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Effect of Different Cooking Methods on the Physicochemical and Sensory Quality Characteristics of Chicken Meat *Samosas*

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ABSTRACT

The present study was undertaken to evaluate the effects of different cooking methods on the physicochemical and sensory quality attributes of spent-hen meat *samosas*. *Samosas* were prepared using spent-hen meat filling and cooked by conventional deep-fat frying (DF), oven-baking (OB), and air-frying (AF). The cooked products were evaluated for physicochemical characteristics, including water activity, pH, instrumental colour, moisture content, and cooking yield, as well as sensory attributes. The pH of both the *samosa* sheet and filling differed significantly ($p<0.05$) among the cooking methods, with AF samples exhibiting the lowest values and DF samples the highest. The cooking yield was significantly ($p<0.05$) higher in DF *samosas* than in AF and OB *samosas*. Oven-baked *samosas* exhibited the highest lightness (L^*) values, followed by AF and DF samples. The redness (a^*) and yellowness (b^*) values were significantly ($p<0.05$) lower in DF *samosas* than in AF and OB *samosas*. Sensory evaluation revealed that DF *samosas* received the highest scores for flavour, juiciness, and overall acceptability; however, these scores were statistically comparable to those of AF *samosas*. The findings indicate that air frying can produce spent-hen meat *samosas* with physicochemical and sensory qualities comparable to those of conventionally deep-fat-fried products while offering a healthier cooking alternative.

HIGHLIGHTS

- Cooking method significantly influenced the quality of spent-hen meat *samosas*.
- Deep-fat frying resulted in the highest cooking yield and sensory acceptability.
- Air-fried *samosas* exhibited sensory quality comparable to deep-fat-fried products.
- Air frying offers a healthier alternative without compromising product quality.

Keywords: Air frying, meat *samosa*, oven baking, quality attributes

The poultry sector in India is rapidly growing, with a growth rate of 3.10%, and poultry meat accounts for 5.18 million tonnes (49.33%) of India's total meat production of 10.50 million tonnes (BAHS, 2025). The rapid growth in the poultry sector is attributed to the increasing consumer preference and demand due to the absence of any religious taboos, high quality animal protein, better biosecurity due to 'all-in and all-out' concept, quick returns, higher sensory properties and bland taste so to preferred for preparing various value added meat products, ease of preparation due to small size, rapid urbanization and industrialization (Kumar *et al*., 2012a). Simultaneously, the growth of the commercial egg-laying industry has resulted in the generation of large numbers of spent laying hens. However, meat from spent hens is generally less preferred by consumers because of its greater toughness, lower water-holding capacity, and poor binding properties. Consequently, the poultry processing industry is exploring various processing interventions to enhance the quality,

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palatability, and consumer acceptance of products prepared from spent hen meat. The conversion of spent hen meat into value-added products offers an effective strategy for its profitable utilization and value enhancement (Kumar *et al*., 2012b; Bhat *et al*., 2013).

The development of ready-to-eat/ready-to-cook meat products is gaining widespread popularity due to ease of preparation, convenience, ability to satisfy short-term hunger and provide nutrients, and availability across a range of product categories and tastes (Verma *et al*., 2016; Kumar *et al*., 2019). This snack food segment further underwent rapid changes amid industrialisation, urbanisation, busy lifestyles, and the nuclear family. Among snack products, the *samosa* is very popular throughout India and other parts of the world. It is made of a thin pastry outer sheet enclosing a savoury filling of boiled potato, green chillies, seasoning, peas, textured soy protein chunks, etc. Traditionally, these products are deep-fat-fried and have high fat and carbohydrate content. The incorporation of minced meat into the *samosa* filling could improve the nutritive value, palatability, protein content, taste, and utilisation of meat from spent and culled animals (Kantale *et al*., 2019).

Cooking is a crucial step that directly affects a product's quality, nutritional value, safety, and consumer acceptance. Different cooking methods vary in energy consumption and in the development of colour, flavour, texture, and stability of meat products (Alfaifi*et al*., 2023). For *samosas*, deep-fat frying is the most widely practised method (Kantale *et al*., 2019). This method leads to the development of desirable crispy texture, flavour, and colour development but increases the calorific value and fat content of cooked *samosa* (Nayak *et al*., 2025). Thus, deep-fried *samosas* are not preferred by health-conscious consumers, and there is growing demand for snack meat products prepared using novel alternative cooking technologies such as oven baking and air frying. These technologies resulted in an end product with lower fat uptake and content and acceptable sensory attributes. In air frying, cooking is achieved by circulating hot air to produce a crispy, fried-like texture in snack products (Nawaz *et al*., 2021).

