



## Development of Functional Spent Hen Meat Biscuits Incorporated with Chia Seed Powder

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### ABSTRACT

The present study was undertaken to develop spent hen meat biscuits incorporated with chia seed powders (CSP). During the preparation of spent hen meat biscuit dough, three different levels of CSP replacing refined wheat flour (viz. 4%, 6.0% and 8% of total flours in the basic formulation) were incorporated, thereby resulting in the preparation of four types of meat biscuit samples viz., C (without CSP), T1 (4% CSP), T2 (6.0% CSP) and T3 (8% CSP). The developed products were assessed for various quality evaluations in terms of physico-chemical, proximate, colour, texture, and sensory parameters. The CSP incorporation resulted in increased pH values, fat, dietary fibre, calorific value, and ash content. The crude fibre and ash content of meat biscuits with 8% CSP was recorded as the highest among all samples. The hardness values increased significantly ( $p < 0.05$ ) in treated biscuits than controls. The overall acceptability of the spent hen meat biscuit with 6% CSP was recorded as the highest. Thus, good-quality spent hen meat biscuits could be successfully prepared by incorporating 6% CSP.

### HIGHLIGHTS

- Good quality meat biscuits prepared by adding 6% chia seed powder.
- Developed products have high crude fibre, fat, mineral, and calorific value.

**Keywords:** Chia seed, meat biscuit, dietary fibre

The snack food market is rapidly growing due to the popularity and consumer acceptance of these products owing to their wide range of availability of different shape, size and taste as per the liking of the specific population, availability in small size making transport, marketing and handling easier, extended shelf-life even at room temperature, and easier preparations. Furthermore, the rapid urbanization, industrialization, increasing net income, and nuclear families, rising women workforce, also contributed to their rapid growth (Kumar *et al.*, 2019). Snacks are the lighter meals that are mostly consumed between regular meals to meet the short-term demand for energy, nutrients, and to satisfy hunger (Singh *et al.*,

2014, 2015; Verma *et al.*, 2014). Among snack products, biscuits are one of the most consumed snacks worldwide, attributed to ready-to-eat products having versatility, variety, being chemically leavened, nutritive value, and extended storage stability at ambient temperature (Kumar *et al.*, 2016, 2021).

The traditional biscuits available in the market are flour-based, have a high content of saturated fat, carbohydrates,

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and sugar. These are lacking in protein, dietary fibre, and essential amino acids (Nogueira and Steel, 2018). The incorporation of animal protein, such as chicken meat (Kumar *et al.*, 2016), chevon (Kumar *et al.*, 2021), fish (Abraha *et al.*, 2018) during the development of biscuits could significantly improve the protein content and availability of essential amino acids, and mineral content. Dietary fibre plays a very important role in controlling cardiovascular diseases, gut health, and obesity (Mehta *et al.*, 2015). Furthermore, the addition of dietary fibre could also improve the dietary fibre content of the developed biscuits, thereby improving functional and technological properties of biscuits in addition to improving the nutritive value of the developed meat biscuits (Bristone *et al.*, 2017; Kumar *et al.*, 2021).

For improving the dietary fibre content of meat biscuits, various vegetable powders and flours have been added, such as wheat and oat brans (Kumar *et al.*, 2016), peanut hulls (Kumar *et al.*, 2021), date (Agu *et al.*, 2020), sorghum (Singh *et al.*, 2015), etc. Chia seeds (*Salvia hispanica* L. *semen*), becoming popular as a novel food, are an excellent source of dietary fibre, vitamins, minerals, protein, polyunsaturated fatty acids, omega-3 fatty acids, and polyphenolic compounds (Knez Hrnič *et al.*, 2019; Kulczyński *et al.*, 2019). Due to their high nutritional value, chia seeds are increasingly used as dietary supplements and commonly incorporated into breakfast cereals, snacks, and nutritional bars. Chia seeds contain approximately 40% oil, of which 60% is linoleic acid, along with 19% protein and 30% dietary fiber (Muñoz *et al.*, 2012). Chia seeds have a higher content of bioactive compounds, and their consumption is reported to have cardioprotective, hepatoprotective, neuroprotective, hypolipemic, anti-inflammatory, antidiabetic, antioxidant, and hypotensive effects (Motyka *et al.*, 2023). Several studies reported improved nutritional, technological, and functional attributes of the meat products upon incorporation of chia seed (Ding *et al.*, 2018; Fernández-López *et al.*, 2020).

