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Development of finger millet incorporated chicken meat biscuits#

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Abstract

Meat-based snacks enhanced with finger millet provide a healthy and creative option for convenient, ready-to-eat food. This study examines chicken meat biscuits formulated with varying levels of finger millet flour, replacing refined wheat flour by 20% (T_1), 30% (T_2) and 40% (T_3) to enhance nutritional content. Significant differences ($p<0.01$) were found in cooking yields and pH among the groups, with T_3 achieving the highest yield. Water activity complied with FSSAI standards, with the control at 0.55 and T_1 at 0.405. Lightness (L), redness (a*) and yellowness (b*) values also varied significantly, with the control showing the highest L* value. T_1 exhibited the highest moisture content and T_3 had the greatest ash content (2.6%). In sensory evaluation, appearance and colour scores differed significantly, with the control scoring the highest (7.57), while T_2 excelled in crispiness and overall acceptability. Incorporating 30% finger millet flour resulted in the optimal value addition of meat, creating a delicious and healthful snack.*

Keywords: *Meat-based snack, meat biscuits, finger millet, value addition, fibre, chicken meat powder*

Chicken meat-based snacks, combined with the nutritional benefits of finger millet, offer a wholesome and innovative approach to snacking. Chicken, a lean protein, is rich in essential nutrients like amino acids, vitamins and minerals that support muscle health and overall well-being. When paired with finger millet, a superfood known for its high calcium content, dietary fibre and antioxidant properties, these snacks become delicious and a powerhouse of nutrition. Deepika *et al*. (2022) highlighted several innovations aimed at increasing the value of meat. One example involved incorporating meat into traditional cereal-based snacks, leading to the creation of lighter, crispier products in a variety of shapes and sizes. Additionally, ingredients with functional benefits, such as high dietary fibre and spices, were included to enhance the nutritional profile of these snacks.

Finger millet or ragi is a gluten-free grain packed with complex carbohydrates, making it a great choice for sustained energy. Shobana *et al*. (2009) discovered that finger millet contained phenolic compounds capable of reducing blood glucose levels by inhibiting the activity of glucosidase and amylase enzymes. By incorporating finger millet into biscuits and other snacks, we could create a perfect blend of taste and health. These snacks are ideal for those looking to increase their protein intake while enjoying the benefits of whole grains. Combining two nutrient-rich ingredients, they cater to health-conscious consumers who value taste, nutrition and convenience.

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Materials and methods

Broiler chickens weighing between 2 to 2.5 kg were sourced from the local market and slaughtered using scientific methods under hygienic conditions at the Meat Technology Unit in Mannuthy. After dressing, the chickens were packed in high-density polyethylene bags and stored aerobically in a freezer at -21±1°C until the experiments were conducted.

Preparation of chicken meat powder

Frozen dressed chicken was thawed overnight at 4±1°C. After thawing, the chicken was manually deboned and any separable fat, fascia and loose connective tissue were removed. The meat was then cut into small pieces, boiled and minced. The minced meat was dried in a cabinet tray dryer with a blower at 60°C for 3-4 hours. Once dried, it was finely ground into a powder using a grinder, packed in low-density polyethylene bags and stored at 4±1°C.

Preparation of chicken meat biscuit

The ingredients from Table 1 were measured according to the specified amounts according to Kumar *et al*. (2016). Refined wheat flour (RWF), chicken meat powder (CMP), sugar and salt were combined in a planetary mixer. Butter, egg and baking powder were then added and mixed thoroughly. Finally, spice mix and chicken flavour were incorporated and the mixture was blended until all the ingredients were evenly distributed. For further studies, various levels of finger millet were added by replacing 20, 30 and 40% of RWF in the chicken meat biscuits. The dough was shaped into biscuits and baked at 180°C for 20 minutes. After baking, the biscuits were cooled to room temperature, packaged in laminate pouches and stored at ambient temperature. The finger millet-incorporated biscuits were assessed for various physico-chemical, proximate and sensory attributes.

