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EFFECT OF PEARL MILLET FLOUR INCORPORATION ON THE QUALITY CHARACTERISTICS OF CHICKEN MEAT BISCUITS

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ABSTRACT

The development of chicken meat-based biscuits enriched with pearl millet offers a nutritious and innovative snacking alternative. This study aimed to formulate and evaluate the physicochemical, proximate and sensory properties of chicken meat biscuits incorporating different levels of pearl millet flour. Chicken meat powder was prepared and incorporated into biscuit formulations by replacing refined wheat flour (RWF) at 30% (P_1), 40% (P_2) and 50% (P_3) levels. The biscuits were baked at 180°C for 20-25 minutes and analysed for yield, pH, water activity, colour, proximate composition and sensory attributes. Results indicated that P_3 exhibited the highest yield (91.22±0.16%), while P_2 showed the best overall acceptability. A 40% substitution of RWF with pearl millet flour was found to be optimal, improving sensory characteristics while maintaining high nutritional value. These findings suggest that pearl millet-enriched chicken biscuits can serve as source of fibre-based snacks for health-conscious consumers.

Keywords: *Pearl millet, chicken meat biscuits, value addition and meat-based snacks*

INTRODUCTION

Developing chicken meat-based snacks enriched with pearl millet presents a nutritious and innovative approach to nutritious eating choices. Chicken meat is widely preferred due to its excellent flavour, high protein content, ease of digestion, low fat levels and favourable unsaturated fatty acid profile (Para and Ganguly, 2015). To enhance the appeal

and nutritional value of meat products, incorporating innovative ingredients and advanced processing methods has been recognized as an effective strategy (Brar *et al*., 2021). This not only improves the health benefits of meat-based products but also contributes to economic sustainability by developing value-added products and optimizing resource utilization.

Pearl millet (bajra) is known for its superior fat digestibility and rich nutritional profile, including unsaturated fatty acids such as omega-3, along with essential vitamins and minerals (Anil *et al*., 2023). It contains a well-balanced amino acid composition, particularly higher levels of lysine, threonine, methionine and cystine. Compared to other grains, its fatty acid content is notably rich in palmitic, stearic and linolenic acids (Adeola *et al*., 2005). Integrating pearl millet into biscuits and other ready-to-eat snacks provides an excellent balance of taste and nutrition, making them an ideal option for health-conscious consumers. By combining chicken meat and pearl millet, these biscuits offer a protein-rich, fibre-enhanced alternative to conventional snacks. This formulation caters to modern dietary preferences by offering a convenient, nutrient-dense product that aligns with current health and wellness trends. The present study focuses on the development and nutritional evaluation of pearl millet-incorporated chicken meat biscuits to promote a nutritious snacking option.

MATERIALS AND METHODS

Broiler chickens weighing between 2 and 2.5 kg were procured from the local market and processed under strict hygiene standards following established protocols at the Meat Technology Unit in Mannuthy. After slaughter, the chickens were dressed, sealed in high-density polyethylene bags and stored aerobically in a freezer at -21±1°C until further analysis.

Preparation of Chicken Meat Powder

The frozen, dressed chickens were left to thaw overnight at 4±1°C. Once thawed, the meat was manually deboned, with any visible fat, fascia and loose connective tissue carefully removed. It was then chopped into small pieces, boiled and minced. The minced meat was then dried in a cabinet tray dryer at 60°C with a blower for 3 to 4 hours. After drying, it was finely ground into powder using a grinder, packed in low-density polyethylene bags and stored at 4±1°C.

Preparation of chicken meat biscuit

The ingredients listed in Table 1 were measured in precise quantities following the procedure described by Kumar *et al*. (2016). Initially, refined wheat flour (RWF), chicken meat powder (CMP),

Table 1. Formulation of control chicken biscuits

Ingredients	In percentage
Refined wheat flour*	65
Chicken meat powder	35
Total	100
Over and above these, following ingredients were added	
Butter	33
Sugar	26
Salt	1
Spice mix	1
Baking powder	0.6
Symega chicken flavour	0.4
Whole egg**	-

*Refined wheat flour was replaced by pearl millet flour in the treatment samples, **One whole egg

sugar and salt were blended using a planetary mixer. Butter, egg and baking powder were then incorporated and thoroughly mixed. Subsequently, the spice mix and chicken flavour were added, ensuring uniform distribution of all components.