The incorporation of chia seed powder in the preparation of meat biscuits could significantly impact their functional and nutritional properties. Thus, the present study is designed to develop functional chicken meat biscuits by incorporating chia seed powder.

## MATERIALS AND METHODS

### Chicken meat powder

Chicken meat used in the current study was obtained by humane slaughter of spent hens under hygienic conditions sourced from the Directorate of Livestock Farm, Guru Angad Dev Veterinary and Animal Sciences University, Ludhiana, Punjab. The carcasses were manually hot deboned, and separable fat, fascia, and loose connective tissue were trimmed off. Meat was kept overnight in the refrigerator in LDPE bags and kept frozen (-18°C) until further use. Before use, the frozen deboned meat was thawed overnight in a refrigerator at 4±1°C and sliced into 2 cm<sup>3</sup> chunks. The chunks were minced twice in a meat mincer (Mado Eskimo Mew-714), followed by drying minced meat in a tray drier at 70±2°C for 24 h. The dried meat was properly ground and sieved through a 1mm sieve, packed in PET (polyethylene terephthalate) jars, and stored at ambient temperature (24±2°C) for further use.

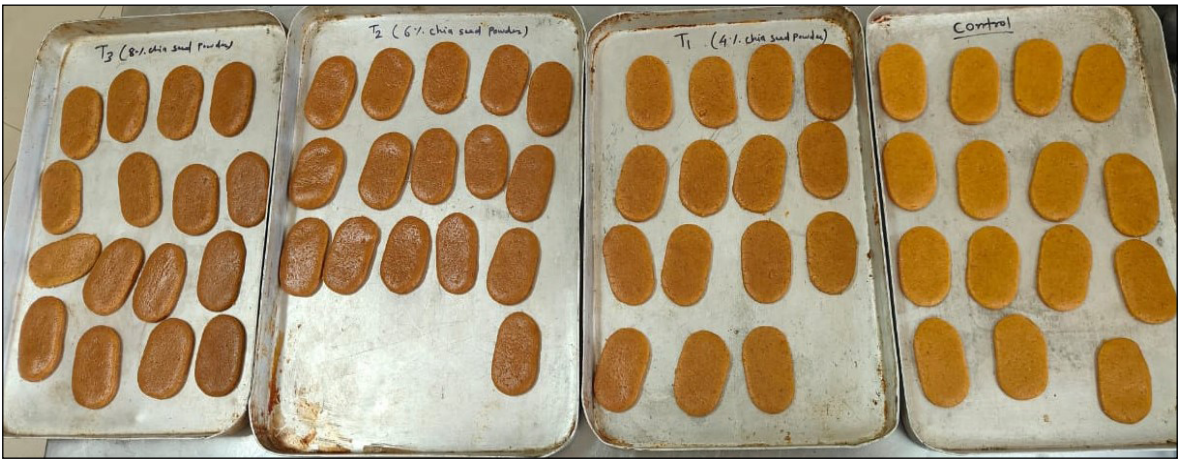
### Meat biscuit preparation

The meat biscuits were prepared as per the method followed by (Kumar *et al.*, 2016). Table 1 enlists various ingredients used in the preparation of biscuits, such as refined wheat flour, meat powder, hydrogenated vegetable oil, sugar powder, chia seed powder, whole egg liquid, salt, baking powder, and spices. Based on several preliminary trials, three levels of chia seed powder (CSP) were incorporated by replacing wheat flour, resulting in the development of 4 batches of biscuits viz., C- (Control with 0% CSP), T1 -4% CSP, T2 - 6% CSP, T3 -8% CSP. Biscuit dough was prepared by thoroughly mixing sugar powder and hydrogenated vegetable oil into the dough mixture for 3 min, followed by adding whole egg liquid. This was followed by the addition of the remaining ingredients and mixing for 60 s. The dough was sheeted on a wooden board with rolling pins and cut into desired shapes using a biscuit cutter (Fig. 1). The cooking of biscuits was done in a pre-heated baking oven at 220 °C for 20 min, followed by tempering at room temperature and packaging in pre-sterilized LDPE pouches for storage and further physicochemical, proximate, and sensory analysis (Fig. 2).