There is a lack of studies on the effect of various cooking methods on the quality attributes of meat *samosa*. An in-depth understanding of the impact of different cooking techniques is needed to optimize the quality of meat *samosas* and to recommend healthier alternatives to conventional deep-fat frying without compromising sensory attributes. In this context, the present study was undertaken to compare the effects of deep-fat frying, oven baking, and air frying on the physicochemical properties, cooking yield, instrumental colour, and sensory attributes of chicken meat *samosas* prepared from spent hen meat. The findings of this study are expected to contribute valuable insights toward the development of healthier poultry-based snack products with enhanced nutritional quality, consumer acceptability, and commercial potential.

MATERIALS AND METHODS

Raw materials

Spent hens over 72 weeks of age were procured from the Directorate, Livestock Farm, Guru Angad Dev Veterinary and Animal Services University, Ludhiana, and slaughtered in the Experimental Slaughterhouse of the Department of Livestock Products Technology as per standard procedure. The carcasses were manually dressed, with visible fat and fascia removed, and then conditioned at refrigeration temperature overnight. The carcasses were manually deboned, and deboned meat was stored at -20°C in polyethylene bags till use. Before the experiment, the meat was thawed overnight in the refrigerator and used to prepare the *samosa* filler.

The other ingredients used in preparing meat *samosas*, such as refined wheat flour, salt, spices, refined vegetable oil, hydrogenated vegetable fat (*dalda*), peas, onion, garlic, red chilies, and green coriander, were purchased from the local market. All chemicals and reagents used in the estimation of quality characteristics were of analytical grade.

Preparation of meat *samosa*

For the preparation of the spent hen meat *samosa*, the *samosa* sheets were prepared by sheeting the *samosa* dough. Samosa dough was prepared by kneading a mixture containing refined wheat flour (93%), *ajwain*/carom seeds (1.0%), lukewarm water (3%), and hydrogenated vegetable oil (3%). The dough was left wrapped in a wet muslin cloth for 15 min to keep it moist. *Samosa* dough was rolled out into a uniform-thickness sheet and cut into semicircular shapes weighing approximately 15 g each.

For preparation of *samosa* filler, the thawed spent hen meat was minced through 8 mm plates in a meat mincer (Mado Eskimo Mew-714, Mado, Germany). The potato (30%) and peas (10%) were boiled, smashed, and mixed with minced meat (54%) along with red chilies (1.5%), green coriander (1.5%), salt (1.5%), and spices (1.5%). The mixture was fried in a preheated frying pan in soybean oil with continuous stirring until golden brown. The developed *samosa* filler was tempered at room temperature, and about 80 g of the mixture was wrapped in a *samosa* sheet weighing then manually molded into a triangular shape.

During cooking, the internal temperature of the *samosas* reached 75°C. The raw *samosas* were cooked using the following three methods—

- DF: Deep-fat frying (185°C for 5 min) in preheated refined soybean oil (T1).
- OB: Oven baking after lightly brushing raw *samosa* with refined soybean oil and heating in a preheated oven at 180°C for 20 min with regular turning after 10 min.
- AF: Air frying of *samosa* lightly sprayed with refined soybean oil in a preheated air fryer at 180°C for 15 min with regular turning after 10 min.

Physicochemical analysis

The cooking yield of the developed *samosa* was measured by noting the weight difference between raw and cooked *samosa* as follows—

Cooking yield = (weight of cooked *samosa*/ weight of raw samosa) × 100

Cooking loss = 100- cooking yield

The moisture content (%) of the developed *samosas* (raw and cooked, sheet and filler) was estimated using an automatic moisture analyzer (AMD MX-50, Essae®, Japan). Samples weighing 2 g each were analyzed in triplicate and heated at 105 °C for 4 minutes until a constant reading was achieved.

The pH of the raw *samosa* sheet, filler, and cooked *samosa* sheet and filler were measured by using a digital pH meter. A homogenate was prepared by blending 10 g of the sample with 50 mL of distilled water in a mortar and pestle, and the pH was recorded after calibrating the instrument at pH 4.0, 7.0, and 9.0 using standard pH solutions.

The water activity of developed *samosas* was measured by a digital water activity meter (Novasina AG, Neuheimstrasse 12 CH-8853 Lachen, Switzerland). Prior to analysis, the instrument was calibrated according to the manufacturer's instructions using standard calibration salts. Approximately 3g of the homogenized samples were placed in a clean, dry disposable sample cup. The sample cup was then inserted into the measuring chamber, and the chamber was sealed to allow equilibrium between the sample and the sensor.