To begin with, the formulation for chicken meat biscuits was standardized. Following this, pearl millet was introduced by substituting 30% (P_1), 40% (P_2) and 50% (P_3) of RWF. The prepared dough was moulded into biscuit shapes and baked at 180°C for 20-25 minutes. Once baked, the biscuits were cooled to room temperature, packed in laminated pouches and stored at ambient conditions. The biscuits containing pearl millet were then analysed for their physicochemical, proximate and sensory attributes.

Cooking yield

The weight of raw and baked biscuits of each replicate was recorded and cooking yield was expressed as percentage by using following formula:

$$\text{Cooking yield (\%)} = \frac{\text{Weight of baked chicken biscuits} \times 100}{\text{Weight of raw chicken biscuits}}$$

pH

The pH of millet-incorporated chicken meat biscuits was determined using a digital pH meter, following the procedure described by AOAC (2016). A 10-gram sample was blended with 50 mL of distilled water and homogenized. The pH value was then measured using a combined electrode digital pH meter (pH system 335, Systronics, India).

Water activity

Water activity was determined following the method outlined by Carbonell *et al*. (2005) using a Lab Swift water activity meter (Novasina, Switzerland). The sample was placed in a designated container and inserted into the measurement chamber. Readings were recorded once the instrument displayed a stable water activity value.

L*, a*, b* colour value

The colour of the biscuits was

assessed using a calibrated Lovibond LC 100 Spectro colorimeter, as per the method described by Navneet and Kshitji (2011). The instrument was calibrated using black and white reference tiles before measuring the L* (lightness), a* (red-green) and b* (blue-yellow) values. Each sample was analysed three times and the average values were recorded.

Proximate composition

The proximate composition of millet-incorporated chicken meat biscuits, along with control samples, was analysed using standard methods. Moisture content was determined through oven drying, protein content was measured using the Kjeldahl distillation method, fat content was assessed via Soxhlet extraction and ash content was evaluated using a muffle furnace. All analyses were conducted following the official procedures outlined by AOAC (2016).

Sensory evaluation

A semi-trained panel of seven members from the Department of Livestock Products Technology, College of Veterinary and Animal Sciences, Mannuthy, Thrissur, conducted the sensory evaluation. An eight-point Hedonic scorecard was used to assess the chicken biscuits based on colour and appearance, meat flavour intensity, crispiness, aftertaste and overall acceptability. Panellists were given uniform samples of millet-incorporated chicken biscuits, each labelled with a three-digit code and rated them using the Hedonic scale. Plain water was provided for palate cleansing between samples and the average scores for each attribute were recorded.

Statistical analysis

All experiments were conducted in six replicates. The data collected on the physico-chemical and sensory properties of both the control and selected treatment chicken biscuits were statistically analyzed using repeated measures ANOVA, one-way ANOVA and the Kruskal-Wallis test. These analyses were performed using SPSS software version 24.0, following the statistical methods described by Snedecor and Cochran (1994).

RESULTS AND DISCUSSION

Product yield, pH and water activity

Table 2 provides a summary of the physico-chemical properties, including product yield, pH and water activity, of chicken meat biscuits formulated with three different levels of pearl millet flour.

Significant differences ($p<0.01$) in cooking yields were observed among C, P1 and P2, with P3 (91.22±0.16) showing the highest yield. This aligns with the findings of Para and Subha (2015) and Santhi and

Table 2. Effect of different levels of pearl millet flour on physico-chemical of chicken meat biscuits

Attributes	C	P_1	P_2	P_3	F value (p value)
Yield (%)	82.5±0.31[a]	83.26±0.24[a]	90.08±0.16[b]	91.22±0.16[b]	53.684 (<0.001)**
pH	6.28±0.007[d]	6.22±0.006[c]	6.18±0.002[b]	6.16±0.002[a]	102.694 (<0.001)**
Water activity	0.55±0.003[b]	0.465±0.001[a]	0.464±0.001[a]	0.464±0.001[a]	437.283 (<0.001)**

* Significant at 0.05 level; ** Significant at 0.01 level; ns – non- significant at 0.05 level.