**Table 1:** Formulation of spent hen meat biscuits incorporated with chia seed powder

| Ingredients                | Control | Chia seed powder |      |      |
|----------------------------|---------|------------------|------|------|
|                            |         | T1               | T2   | T3   |
| Refined wheat flour        | 700     | 660              | 640  | 620  |
| Chia powder                | —       | 40               | 60   | 80   |
| Meat powder                | 300     | 300              | 300  | 300  |
| Sugar powder               | 280     | 280              | 280  | 280  |
| Hydrogenated vegetable oil | 200     | 200              | 200  | 200  |
| Whole egg liquid           | 210     | 210              | 210  | 210  |
| Salt                       | 14.0    | 14.0             | 14.0 | 14.0 |
| Spice mix                  | 7.0     | 7.0              | 7.0  | 7.0  |
| Baking powder              | 0.1     | 0.1              | 0.1  | 0.1  |

T1 -4.0% chia seed powder, T2 -6.0% chia seed powder, T3 -8.0% chia seed powder.



**Fig. 1:** Raw spent hen meat biscuits



**Fig. 2:** Cooked spent hen meat biscuits



## Analytical Techniques

### Proximate analysis

Moisture (oven drying at 105 °C till constant weight), protein (kjeldahl distillation with  $N \times 6.25$ ), fat (Soc plus, soxhlet method by using petroleum ether solvent boiling point of 60-80 °C), crude fibre (Fibra plus) and ash (keeping sample in crucibles in muffle furnace for 16 h and gradually increasing temperature from 150 °C to 600 °C) content of developed spent hen meat biscuits were assessed by following standard procedure as described by (Association of Official Analytical Chemists, 2019). The carbohydrate content of the biscuits was calculated by numerical formula (carbohydrate =  $100 - \text{moisture} + \text{protein} + \text{fat} + \text{ash}$ ).

The total calorific content of the products was calculated based on 100 g weight using Atwater values for fat (9 kcal/g), protein (4.02 kcal/g), and carbohydrates (4 kcal/g).

### Physico-chemical analysis

The pH of spent hen meat biscuits was observed using a digital pH meter (SAB 5000, LABINDIA, Mumbai) pre-calibrated at room temperature using pH buffer solutions of pH 4.0, 7.0, and 9.0.

A chroma meter (Konica-Minolta Model: CR 400, Illumination D65, observer angle 2°, aperture size 8 mm) was used to measure the colour profile of developed meat biscuits. The chroma meter was calibrated using the standard calibration disc supplied with the equipment and following standard protocols as prescribed by the manufacturer. Colour values in terms of  $L^*$ ,  $a^*$ , and  $b^*$  values were measured on both surfaces of the meat biscuit at three different places.

The hardness and penetrability value of the developed spent hen meat biscuit was measured by using Texture Analyzer (TMS-PRO, FTC, Maries Road, Sterling, VA, USA). The uniform cube of the developed products of  $1.0 \times 1.0 \times 1.0$  cm. size was subjected to a double compression cycle to 50% of their original height.

### Sensory evaluation

A seven-member experienced panel comprising scientists and postgraduate students of the Department of Livestock

Products Technology assessed the meat biscuit samples for various sensory attributes viz. appearance and colour, flavour, mouth coating, saltiness, crispiness, and overall acceptability using a 9-point descriptive scale (Keeton, 1983), where 9=extremely desirable and 1=extremely undesirable. Six sittings ( $n=6$ ) were conducted for each replicate. The samples were blind-coded by using 3-digit numbers and served to the evaluators in random order. Potable water was served to the assessors for rinsing their palates during testing of different meat biscuit samples. The evaluators were seated in a room free of noise and odours and suitably illuminated with natural light.

### Statistical analysis

The data of the above study for various parameters were represented as Means and standard errors (Mean $\pm$ SE). Data was analyzed statistically on SPSS- 26.0 (SPSS Inc., Chicago, IL, USA) software package as per standard methods for Analysis of Variance (ANOVA) and Duncan's multiple range test (DMRT) to compare the means. Duplicate samples were drawn for each parameter ( $n=6$ ). The statistical significance (p value) was estimated at a 5% level or below ( $P < 0.05$ ).

## RESULTS AND DISCUSSION

### Physicochemical and proximate analysis

The effect of incorporation of CSP on the physico-chemical and proximate parameters is presented in Table 2. The pH of the developed meat biscuits recorded an increasing trend with the increasing levels of incorporation of chia seed powder. The pH of control biscuits was recorded as the lowest and significantly ( $p < 0.05$ ) lower than the treated products. Furthermore, the pH of all the treated products was recorded as comparable among themselves. This could be due to the slightly alkaline pH of the chia seed powder (7.2) used in the study by replacing refined wheat flour.