Instrumental colour profile

Instrumental colour profile of the developed meat samosa (raw and cooked) was measured using a Chroma Meter (CR-400, Konica Minolta, Japan) set to 2° of cool white light (D65). The values were presented as L^* (brightness 100, lightness 0), a^* (+ redness/-greenness), and b* (+ yellowness/-blueness) values. The instrument was calibrated by using the calibration kit provided with the instrument. Hue and Chroma were calculated as by following formulas—

$$Hue = \tan{-1} \, (b^*/a^*)$$

$$Chroma = (a^*2 + b^*2\,)^{1/2}$$

Sensory evaluation

Sensory evaluation of the developed spent hen meat *samosa* was conducted by an experienced panel of 7 members, including postgraduate students and faculty from the department. The participants gave their willingness to participate in the sensory evaluation of the developed *samosas*. The samples were evaluated for major sensory attributes, namely appearance, flavour, juiciness, crispiness and overall acceptability. A eight-point descriptive scale was employed for assessment, with scores ranging from 8 (extremely desirable) to 1 (extremely undesirable) (ISO 3972:2011, SS-EN ISO 8586:2014). To ensure an unbiased assessment, the samples were served on identical white melamine plates and assigned random three-digit codes for blind evaluation. Potable water was provided to the panellists for rinsing their mouths between successive samples, thereby eliminating residual flavours and ensuring accurate and independent evaluation of each product.

Statistical analysis

The experimental data were analysed using the One-Way Analysis of Variance (ANOVA) using IBM SPSS Statistics Version 27.0 (IBM Corp., Armonk, NY, USA), except for the analysis of raw samosa characteristics, which were analysed by using an independent t-test. Results are expressed as mean ± standard error (SE). When significant differences were detected ($p < 0.05$), mean comparisons were performed using Duncan's Multiple Range Test (DMRT) as a post hoc procedure. All statistical analyses were conducted at the significant (95% confidence level) and highly significant (99% confidence level) levels, and each treatment combination was evaluated using six observations ($n = 6$), obtained from duplicate analyses of samples from three independent experimental replicates.

RESULTS AND DISCUSSION

Physicochemical properties

The physiological properties of the raw and cooked *samosa* sheet and the *samosa* filler, using hot-air oven baking, air frying, and deep-fat frying methods, were analysed.

Raw *samosa* sheet and filler

Various physicochemical parameters of raw *samosa* (*samosa* sheet and *samosa* filler) are presented in Table 1. The pH values of both the *samosa* sheet and the *samosa* filler were comparable and remained within the slightly acidic to near-neutral range. However, the *samosa* filler exhibited a comparable lower pH (p>0.05) than the *samosa* sheet, which could be due to the inclusion of ingredients such as boiled potato, cooked chicken, red chilli powder, and other spices that contribute weak organic acids and buffering compounds. The moisture content of the *samosa* filler was significantly (p<0.05) higher than that of the *samosa* sheet. This difference is expected because the filler contained cooked chicken meat and boiled potato, both of which have high inherent moisture, whereas the *samosa* sheet was prepared primarily from refined wheat flour and formed dough with comparatively lower water incorporation. The higher moisture content of the filler is advantageous for improving the juiciness and palatability of the final products.The water activity (a_w) values of the *samosa* sheet and *samosa* filler were comparable (p>0.05) and were within the range generally associated with intermediate-moisture foods. At these water activity levels, the growth of many spoilage microorganisms is inhibited, except for some osmophilic yeasts, moulds, and xerophilic microorganisms. Consequently, deterioration of the product during storage is more likely to occur through oxidative reactions, particularly lipid oxidation in the meat-containing filler, rather than through rapid microbial spoilage.

Table 1: Physicochemical parameters of raw *samosa* sheet and *samosa* filler

Parameters	*Samosa* sheet	*Samosa* filler
pH	7.2±0.08	6.68±0.09
Moisture (%)	22.11±1.05^{a}	41.25±1.16^{b}
Water activity	0.71±0.02	0.78±0.06
L*	47.52±3.06^{b}	16.62±2.06^{a}
a*	-0.15±0.12^{a}	4.21±0.25^{b}
b*	13.62±1.02^{b}	9.72±1.11^{a}
Hue	89.93±15.23^{b}	66.66±11.32^{a}
Chroma	13.36±0.76^{b}	10.57±0.56^{a}

*Means with different superscripts in a row- small letters (a, b, c, d....) differ significantly (p<0.05); n=6.

