SHORT COMMUNICATION

Development of Ground Chicken Sausages Incorporated with Betel (*Piper betel*) Leaves Powder

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Abstract

The study was aimed to optimize betel (*Piper betel*) leaf powder (PbLP) levels for ground chicken sausages. Betel leaves are rich in antioxidants and contains vitamins, fiber, protein, minerals, essential oils, phenyl propane, diaste, kavibetol, cyneole, and calcium which are beneficial to the body. The ground chicken sausages were prepared by incorporating PbLP at 0 (Control), 0.5 (T1), 1 (T2), and 1.5 (T3) percent with the replacement of equal amount of ground chicken. The PbLP powder was prepared by grinding and sieving of cleaned and dried betel leaves in a hot air oven at 50°C for 3 h. The proximate composition, physico-chemical, and sensory analysis was done for all the groups. The results showed that the pH, and sensory attributes significantly decreased with the increase in PbLP content in the sausages. The protein content of the PbLP containing chicken sausages of all treatments was significantly higher compared to control. At the same time, moisture, fat, ash, cooking yield, and emulsion stability were non-significantly affected by the use of the higher level of PbLP. The results of the study showed that sausages incorporated with 0.5% PbLP performed best overall, comparable to the control in all quality parameters while offering superior nutritive value.

Key words: Chicken fat, Chicken sausages, Emulsion stability, Piper betel leaves, Sensory attributes

Ind J Vet Sci and Biotech (2026): 10.48165/ijvsbt.22.2.29

Introduction

Chicken meat and its products have experienced increasing popularity and become widely spread all over the world. Chicken-based sausages are increasingly studied and developed in India as a nutritious, affordable processed-meat option. Plant-derived extracts and powders (for example, moringa leaf, orange peel, guava leaf, lemon grass, pomegranate peel, psyllium husk, beetroot, garlic, and various spice blends) have been shown to raise the nutritive and functional value of chicken sausages by adding dietary fiber, polyphenols and vitamins while simultaneously delivering antioxidant and antimicrobial activity that slows lipid oxidation and microbial growth (Sharma *et al*. 2017; Bishnoi *et al*. 2022; Singh *et al*. 2024; Maritsha *et al*.. 2025). In practice, Indian studies report that modest levels of plant powders or extracts can improve nutritive value and sensory acceptability without compromising texture when optimized correctly (Das *et al*. 2025; Bishnoi *et al*. 2025)

Piper betel, often known as Pan, is a *Piperaceae* plant that is widely grown in India, Indonesia, the Philippines, and East Africa (Guzman *et al*., 2022). Its leaves have high concentration of bioactive compounds such as lutein, zeaxanthin, steroids, saponins, and tannins than other parts of the plant (Salehi *et al*., 2019). Alkaloids, saponins, tannins, essential oils, and flavonoids are major phytochemical components found in betel leaves (Richa and Singh, 2017). Plants rich in flavonoids have anticancer, antioxidant, anti-inflammatory, anti-fungal and antihypertensive properties. The flavonoids found in betel leaf have a significant role in lowering the risk of developing heart disease and stroke (Lodang *et al*., 2020). One of the widely consumed ready-to-eat meat products is sausage. Nevertheless, the literature about using *Piper betel* leaf powder in meat products is limited. Thus, the study was undertaken to optimize the level of incorporation of betel (*Piper betel*) leaf powder in the ground chicken sausages based on different quality attributes.

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How to cite this article: Mane, D. V., Sakunde, D. T., Kadam, B. R., Waskar, V. S., Barate, A. K., & Pawar, S. S. (2026). Development of Ground Chicken Sausages Incorporated with Betel (*Piper betel*) Leaves Powder. Ind J Vet Sci and Biotech, 22(2), 159-162.