The moisture content of meat biscuits followed an increasing trend with the incorporation of higher levels of CSP. The lowest moisture content was recorded for the control meat biscuits, and the highest moisture content was recorded for the T3 samples, having the 8% CSP in their formulation. The higher levels of moisture retention

in the treated biscuits could be attributed to the higher fibre content in these biscuits, thereby improving the moisture retention of these biscuits. Similar findings of higher moisture content in spent hen meat biscuits upon incorporation of oat and wheat bran (Kumar *et al.*, 2016) and peanut hull powder in chevon biscuits (Kumar *et al.*, 2021) were also reported. Furthermore, chia seeds had a high amount of mucilage (Vera-Cespedes *et al.*, 2023), which in addition to dietary fibre, could also assisted in the better retention of the moisture content in the developed products.

The incorporation of CSP has a significant ( $p<0.05$ ) effect on the fat percentage in the developed meat biscuits. With the increasing levels of CSP incorporation, the fat levels recorded increasing trends, with the C sample having the lowest and the T3 sample having the highest fat content ( $C<T1<T2<T3$ ). The fat levels in T2 samples were comparable to T1 and T3 samples. This could be attributed to the higher fat levels in the CSP (30-35%) (Rani *et al.*, 2021). The protein content of the developed meat biscuits followed a similar trend, with an increase in the protein content with the increasing CSP incorporation levels. This could be due to the incorporation of CSP, having a higher protein content of 15-17%, by replacing refined wheat flour with a lower protein content of 10-11% (Senna *et al.*, 2024; Vera-Cespedes *et al.*, 2023).

Ash content of control meat biscuits was recorded as significantly ( $p<0.05$ ) lower than the ash content of treated meat biscuits. The highest ash content was recorded for the T3 meat biscuits with 8% CSP. This increasing ash

content with the incorporation of CSP could be due to the higher ash content of CSP (4-6%) (Kulczyński *et al.*, 2019). Crude fibre content of spent hen meat biscuits was recorded as increased ( $p<0.05$ ) with the incorporation of CSP, with the T3 sample recorded with the highest crude fibre content. This could be attributed to the higher fibre content in CSP (up to 30%) (Fernández-López *et al.*, 2021). The higher calorific content of the developed meat biscuits could be attributed to the higher fat content of the developed products due to higher fat levels in the CSP.

### Texture and colour profile

The mean hardness value of the developed products recorded a significant ( $p<0.05$ ) increase with increasing CSP levels and followed the following order-  $C<T1<T2<T3$  (Table 3). This could be attributed to the addition of CSP decreased the spread of biscuit dough without significantly altering the thickness of the meat biscuit dough, thereby increasing the breaking strength. This resulted in the formation of harder products upon baking. The increased fibre content increased the hardness of meat biscuits. However, the penetrability of the developed products decreased with the increasing levels of CSP incorporation. This could be attributed to increasing levels of fat in the treated products upon the incorporation of CSP. Similarly increase in the shear force value in meat biscuits upon incorporation of fibre sources (oat bran, wheat bran, and peanut hull powder) was also reported (Kumar *et al.*, 2016, 2021).

**Table 2:** Physico-chemical and proximate analysis of spent hen meat biscuits incorporated with chia seed powder (Mean±S.E.)\*