The *samosa* filler appeared darker, with a significantly lower lightness score (p<0.05), mainly due to the colour of spices, seasonings, and cooked spent hen meat. This lower lightness (L*) could be attributed to the incorporation of cooked chicken meat, red chilli powder, spices, and seasonings, which impart a darker, more intense colour to the filling. Furthermore, thermal processing of the chicken meat also contributed to pigment denaturation and non-enzymatic browning, further reducing the lightness of the filler. The a* value of the *samosa* sheet was recorded as a negative value (towards the greener side).The natural colour characteristics of refined wheat flour and the absence of red-coloured ingredients in the sheet could be the reason for this colour trend. In contrast, the *samosa* filler exhibited higher a^* values due to the presence of spices such as red chilli powder and cooked meat pigments, which contributed to greater redness. The *samosa* filler had a significantly lower b^* value as compared to the *samosa* sheet.

Cooked the *samosa* sheet and filler

The cooking methods significantly ($p<0.05$) affected the physicochemical properties of the cooked *samosa* sheet and filler (Table 2). The pH of both components varied significantly among the cooking treatments, with air-fried (AF) samples exhibiting the lowest values and deep fat-fried (DF) samples the highest. These variations may be attributed to differences in heat transfer, moisture loss, and physicochemical changes occurring during cooking. The different cooking methods did not affect the water activity of the *samosa* sheet and filler. The highest water activity was recorded for the DF sheet; for AF samples, the highest was for the *samosa* sheet; and for filler, the highest value was recorded for OB. As in the present study, the pH of the *samosa* mix was lower than that of the *samosa*dough. Samosa dough mainly contained refined wheat flour, having a pH of 6.25, and upon storing/maturing the dough by wrapping it in moist muslin cloth, a decreasing trend was noticed (Kantale *et al*., 2019).

The DF sheet had the highest moisture content, while the AF and oven-baking (OB) sheets had the lowest. The moisture content of the *samosa* filler did not vary with the cooking methods. The higher moisture content in the FF sheet could be due to the rapid formation of a surface crust during deep-fat frying, which limits moisture evaporation from the interior while allowing oil uptake. Furthermore, the hot-air cooking method in OB and AF cooking facilitated greater moisture loss, resulting in lower moisture content. The moisture content of the *samosa* filler did not differ significantly ($p>0.05$) among the cooking methods, indicating that the filling matrix retained moisture better. Thus, the *samosa* sheet is more susceptible to moisture changes during cooking than the enclosed filling because it is directly exposed to the heating medium.

During the frying of *samosas*, heat is transferred from the oil to the *samosa* sheet by convection, and from the sheet to the *samosa* mix by conduction. This heating removed moisture from the *samosa* and subsequently increased its temperature, leading to crust formation (Mellema, 2003; Oke *et al*., 2018).

Table 2: Physicochemical parameters of cooked *samosa* sheet and *samosa* filler

Parameters	*Samosa* sheet	*Samosa* filler
	pH	
AF	6.6±0.08[a]	6.4±0.07a
OB	7.2±0.10[ab]	7.0±0.09b
DF	7.6±0.21[b]	7.1±0.11b
	Water activity	
AF	0.68±0.07	0.61±0.09
OB	0.61±0.06	0.68±0.04
DF	0.59±0.06	0.61±0.07
	Moisture (%)	
AF	8.81±1.07[b]	42.33±3.45
OB	7.95±1.31[a]	43.12±2.78
DF	12.52±1.27[c]	44.56±3.64

*Means with different superscripts in a column- small letters (a, b, c, d....) differ significantly (p<0.05); AF-air fried *samosa*, OB- Oven baking *samosa*, DF-deep fat fried *samosa*, *n*=6.

Cooking yield and colour profile

The cooking method had a significant effect on the *samosa* yield (Table 3). The cooking yield of DF *samosa* was significantly higher (p<0.05) than that of AF and OB samples. This could be attributed to the higher oil uptake by these *samosas* during deep-fat frying, whereas in the remaining two methods, the cooking yield decreased due to moisture evaporation.

The colour profile of cooked *samosas* was significantly influenced by the cooking method ($p < 0.05$). The highest lightness (L^*) value was observed in oven-baked (OB) *samosa*, followed by air-fried (AF) and deep fat-fried (DF) samples (OB> AF > FF) (Table 3). Similarly, the redness (a^*) and yellowness (b^*) values were also significantly ($p<0.05$) lower in DF *samosa* than in AF and OB samples. The darker appearance of the fat-fried *samosa* could be due to the greater extent of the Maillard reaction and caramelization occurring at the higher surface temperatures achieved during deep-fat frying. Furthermore, oil absorption during frying could also enhance heat transfer, accelerating non-enzymatic browning reactions and increasing melanoidins formation, imparting a darker brown colour to the *samosa* sheet. The colour development during frying process is governed by several reactions occurring during frying such as starch gelatinizing, protein denaturation, Maillard reaction, dough browning and breading (Rani *et al.*, 2023). The colour profile of the product during air frying depends on temperature and time, with prolonged exposure to higher temperatures also decreasing the colour score (Téllez-Morales *et al*., 2024). Joshi *et al*. (2020) also reported improved appearance of air-fried fish snack as compared to deep-fat-fried fish snack.

