of CMC.

For water absorption index (WAI) (Anderson *et al.*, 1969), 2.5 gram sample of CMC was added with 30 ml of distilled water in a test tube and the sample was left to equilibrate for 30 minutes with occasional stirring. After centrifugation at 5000 rpm for 10 minutes, the supernatant was collected in a petridish and the remaining gel was weighed. The water absorption index was calculated as the ratio of weight of gel obtained to that of initial weight of the sample (g/g).

For water solubility index (WSI) (Machado *et al.*, 1998), the supernatant liquid obtained from WAI determination was collected and kept in a hot air oven to evaporate to dryness. After drying, the petridishes were cooled and weighed. The water solubility index was calculated as weight of solids to the initial weight of the sample (g/g).

Texture profile analysis

Texture profile analysis (Bourne, 1978) was conducted using Texture Analyzer (TMS-PRO, Food Technology Corporation, USA). Each CMC was subjected to pretest speed (30mm/sec), post test speed (100mm/sec) and test speed (100mm/sec) to a single Warner-Bratzler shear blade with a load cell of 2500 N. Parameters such as hardness (Newton; N), adhesiveness (milli Joules; mJ), adhesive force (Newton; N) and stringiness (millimeter; mm) were calculated automatically by the preloaded Texture Pro software in the equipment from the force-time plot.

Colour profile analysis

Colour profile was measured on a set of three cooked CMC (placed in a plate) using Lovibond Tintometer (Lovibond RT-300, Reflectance Tintometer, United Kingdom) set at 2° of cool white light (D_{65}) and known as L^* , a^* , and

b^* values. However, hue and chroma were calculated as follows (Little, 1975).

$$\text{Hue} = (\tan^{-1}) b/a; \text{Chroma} = [a^2 + b^2]^{0.5}$$

Proximate composition

Proximate composition such as moisture (Automatic Moisture Analyzer; Essae, AND MX-50), fat (Socs Plus; SCS-6-AS, Pelican Industries, Chennai, India), protein (Automatic Digestion and Distillation unit; Kel Plus-KES 12L, Pelican Industries, Chennai), crude fiber (Fibra Plus Automatic unit; FES-6, F-09014, Pelican Industries, Chennai) and ash (muffle furnace) of CMC were determined using AOAC (1995) methods. Carbohydrate (%) was calculated by subtracting % moisture, fat, protein, fiber and ash from 100. Moisture: Protein ratio was calculated by dividing % moisture with % protein.

Sensory analysis

Sensory analysis of CMC was conducted by seven (n=21) experienced panelists from the staff at the Department of Livestock Products Technology, GADVASU using an eight point hedonic scale (Keeton, 1983), where 8 was extremely desirable and 1 was extremely undesirable.

Statistical analysis

Experiment was carried out thrice in duplicates (n=6) and data were analyzed on SPSS-16.0 software package (SPSS Inc. Chicago, IL, USA) as per standard procedures (Snedecor and Cochran, 1994) for analysis of variance using Duncan's Multiple Range Tests and Homogeneity tests to test the significance of difference between means at 5% level ($P < 0.05$) of significance.

RESULTS AND DISCUSSION

Effect of different fillers on the physico-chemical parameters of chicken meat caruncles

The mean values of various physico-chemical parameters of CMC containing RF, TS and PS are presented in the Table 1. Among the treated batches, cooking yield (%) was significantly higher ($P < 0.05$) in T-2 batch followed by T-3 and then T-1 batch. The increase in cooking yield might have been resulted from increase in the water binding

capacity due to addition of flours and starches in the treated samples (Hedrick *et al.*, 1994). Among the treated batches, water activity was significantly higher ($P < 0.05$) in T-1 followed by T-2 and T-3. There was no significant difference of hydratability and WSI of control and treated samples. Kale (2009), also reported no significant differences for hydratability and WSI of chicken snack sticks incorporated with different fillers. There was continued and significant ($P < 0.05$) increase in WAI of all the samples from control to T-3. WAI of treated samples ranged from 4.17-5.10. The increase in WAI of treated samples may be due to increased gelatinization of tapioca and potato starch as documented by Davidson *et al.* (1984) and Cheftel (1986). Similar results were reported by Iwe and Ngoddy (1998) in extrusion cooked products.