Table 1. Formulation of control chicken biscuits

Ingredients	In percentage
Refined wheat flour*	65
Chicken meat powder	35
Total	100
Over and above these, the 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 millet flour in the treatment samples, **One whole egg

Physico-chemical, proximate and sensory attributes

The pH of the chicken meat biscuits containing millet was measured using a digital pH meter, following the method outlined by AOAC (2016). Water activity was measured according to the method described by Carbonell *et al*. (2005) using a water activity meter (Lab Swift, Novasina, Switzerland). The cooking yield percentage is calculated by taking the weight of the baked chicken biscuits, multiplying it by 100 and then dividing that result by the weight of the raw chicken biscuits. The colour of the biscuit was objectively assessed according to the method outlined by Navneet and Kshitji (2011) using a calibrated colour reader (Lovibond LC 100 Spectro colourimeter with diffuse illumination). Finger millet-incorporated chicken meat biscuits were analysed for proximate composition, including moisture content, protein, fat content and ash, following the necessary drying process on the day of preparation, in accordance with the AOAC (2016) procedure. Sensory evaluation was conducted with a semi-trained panel of seven members selected from the Department of Livestock Products Technology at the College of Veterinary and Animal Sciences in Mannuthy, Thrissur, using an eight-point Hedonic scale. The data collected on the physicochemical, proximate and sensory characteristics of both the control and finger millet-incorporated chicken biscuits were statistically analysed using repeated measures ANOVA, one-way ANOVA and the Kruskal-Wallis test, employing version 24.0 of the Statistical Package for Social Sciences (SPSS) software (Snedecor and Cochran, 1994).

Results and discussion

The standardised formulation of biscuits containing CMP was created based on the specifications outlined in Table 1. Table 2 presents the physicochemical properties of chicken meat biscuits which incorporated various levels of finger millet flour. The evaluated physicochemical parameters included product yield, pH and water activity. A significant difference ($p<0.01$) was noted in the cooking yields among the control and treatment groups (T_1, T_2 and T_3), with T_3 achieving the highest yield, which was significantly greater than that of the control, the latter showing the lowest yield. This finding is consistent with Cofrades *et al*. (2000), who noted that meat enriched with good sources of fibre improved cooking yield due to their water- and fat-binding abilities.

Significant differences ($p<0.01$) were also found in pH values between control and treatment samples, ranging from 6.17 to 6.28, with the control exhibiting the highest pH value (6.28±0.007). This result corresponds with findings from Abinayaselvi *et al*. (2018), who reported a significant decrease in pH with higher levels of finger millet in chicken soup, where the control had the highest pH and the formulation with the highest concentration of finger millet (15%) showed the lowest, attributed to finger millet's

Table 2. Effect of different levels of finger millet flour on the physicochemical and sensory attributes of chicken meat biscuits

Attributes	C	T_1	T_2	T_3	F value (p-value)
Yield (%)	82.63±0.33[a]	89.32±0.16[b]	91.10±0.16[c]	92.61±0.23[d]	347.393 (<0.001)**
pH	6.28±0.007[d]	6.24±0.003[c]	6.21±0.003[b]	6.17±0.003[a]	88.105 (<0.001)**
Water activity	0.55±0.003[b]	0.405±0.005[a]	0.407±0.001[a]	0.408±0.001[a]	1154.447 (<0.001)**
Sensory evaluation					
Appearance and colour	7.57±0.08[b]	7.05±0.11[a]	6.97±0.11[a]	6.81±0.13[a]	(<0.001)**
Meat flavour intensity	6.46±0.12	6.76±0.15	6.702±0.15	6.66±0.16	(0.492)[ns]
Crispiness	6.404±0.11	6.54±0.14	6.59±0.11	6.54±0.12	(0.681)[ns]
After taste	6.78±0.09	6.88±0.12	6.91±0.10	6.55±0.11	(0.140)[ns]
Overall acceptability	6.85±0.08[a]	7.16±0.12[a]	7.40±0.09[b]	7.07±0.08[a]	(0.001)**

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

This 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)

T_1: C+ 20% RWF replaced with finger millet flour, $T_{2:}$ C+ 30% RWF replaced with finger millet flour

T_3: C+ 40% RWF replaced with finger millet flour

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

	C	T_1	T_2	T_3	F value (p-value)
L*	62.03±0.51[d]	58.46±0.60[c]	55.73±0.29[b]	52.63±0.77[a]	48.365 (<0.001)**
a*	11.96±0.24[b]	9.83±0.31[a]	9.58±0.18[a]	11.75±0.32[b]	20.537 (<0.001)**
b*	34.88±0.38[c]	28.83±0.27[b]	26.78±0.12[a]	26.35±0.35[a]	168.946 (<0.001)**

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

naturally lower pH. The water activity of both control and treatment samples complied with FSSAI (2011) standards, which stated that dried meat products must have a water activity below 0.6 and moisture content below 25%. The control exhibited the highest water activity (0.55±0.003), while T_1 had the lowest value (0.405±0.0005).