Table 3: Cooking yield and colour profile of cooked *samosa*

Parameters	AF	OB	DF
Cooking yield (%)	86.12±3.57[a]	84.14±2.46[a]	103.65±4.38[b]
*L**	31.74±1.25[b]	42.32±2.64[c]	26.08±1.78[a]
*a**	6.71±1.02[c]	4.65±0.81[b]	3.45±0.97[a]
*b**	15.84±1.11[b]	17.15±1.07[b]	11.61±1.12[a]
Hue	73.12±6.28[ab]	75.41±5.36[b]	66.62±8.11[a]
Chroma	16.97±1.52[b]	18.46±1.87[b]	12.13±1.35[a]

*Means with different superscripts in a column- small letters (a, b, c, d....) differ significantly ($p<0.05$); AF-air fried *samosa*, OB- Oven baking *samosa*, DF-deep fat fried *samosa*, $n=6$.

Sensory attributes

The cooking methods had a significant ($p<0.05$) effect on the sensory parameters of the spent hen meat *samosa*. The air-fried (AF) *samosas* received the highest appearance scores, followed by oven-baked (OB) and fat-fried (DF) *samosas*. The improved appearance of AF *samosas* might be due to their uniform golden-brown colour and absence/ minimum surface oiliness. FF *samosas* recorded the highest flavour scores; however, these scores were statistically comparable ($p>0.05$) to those of AF and OB *samosas*. The higher flavour score of FF *samosas* attributed to enhanced Maillard reactions, non-enzymatic browning, and greater formation of flavour-active melanoidins during deep-fat frying (Chang *et al*., 2020). Chang *et al*. (2020) noted the improved flavour profile and increased consumer acceptance of fat-fried foods due to the generation of several volatile compounds such as aldehydes, alcohols, ketones, hydrocarbons, carboxylic acids, furans, pyrazines, and pyridines.

Juiciness scores were significantly ($p<0.05$) higher in FF *samosas* than in AF and OB samples, likely due to greater fat uptake and improved moisture retention during frying. Similarly, DF *samosas* exhibited significantly higher ($p<0.05$) crispiness scores than the other treatments, attributable to rapid crust formation, surface dehydration, and enhanced caramelization during frying. Although DF *samosas* achieved the highest overall acceptability scores, these were statistically comparable to those of AF *samosas*, indicating that air frying produced a product with sensory quality similar to conventional deep-fat frying. The OB *samosas* received significantly ($p<0.05$) lower overall acceptability scores than FF *samosas*, primarily due to their comparatively lower juiciness and crispiness. Téllez-Morales *et al*. (2024) noted satisfactory sensory attributes, lower oil uptake, and the formation of a few acrylamides during processing. Joshi *et al*. (2020) reported comparable texture profiles and sensory attributes of air-fried fish snacks (at 180°C for 12 min) to deep-fat-fried fish snacks and recommended air frying as an alternative, healthier cooking method to deep-fat frying for snacks. Similarly, Sharma *et al*. (2026) observed comparable sensory attributes in air-fried potato to those of deep-fat-fried potato.

Table 4: Sensory attributes of the *samosa* cooked under various methods

Parameters	AF	OB	DF
Appearance	7.32±0.12[b]	7.20±0.54[ab]	7.12±0.76[a]
Flavour	7.17±028	7.19±0.78	7.23±1.13
Juiciness	7.12±0.89[a]	7.16±0.85[a]	7.31±0.48[b]
Crispiness	7.10±0.23[a]	7.08±0.43[a]	7.27±0.76[b]
Overall acceptability	7.18±0.85[ab]	7.10±0.89[a]	7.25±1.02[b]

*Means with different superscripts in a row- small letters (a, b, c, d....) differ significantly ($p<0.05$); AF-air-fried *samosa*, OB- Oven baking *samosa*, DF- deep-fat fried *samosa*, $n=21$.

CONCLUSION

The present findings indicate that air frying can produce spent-hen meat *samosas* with physicochemical and sensory qualities comparable to those of conventionally deep-fat-fried products while offering a healthier cooking alternative.

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