Table 1. Effect of different fillers on the physico-chemical parameters of chicken meat caruncles

Parameters	C	T ¹	T ²	T ³
Cooking yield (%)	52.33±0.03 ^a	52.49±0.33 ^a	56.07±0.27 ^c	54.02±0.09 ^b
Water activity (a_w)	0.35±0.02 ^{bc}	0.37±0.01 ^c	0.34±0.00 ^b	0.29±0.00 ^a
Hydratability	1.30±0.10	1.25±0.13	1.30±0.05	1.11±0.07
WAI	3.79±0.08 ^a	4.17±0.06 ^b	5.03±0.18 ^c	5.10±0.12 ^c
WSI	0.04±0.01 ^a	0.08±0.02 ^b	0.06±0.00 ^{ab}	0.04±0.00 ^a

Mean ± S.E with different superscripts in a row differ significantly ($P < 0.05$). C = Control (35% RWF), T-1 = 22.75% RWF+12.25% RF, T-2 = 14.00% RWF+21.00% TS, T-3 = 35% PS

Effect of different fillers on the texture and colour profile of chicken meat caruncles

The data related to texture profile analysis are presented in Table 2. In texture profile, hardness was significantly higher ($P < 0.05$) in T-3 batch than control, T-1 and T-2. This indicates that total replacement of RWF with potato starch produced much more hardness in the product than rice flour and tapioca starch. Similar findings were reported by Garcia-Garcia and Totosaus (2008), Hachmeister and Herald (1998), Bushway *et al.* (1982) etc. Adhesiveness, adhesive force and stringiness remained non-significant ($P > 0.05$) in control and treated batches. However,

literature does not address the effect of rice flour, tapioca starch and potato starch on adhesiveness, adhesive force and stringiness of meat snacks. Sajilata and Singhal (2005) also documented that incorporation of modified starches into snacks can have a high degree of mouth melt, less waxiness, improved texture and increased crispiness. In color profile, all the parameters were non-significant ($P > 0.05$) between control and treated batches. The non-significant ($P > 0.05$) increase in L^* value in all the treated batches was due to addition of flours and starches. Similar results were reported by Lee *et al.* (2003) in spent hen meat snacks incorporated with rice flour and potato starch. However, the values for hue angle and chroma correspond to the values of a^* and b^* (Figure 1).

Table 2. Effect of different fillers on the texture profile of chicken meat caruncles

Parameters	C	T ¹	T ²	T ³
Hardness (N)	59.43±3.91 ^a	72.37±3.97 ^{ab}	78.70±5.41 ^b	101.28±5.13 ^c
Adhesiveness (mJ)	35.54±7.37	53.40±2.32	35.39±3.88	48.97±8.65
Adhesive force (-ve N)	14.82±1.33	12.70±2.41	18.95±2.43	15.43±2.34
Stringiness (mm)	0.70±0.32	2.01±0.83	0.83±0.38	1.22±0.35

Mean ± S.E with different superscripts in a row differ significantly ($P < 0.05$). C = Control (35% RWF), T-1 = 22.75% RWF+12.25% RF, T-2 = 14.00% RWF+21.00% TS, T-3 = 35% PS

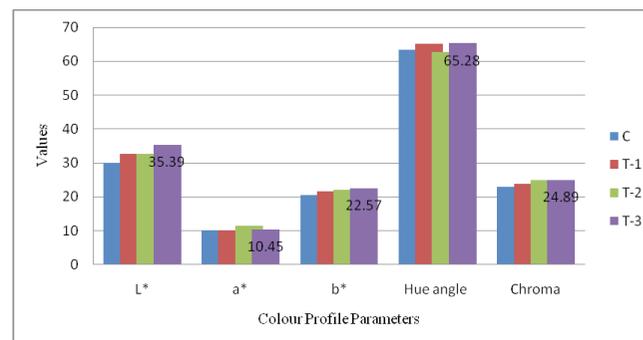


Figure 1. Effect of different fillers on colour profile parameters of chicken meat caruncles (C = Control (35% RWF), T-1 = 22.75% RWF+12.25% RF, T-2 = 14.00% RWF+21.00% TS, T-3 = 35% PS)

Table 3. Effect of different fillers on the proximate composition of chicken meat caruncles