| Parameters         | Control                  | T1                       | T2                       | T3                       |
|--------------------|--------------------------|--------------------------|--------------------------|--------------------------|
| pH                 | 6.28±0.02 <sup>a</sup>   | 6.38±0.03 <sup>b</sup>   | 6.42±0.08 <sup>b</sup>   | 6.45±0.09 <sup>b</sup>   |
| Moisture (%)       | 6.39±0.21 <sup>a</sup>   | 6.72±0.19 <sup>ab</sup>  | 6.94±0.20 <sup>bc</sup>  | 7.10±0.12 <sup>c</sup>   |
| Fat (%)            | 21.11±0.28 <sup>a</sup>  | 22.75±0.39 <sup>b</sup>  | 22.95±0.65 <sup>bc</sup> | 23.25±0.98 <sup>c</sup>  |
| Protein (%)        | 22.11±0.15 <sup>a</sup>  | 22.71±0.21 <sup>ab</sup> | 22.85±0.31 <sup>bc</sup> | 23.16±0.28 <sup>c</sup>  |
| Ash (%)            | 2.92±0.08 <sup>a</sup>   | 3.42±0.18 <sup>b</sup>   | 3.64±0.21 <sup>bc</sup>  | 3.82±0.11 <sup>c</sup>   |
| Crude fibre (%)    | 0.68±0.05 <sup>a</sup>   | 0.78±0.08 <sup>b</sup>   | 0.85±0.07 <sup>bc</sup>  | 0.92±0.11 <sup>c</sup>   |
| Energy/ 100 (Kcal) | 452.01±1.75 <sup>a</sup> | 461.34±0.67 <sup>b</sup> | 464.50±1.96 <sup>c</sup> | 471.62±1.75 <sup>d</sup> |

\*Means with different superscripts differ significantly ( $P<0.05$ ) in a row; n = 6 for each treatment.

Control: meat biscuit prepared without CSP; T1 -meat biscuits with 4.0% CSP, T2 -meat biscuits with 6.0% CSP, T3 -meat biscuit with 8.0% CSP.

**Table 3:** Instrumental texture and colour profile of spent hen meat biscuits incorporated with chia seed powder (Mean±S.E.)\*

| Parameters              | Control                  | T1                       | T2                       | T3                      |
|-------------------------|--------------------------|--------------------------|--------------------------|-------------------------|
| <b>Texture analysis</b> |                          |                          |                          |                         |
| Hardness (N)            | 31.16±1.75 <sup>a</sup>  | 35.15±1.49 <sup>b</sup>  | 40.67±2.21 <sup>c</sup>  | 45.57±1.76 <sup>d</sup> |
| Penetrability (N)       | 51.67±2.65 <sup>c</sup>  | 47.64±3.51 <sup>b</sup>  | 46.92±1.89 <sup>b</sup>  | 41.92±2.62 <sup>a</sup> |
| <b>Colour profile</b>   |                          |                          |                          |                         |
| <i>L</i> *              | 44.78±0.92 <sup>bc</sup> | 46.12±1.08 <sup>c</sup>  | 43.18±1.11 <sup>b</sup>  | 35.38±0.78 <sup>a</sup> |
| <i>a</i> *              | 9.51±0.14 <sup>b</sup>   | 8.82±0.45 <sup>a</sup>   | 9.56±0.34 <sup>b</sup>   | 9.63±0.22 <sup>b</sup>  |
| <i>b</i> *              | 22.15±0.24 <sup>c</sup>  | 21.11±0.17 <sup>bc</sup> | 20.62±0.31 <sup>ab</sup> | 16.82±0.21 <sup>a</sup> |
| chroma                  | 24.11±0.26 <sup>c</sup>  | 22.88±0.18 <sup>b</sup>  | 22.75±0.22 <sup>b</sup>  | 19.14±0.25 <sup>a</sup> |
| Hue                     | 66.78±1.24 <sup>bc</sup> | 67.37±1.67 <sup>c</sup>  | 65.01±1.39 <sup>b</sup>  | 59.98±1.02 <sup>a</sup> |

\*Means with different superscripts differ significantly ( $P<0.05$ ) in a row;  $n = 6$  for each treatment.

Control: meat biscuit prepared without CSP; T1 -meat biscuits with 4.0% CSP, T2 -meat biscuits with 6.0% CSP, T3 -meat biscuit with 8.0% CSP.

The colour attributes had a very crucial role in determining consumers' acceptability of baked products such as meat biscuits. The colour development of meat biscuits is determined by the time and temperature combinations used during baking (Maillard reaction/ surface browning). The colour profile of spent hen meat biscuits incorporated with various levels of CSP is presented in Table 3. The CSP incorporation resulted in the lowering of the lightness ( $L^*$ ) value of the meat biscuits.  $L^*$  value of T3 was recorded as the lowest, with the  $L^*$  value of the control and T1 and T3 samples being comparable. The natural dark colour of CSP also contributed to the development of dark colour in addition to the higher amount of starch (due to refined wheat flour and CSP) and protein (due to spent hen meat powder) in meat biscuits at low moisture content and higher baking temperature caused darkening of the developed meat biscuits. Similar findings of lowered lightness value ( $L^*$ ) were also reported by Arifin *et al.* (2021) in chicken sausage and Oliveira *et al.* (2015) in pasta preparations.