The L* (lightness), a* (redness) and b* (yellowness) values for both control and treatment samples were assessed and are presented in Table 3. The average L* values for the C, T_1, T_2 and T_3 samples showed significant differences (p<0.01), with the control exhibiting the highest value (62.03±0.51). This finding aligns with the research by Naveena *et al*. (2006), which found that adding finger millet at levels of 2.5%, 5% and 7.5% to chicken patties resulted in significantly lower lightness (L*) and yellowness (b*) values compared to the control, likely due to the darker colour contributed by finger millet.

The sensory evaluation results, including aspects such as appearance and colour, flavour, crispiness, aftertaste, and overall acceptability, are summarised in Table 3. These parameters were analysed to determine the impact of incorporating different levels of finger millet flour into chicken meat biscuits. A significant difference (p<0.01) was found in the mean appearance and colour scores between the control and treatment samples in the sensory evaluation, with the control scoring highest (7.57±0.08), followed by T_1 (7.05±0.11) and T_3 (6.81±0.13). This aligns with Patel *et al*. (2015), who reported that ice cream with finger millet had lower scores for 10% and 15% formulations due to the darker colour. T_2 stood out in crispiness, aftertaste and overall acceptability, significantly outperforming the control and other treatments. This preference may be due to the chicken flavour being masked by higher levels of finger millet. These findings support Abinayaselvi *et al*. (2018), who observed lower

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

Parameters	C	T_1	T_2	T_3	F value (p-value)
Moisture (%)	10.40±0.30[bc]	10.56±0.17[c]	8.88±0.13[a]	9.85±0.27[b]	10.853 (<0.001)**
Crude Protein (%)	28.101±0.43[d]	25.79±0.12[c]	25.07±0.12[b]	24.16±0.03[a]	52.482 (<0.001)**
Ether extract (%)	26.35±0.18[b]	25.45±0.17[a]	25.50±0.07[a]	25.64±0.11[a]	8.023 (0.001)**
Total Ash (%)	2.38±0.02[a]	2.59±0.01[b]	2.64±0.01[bc]	2.68±0.01[c]	42.613 (<0.001)**

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

scores in appearance, flavour and mouthfeel in chicken soup with increased finger millet levels.

Table 4 presents the proximate analysis of chicken meat biscuits incorporating different levels of finger millet flour, including moisture, crude protein, ether extract and total ash contents. T_1 exhibited the highest moisture content, showing a significant difference ($p<0.01$) compared to T_2 and T_3. There were also significant differences ($p<0.01$) in the crude protein content among C, T_1, T_2 and T_3. Additionally, the ether extract and total ash content differed significantly ($p<0.01$) between the control and the treatments, with T_3 showing the highest ash content (2.68±0.01) and the control the lowest (2.38±0.02). This finding is consistent with Kumar *et al*. (2015), who reported that incorporating finger millet into chevon patties increased moisture, carbohydrate and ash contents while reducing fat and protein levels.

Based on the findings, a 30% substitution of RWF with finger millet flour provides the best balance between product yield and sensory appeal. These findings echo the research of Pavan *et al.* (2016) who demonstrated that incorporating finger millet flour in meatballs enhanced their novelty and provided health benefits without compromising sensory quality.

Conclusion

Based on the combined findings from product yield and sensory evaluations, a 30% substitution of RWF is the optimum level of finger millet flour incorporation in chicken meat biscuits. A 30% substitution of RWF with finger millet flour provides a value addition to the meat. Adding millet flour improved the yield and lowered both the pH and water activity, which could also help extend shelf life. Chicken meat and finger millet make a great combination for creating meat biscuits that are highly acceptable, and rich in protein and fibre. Incorporating finger millet by replacing 30% RWF level as a fibre source is considered optimal for meat biscuits without adversely affecting the sensory attributes.

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Conflicts of interest

The authors declare that they have no conflict of interest.

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