Source of support: Nil

Conflict of interest: None

Submitted 15/11/2025 **Accepted** 12/01/2026 **Published** 10/03/2026

Materials and Methods

Preparation of *Piper betel* Leaf Powder (PbLP)

Fresh *Piper betel* leaves were purchased from the local market. The leaves were washed with tap water followed by distilled water to remove the dirt and dust or any other foreign material on its surface. After washing, leaves were dried in the hot air oven at 50°C till constant weight was obtained. Dried leaves were then powdered using a heavy duty mixer grinder (Bajaj FX 1000) and sieved. The dried powder was packaged in LDPE pouches and stored at refrigeration and was used for further studies.

Preparation of Ground Chicken Sausages

Ground chicken sausages were prepared according to the method of Liu *et al*. (2009). Appropriate proportions of powdered spices ingredients were used to prepare a spice mix according to Sakunde (2004) and Gomkale *et al.* (2023). Chilled deboned meat was chopped into pieces and minced in a meat mincer. Salt, sodium nitrite, and sodium tripolyphosphate were added to minced meat and minced chicken skin, which was then blended in a heavy duty mixer (Bajaj FX 1000) for 1-2 min. Then ice and vegetable oil were added and blended into the mix for approximately 1-2 min. Thereafter other ingredients were mixed thoroughly in the mixer (approx. 2-3 min) to obtain a homogenous mixture. The emulsion was stuffed in a casing (22 mm) using sausage stuffer to get the proper sausage shapes. Then it was tied at approximate distance of 10 cm. The sausages were kept in a hot water bath at 90°C and cooked for 20 min. The casing was then removed manually. Sausages were then packed in LDPE pouches.

Optimization of Levels of Betel (*Piper betel*) Leaf Powder in Ground Chicken Sausages

Ground chicken sausages were prepared by incorporating with varying levels of *Piper betel* leaf powder (PbLP) in the standardized formulation of sausages. The deboned chicken meat was replaced with PbLP @ 0%, 0.5%, 1%, and 1.5% in treatments T0, T1, T2, & T3, respectively. The product was assessed in three replicates for its quality based on proximate composition, physico-chemical properties such as pH, cooking yield, emulsion stability, and sensory evaluation, and the optimum level of PbLP was selected.

Proximate Composition and Physio-Chemical Analysis:

The moisture, fat, protein, and ash content of cooked ground chicken sausages were determined by following the standard method of AOAC (1995)

The physico-chemical parameters of the samples analyzed included pH, cooking yield and emulsion stability. The pH of cooked sausages was determined by the method of AOAC (2012), while cooking yield and emulsion stability were determined using standard formulae.

Sensory Evaluation

Sensory evaluation of the meat samples was carried out by semi-trained panelists. The meat samples were served to the panelists to assess the sensory attributes, *viz.,* colour & appearance, odour, and general acceptability using 8 points hedonic scale (Keeton *et al*., 1983).

Statistical Analysis

The data analysis was carried out using SPSS software (version 20.0) as per the standard methods described by Snedecor and Cochran (1994).

Results and Discussion

Proximate Composition

The moisture percentage in the PbLP-treated chicken sausages showed a significant ($p<0.05$) decrease in T3 (1.5% PbLP) compared to the control, while the decrease was non-significant in T1 and T2 (0.5 & 1 % PbLP) (Table 1). Gorachiya

Table 1: Effect of different levels of PbLP on proximate composition, physico-chemical, and sensory attributes of ground chicken sausages