The redness ( $a^*$ ) value of T3 and T2 samples was recorded as comparable, and significantly ( $p<0.05$ ) higher than the control samples. This could be attributed to the dark colour of CSP added to the treated products. Furthermore, the CSP incorporation in the meat biscuits was observed to lower the yellowness ( $b^*$ ) value. Similar findings have also been reported by Arifin *et al.* (2021) in chicken sausages, Paula *et al.* (2019) in the chicken burger, and Karpińska-Tymoszczyk *et al.* (2021) in pork patties prepared by substituting chicken meat with various levels of CSP.

This could also be attributed to the natural plant pigments and phenolic compounds present in CSP. Furthermore, the treated meat biscuits had lower hue angle values and were closely related to a pink colour as compared to that of control biscuits without CSP. The chroma, denoting saturation index or the intensity of the colour, also lowered with the incorporation of CSP in the treated products as compared to the control. Similar findings of lowered chroma and hue value with the incorporation of CSP were also reported by Karpińska-Tymoszczyk *et al.* (2021) in pork patties.

### Sensory analysis

The CSP incorporation in the development of spent hen meat biscuits affected the sensory attributes of the developed product (Table 4). All the sensory attributes except appearance and colour of the control biscuits were recorded significantly ( $p<0.05$ ) lower than the treated meat biscuits manufactured by incorporating CSP. The appearance and colour scores of T1 meat biscuits were reported as the highest, followed by those of T2 biscuits. The initial higher appearance and colour score of T1 samples could be due to the higher browning and surface darkening due to incorporation of CSP. However, the higher levels of CSP incorporation could be attributed to the excessive browning, that were not preferred by the sensory panellists. These findings are in accordance with the instrumental colour profile as depicted in Table 2. The

**Table 4:** Sensory evaluation of spent hen meat biscuits incorporated with chia seed powder (Mean±S.E.)\*

| Parameters            | Control                | Chia seed powder        |                        |                        |
|-----------------------|------------------------|-------------------------|------------------------|------------------------|
|                       |                        | T1 (4%)                 | T2 (6%)                | T3 (8%)                |
| Appearance and colour | 6.85±0.04 <sup>a</sup> | 7.35±0.07 <sup>c</sup>  | 7.16±0.18 <sup>b</sup> | 6.75±0.08 <sup>a</sup> |
| Flavour               | 6.84±0.06 <sup>a</sup> | 6.95±0.12 <sup>ab</sup> | 7.17±0.07 <sup>c</sup> | 7.03±0.09 <sup>b</sup> |
| Mouth coating         | 6.84±0.06 <sup>a</sup> | 7.12±0.09 <sup>b</sup>  | 7.35±0.08 <sup>c</sup> | 6.95±0.07 <sup>a</sup> |
| Saltiness             | 6.78±0.05 <sup>a</sup> | 7.08±0.06 <sup>c</sup>  | 7.21±0.09 <sup>d</sup> | 6.92±0.12 <sup>b</sup> |
| Crispiness            | 6.81±0.04 <sup>a</sup> | 7.08±0.11 <sup>b</sup>  | 7.25±0.05 <sup>c</sup> | 6.93±0.04 <sup>a</sup> |
| Overall acceptability | 6.91±0.07 <sup>a</sup> | 7.11±0.10 <sup>b</sup>  | 7.38±0.05 <sup>c</sup> | 6.92±0.08 <sup>a</sup> |

\*Means with different superscripts differ significantly ( $P < 0.05$ ) in a row;  $n = 21$  for each treatment.

Control: meat biscuit prepared without CSP; T1 -meat biscuits with 4.0% CSP, T2 -meat biscuits with 6.0% CSP, T3 -meat biscuit with 8.0% CSP.

mean flavour score of T2 meat biscuits was recorded as the highest and significantly ( $p < 0.05$ ) higher than the control and other treated samples. The mouth coating of the T2 sample was recorded as the highest and significantly ( $p < 0.05$ ) higher than T1 and T3. The mouth coating score of T2 meat biscuits was recorded significantly higher than other samples, including the control and treatments. Similarly, findings were also reported by Kumar *et al.* (2016) by incorporating oat and wheat bran in spent hen meat biscuits and Kumar *et al.* (2021) in chevon biscuits incorporated with peanut hull powder.