Means with different superscripts in rows differ significantly.

The values are expressed as their Mean ± Standard error.

C: Control chicken meat biscuits with 35% CMP (without incorporating millet)

P_1: C+ 30% RWF replaced with pearl millet flour

P_2: C+ 40% RWF replaced with pearl millet flour

P_3: C+ 50% RWF replaced with pearl millet flour

Table 3. L*, a*, b* colour value of control and three treatments of chicken meat biscuits incorporated with different levels of pearl millet flour

	C	P_1	P_2	P_3	F value (p value)
L*	62.03±0.51[c]	53.93±1.42[b]	52.26±1.32[ab]	48.66±2.20[a]	14.326 (<0.001)**
a*	11.96±0.24	10.78±1.29	13.23±0.64	11.65±0.78	1.489 (0.248)[ns]
b*	34.88±0.38	31.35±1.39	31.03±0.91	30.18±1.79	2.789 (0.067)[ns]

* Significant at 0.05 level; ** Significant at 0.01 level; ns – non- significant at 0.05 level.

Means with different superscripts in rows differ significantly.

The values are expressed as their Mean ± Standard error.

C: Control chicken meat biscuits with 35% CMP (without incorporating millet)

P_1: C+ 30% RWF replaced with pearl millet flour

P_2: C+ 40% RWF replaced with pearl millet flour

P_3: C+ 50% RWF replaced with pearl millet flour

Kalaikannan (2015), who reported enhanced product yields in chicken nuggets and low-fat chicken meatballs as pearl millet levels increased.

Regarding pH, notable differences ($p<0.01$) were found between the control, P1, P2 and P3, with the control (6.28±0.007) exhibiting the highest pH and P3 (6.16±0.002) the lowest. This contrasts with the findings of Para and Subha (2015), who observed a significant increase in pH when 20% pearl millet flour was added to chicken nuggets.

Water activity in the control sample was significantly higher ($p<0.01$) than in P1, P2 and P3, although no significant variations were found among the treated samples. The reduction in water activity in millet-incorporated biscuits can be attributed to the higher fibre content in pearl millet, which binds water and limits its availability. This is consistent with

Table 4. Effect of different levels of pearl millet flour on proximate composition of chicken meat biscuits

Attributes	C	P_1	P_2	P_3	F value (p value)
Moisture (%)	10.40±0.30^b	11.67±0.11^c	12.10±0.11^c	9.79±0.10^a	35.515 (<0.001)**
Crude Protein (%)	28.11±0.43^b	27.92±0.06^b	27.21±0.06^a	26.61±0.06^a	9.488 (<0.001)**
Ether extract (%)	26.35±0.18^b	25.44±0.08^a	26.22±0.05^b	26.98±0.04^c	36.013 (<0.001)**
Total Ash (%)	2.38±0.02^c	2.15±0.02^a	2.17±0.02^a	2.30±0.01^b	25.866 (<0.001)**

* Significant at 0.05 level; ** Significant at 0.01 level; ns – non- significant at 0.05 level.
Means with different superscripts in rows differ significantly.
The values are expressed as their Mean ± Standard error.
C: Control chicken meat biscuits with 35% CMP (without incorporating millet)
P_1: C+ 30% RWF replaced with pearl millet flour
P_2: C+ 40% RWF replaced with pearl millet flour
P_3: C+ 50% RWF replaced with pearl millet flour

Santhi and Kalaikannan (2015), who noted that millet's water-binding capacity leads to lower water activity in meat products.

L*, a*, b* colour values

The L* (lightness), a* (redness) and b* (yellowness) values for both control and treatment samples are presented in Table 3. A significant difference ($p<0.01$) was observed in the L* values between the control and treatments, while no significant differences ($p>0.05$) were noted in a* and b* values. These results may be attributed to similar factors observed in finger millet-enriched chicken patties, as reported by Naveena *et al*. (2006).