Assessment	Parameters	Control	*Piper betel* powder levels %		
			T1 (0.5 %)	T2 (1%)	T3(1.5%)
Proximate composition	Moisture (%)	67.22±0.12^{bc}	67.88±0.33^{c}	66.62±0.10^{ab}	66.36±0.20^{a}
	Protein (%)	15.66±0.08^{a}	16.05±0.05^{b}	16.53±0.02^{c}	16.87±0.04^{d}
	Fat (%)	18.57±0.02	18.60±0.10	18.62±0.04	18.63±0.02
	Ash (%)	4.04±0.05	4.16±0.15	4.17±0.08	4.21±0.01
Physico-chemical properties	pH	6.19±0.00^{b}	6.15±0.02^{ab}	6.14±0.02^{ab}	6.13±0.01^{a}
	Cooking yield (%)	95.25±0.22	95.44±0.07	95.64±0.38	95.87±0.69
	Emulsion stability (%)	92.90±1.52	93.75±1.32	94.07±1.19	94.38±0.45
Sensory attributes	Appearance	7.88±0.08^{b}	7.80±0.10^{b}	7.17±0.11^{a}	7.00±0.00^{a}
	Flavour	8.00±0.00^{c}	7.85±0.10^{c}	7.30±0.11^{b}	6.80±0.16^{a}
	Texture	7.82±0.16^{b}	7.67±0.21^{b}	7.00±0.22^{a}	6.50±0.22^{a}
	Juiciness	7.90±0.07^{c}	7.47±0.17^{bc}	7.00±0.11^{ab}	6.88±0.10^{a}
	Overall acceptability	7.83±0.17^{b}	7.58±0.20^{b}	6.92±0.20^{a}	6.75±0.25^{a}

Mean ± SE values with different superscripts (a,b.c) in a row differ significantly ($p< 0.05$).

et al. (2022) observed similar trends in the moisture content of chicken sausage incorporated with different levels of mint leaves powder.

It was observed that when the amount of PbLP in the finished product was increased, the protein percentage in final product increased significantly ($p<0.05$). The protein content of *Piper betel* leaf powder is most likely the outcome of this rise in the protein percent of PbLP-treated ground chicken sausages. Manzoor *et al*. (2023) observed a similar increase in protein in the buffalo meat sausage that contained different extract levels of *Piper betel* leaves. Similar results were reported by Kenawi and El-Hameed (2019) when 1% mint leaf extract added to buffalo meat products.

The amount of fat in the ground chicken sausages was not affected by the addition of PbLP, though it was higher in all treated sausages compared to control (Table 1). In a similar way, Manzoor *et al*. (2023) also reported no significant change in the fat content in buffalo meat sausages supplemented with *Piper betel* leaf extracts. As the amount of PbLP in the finished product increased, the ash content of ground chicken sausages also increased non-significantly (Table 1). Similarly, Mashau *et al*. (2021), added powdered *Moringa oleifera* leaves to cooked ground beef without significant rise in ash content.

Physico-Chemical Properties

The pH in the PbLP-treated chicken sausages was significantly decreased in T3 compared to control, while non-significant effect was seen in T1 and T2. Kantale *et al*. (2022) and Manzoor *et al*. (2023) reported similar trends in pH values in chicken and buffalo sausages incorporated with *Piper betel* leaf extract. Higher levels of PbLP incorporation had a non-significant impact on the cooking yield and emulsion stability of the final product. Similar results were reported by Malav *et al*. (2016) in mutton patties with various levels of red kidney bean powder, and Das *et al*. (2015) in goat meat nuggets with varying amounts of bael pulp residue.

Sensory Attributes

The sensory ratings of the ground chicken sausages varied significantly with different PbLP levels for all the recorded attributes as compared to the control. As PbLP level increased, a decrease in sensory attributes was seen. Additionally, 1.5% PbLP-treated ground chicken sausages showed a strong spicy flavour (Table 1). Rathee *et al*. (2006) documented that *Piper betel* leaves have a strong pungent and aromatic flavour. According to Roy and Gupta (2021), betel leaves possess a sharp, hot, astringent, and acrid taste which might be due to a significant amount of essential oils constituted majorly chavicol, estragole, chavibetol, β-cubebene and caryophyllene.

In brief, incorporation of *Piper betel* leaf powder improved the nutritional profile of ground chicken sausages by enhancing protein content without adversely affecting fat, ash, cooking yield, or emulsion stability. Overall, 0.5% PbLP was identified as the optimum level, offering better nutritive value while maintaining desirable quality and acceptability.

Acknowledgement

The authors acknowledge the Associate Dean, KNP College of Veterinary Science Shirwal by providing facilities for conducting the research work.

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