Parameters	C	T ¹	T ²	T ³
Moisture (%)	4.75±0.15 ^b	6.21±0.18 ^d	5.48±0.12 ^c	4.29±0.01 ^a
Protein (%)	24.58±0.49 ^a	23.52±0.10 ^a	24.12±0.11 ^a	26.97±0.83 ^b
Fat (%)	9.66±0.11	9.75±0.07	9.88±0.09	8.73±1.48
Crude Fiber (%)	1.45±0.09 ^a	1.24±0.06 ^a	2.77±0.22 ^b	1.31±0.10 ^a
Ash (%)	4.47±0.15 ^c	4.00±0.05 ^{ab}	4.20±0.07 ^{bc}	3.68±0.24 ^a
Carbohydrates (%)	55.10±0.68	55.29±0.21	53.55±0.46	55.01±2.04
Moisture: Protein ratio	0.193±0.0037 ^b	0.264±0.0085 ^d	0.227±0.0049 ^c	0.160±0.0052 ^a
Energy (Kcal/100g)	406.12±1.37	403.44±0.59	400.09±1.29	407.08±7.07

Mean ± S.E with different superscripts in a row differ significantly (P<0.05). C = Control (35% RWF), T-1 = 22.75% RWF+12.25% RF, T-2 = 14.00% RWF+21.00% TS, T-3 = 35% PS

Table 4. Effect of different fillers on the sensory attributes of chicken meat caruncles

Parameters	C	T-1	T-2	T-3
Colour/Appearance	6.40±0.08 ^a	6.45±0.07 ^a	6.88±0.07 ^b	6.33±0.05 ^a
Flavour	6.21±0.07 ^a	6.67±0.07 ^b	6.81±0.07 ^b	6.33±0.05 ^a
Crispiness	6.31±0.05 ^a	6.52±0.07 ^b	6.93±0.07 ^c	6.27±0.06 ^a
After-taste	6.21±0.06 ^a	6.40±0.10 ^{ab}	6.86±0.06 ^c	6.60±0.07 ^b
Meat flavour intensity	6.21±0.07 ^a	6.48±0.07 ^b	6.93±0.08 ^c	6.33±0.06 ^{ab}
Overall acceptability	6.33±0.07 ^a	6.83±0.05 ^c	7.31±0.05 ^d	6.62±0.05 ^b

Mean ± S.E with different superscripts in a row differ significantly (P<0.05). C = Control (35% RWF), T-1 = 22.75% RWF+12.25% RF, T-2 = 14.00% RWF+21.00% TS, T-3 = 35% PS

Effect of different fillers on the proximate composition of chicken meat caruncles

Perusal of Table 3 revealed that in proximate composition, moisture (%) was significantly higher (P<0.05) in T-1 followed by T-2, control and T-3. This indicates that rice flour produced much more water retention in the product than the tapioca and potato starch batches. Jean *et al.* (1996) reported that moisture level in the extrudates should be less than 5% for making the product brittle. However, in the present experiment it was slightly more than 5%. Protein (%) was significantly higher (P<0.05) in T-3 than control, T-1 and T-2. Fat (%), carbohydrates (%) and energy values were non-significant (P>0.05) between control and treated batches. Crude fiber (%) was significantly higher (P<0.05) in T-2 than control and other treated groups. Moisture: Protein ratio was significantly

higher (P<0.05) in T-1 followed by T-2, control and T-3. This corresponds to the respective values of moisture and protein content of the samples.

Effect of different fillers on the sensory attributes of chicken meat caruncles

Data pertaining to various sensory attributes of CMC incorporated with RF, TS and PS are presented in Table 4. Among the sensory attributes, colour/appearance, crispiness, after-taste, meat flavour intensity and overall acceptability were significantly higher (P<0.05) in T-2 (tapioca starch) batch than control, T-1 and T-3 batches. However, the flavour scores of T-2 were non-significantly higher (P>0.05) than T-1, but significantly higher (P<0.05) than control and T-3. Since the sensory scores of T-2 were highest among all the treated batches, so tapioca starch

was considered best filler for development of chicken meat caruncles.

CONCLUSION

From this study, it can be concluded that 60% tapioca starch improved some physico-chemical (cooking yield, moisture, hardness) and sensory attributes (colour/appearance, flavour, crispiness, after-taste, meat flavour intensity and overall acceptability) of chicken meat caruncles. Also it revealed that 65% spent hen meat can be utilized after tenderization, for the development of good quality chicken meat caruncles. Overall tapioca starch was considered as best filler for chicken meat caruncles.

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