Proximate composition

Kumar *et al*. (2016) reported that meat biscuits containing wheat and oat bran had significantly higher moisture content than the control, attributing this to the improved water retention capacity of dietary fibres. This finding aligns with the present study, where the moisture content of P_1 and P_2 was significantly different ($p<0.01$) from the control.

The crude protein content of the control and P_1 showed no significant difference, which may be due to similar factors observed in finger millet-incorporated chevon patties, as noted by Kumar *et al*. (2015). Among the samples, P_3 recorded the highest ether extract content (26.98±0.04), likely due to the higher fat content in pearl millet, as documented by Akhila *et al*. (2023).

For total ash content, P_1 and P_2 exhibited statistically similar values but were significantly different ($p<0.01$) from the control and P3. Santhi *et al*. (2020) also found that the incorporation of millets increased the total ash content in chicken meatballs.

Table 5. Effect of different levels of pearl millet flour on the sensory attributes of chicken meat biscuits

Attributes	C	P_1	P_2	P_3	F value (p value)
Appearance and colour	7.09±0.11	7.07±0.09	7.04±0.09	7.03±0.12	$(0.927)^{ns}$
Meat flavour intensity	6.54±0.13	6.59±0.12	6.63±0.12	6.64±0.12	$(0.945)^{ns}$
Crispiness	6.51±0.13	6.54±0.13	6.71±0.11	6.73±0.11	$(0.548)^{ns}$
After taste	6.64±0.13	6.71±0.09	6.9±0.09	6.97±0.11	$(0.183)^{ns}$
Overall acceptability	$6.48±0.1^{a}$	$6.78±0.09^{a}$	$7.13±0.12^{b}$	$6.83±0.06^{a}$	$(<0.001)^{**}$

* Significant at 0.05 level; ** Significant at 0.01 level; ns – non- significant at 0.05 level.

Means with different superscripts in rows differ significantly.

The values are expressed as their Mean ± Standard error.

C: Control chicken meat biscuits with 35% CMP (without incorporating millet)

P_1: C+ 30% RWF replaced with pearl millet flour

P_2: C+ 40% RWF replaced with pearl millet flour

P_3: C+ 50% RWF replaced with pearl millet flour

Sensory evaluation

The sensory evaluation parameters, including appearance and colour, flavour, crispiness, aftertaste and overall acceptability, were analysed. The compiled scores of the sensory evaluation are given in the Table 5.

The control sample received the highest score for appearance and colour, which was statistically comparable to the treatment samples. P_3 achieved the highest flavour score, showing no significant difference ($p>0.05$) from the control and other treatments. This result contrasts with the findings of Nandhini *et al*. (2018), who reported that the meat flavour in chicken cutlets containing pearl millet was masked by the millet flavour at 20% and 30% incorporation levels. For overall acceptability, P_2 received a significantly higher score ($p<0.01$) than the control and other treatments. This finding is consistent with the study by Brasil *et al*. (2015), which concluded that kibbeh made with roasted pearl millet flour had superior sensory properties compared to the control version.

A 40% replacement with pearl millet was found to be the optimal level for enhancing sensory characteristics, despite the higher yield observed in other formulations. These results align with the study by Anil *et al*. (2023), which found that a ready-to-cook porridge mix containing dried chicken meat powder and pearl millet flour outperformed the control mix in both nutritional value and sensory appeal.

CONCLUSION

Based on the combined results of product yield and sensory evaluation, replacing 40% of refined wheat flour (RWF) with pearl millet flour is the optimal choice for formulating chicken meat biscuits. This substitution enhances the nutritional profile, increases yield and reduces pH and water activity, which may contribute to a longer shelf life while preserving strong consumer acceptance. Using pearl millet as a fibre source at this level strikes an ideal balance, offering nutritional benefits without compromising sensory quality.

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CONFLICTS OF INTEREST

The authors declare that they have no conflict of interest.

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