For snack products, like meat biscuits, crispiness is a very important determinant of consumer acceptability and marketability. The crispiness and saltiness perception recorded an increase upon CSP incorporation of except at the T3 level. This might be attributed to the high fibre and mineral contents in CSP. At a higher level of CSP, the incorporation (8%) in T3 samples, the panelists did not like the excessive salty taste in the T3 sample. The overall acceptability of T2 was recorded significantly ( $p < 0.05$ ) higher than control and T3 samples. The overall acceptability of control and T3 was recorded as comparable. This might be attributed to the higher value for appearance and colour, flavour, mouth coating, saltiness, and crispiness values, as overall acceptability reflects the overall sensory quality of the developed spent hen meat biscuits.

## CONCLUSION

Chia seed powder (CSP) could be successfully used

to develop high-quality spent hen meat biscuits. The incorporation of CSP in the meat biscuits resulted in increased pH values, fat, dietary fibre, and ash content. The incorporation of CSP at 6% improved the nutritive value and sensory attributes of the developed products.

## REFERENCES

- Abraha, B., Mahmud, A., Admassu, H., Yang, F., Tsighe, N., Girmatsion, M., Xia, W., Magoha, P., Yu, P., Jiang, Q. and Xu, Y. 2018. Production and quality evaluation of biscuit incorporated with fish fillet protein concentrate. *J. Nutr. Food Sci.*, **08**(06): 744.
- Agu, H.O., Onuoha, G.O., Elijah, O.E. and Jideani, V.A. 2020. Consumer acceptability of acha and malted Bambara groundnut (BGN) biscuits sweetened with date palm. *Heliyon*, **6**(11): e05522.
- Arifin, N., Hanifah, N.F.M. and Yahya, H.N. 2021. Physicochemical properties, nutritional composition and sensory acceptance of chicken meat sausages with chia seed powder substitution. *Malaysian J. Sci. Health Technol.*, **7**(1): 34–42.
- Association of Official Analytical Chemists, A.O.A.C. (US). 2019. *Official methods of analysis of the Association of Official Analytical Chemists 21<sup>st</sup> Edition*. <https://www.aoac.org/official-methods-of-analysis-21st-edition-2019/>
- Bristone, C., Charles, A. and Idakwo, P. 2017. Development of Nigerian based food like biscuit (Guliguli) from mixtures of sorghum, maize, soybean, moringa leave and crayfish. *Int. J. Curr. Res.*, **9**(10): 59664–59671.
- Ding, Y., Lin, H.-W., Lin, Y.-L., Yang, D.-J., Yu, Y.-S., Chen, J.-W., Wang, S.-Y. and Chen, Y.-C. 2018. Nutritional



- composition in the chia seed and its processing properties on restructured ham-like products. *J. Food Drug Anal.*, **26**(1): 124–134.
- Fernández-López, J., Viuda-Martos, M. and Pérez-Alvarez, J. A. 2021. Quinoa and chia products as ingredients for healthier processed meat products: Technological strategies for their application and effects on the final product. *Curr. Opin. Food Sci.*, **40**: 26–32.
- Fernández-López, J., Viuda-Martos, M., Sayas-Barberá, M.E., Navarro-Rodríguez de Vera, C., Lucas-González, R., Roldán-Verdú, A., Botella-Martínez, C. and Pérez-Alvarez, J.A. 2020. Chia, quinoa, and their coproducts as potential antioxidants for the meat industry. *Plants*, **9**(10): 1359.
- Karpińska-Tymoszczyk, M., Danowska-Oziewicz, M. and Draszanowska, A. 2021. Effect of the addition of chia seed gel as egg replacer and storage time on the quality of pork patties. *Foods*, **10**(8): 1744.
- Keeton, J.T. 1983. Effects of fat and NaCl/phosphate levels on the chemical and sensory properties of pork patties. *J. Food Sci.*, **48**(3): 878–881.
- Knez Hrnčič, M., Ivanovski, M., Cör, D. and Knez, Ž. 2019. Chia seeds (*Salvia hispanica* L.): An overview—phytochemical profile, isolation methods, and application. *Molecules*, **25**(1): 11.
- Kulczyński, B., Kobus-Cisowska, J., Taczanowski, M., Kmiecik, D. and Gramza-Michałowska, A. 2019. The chemical composition and nutritional value of chia seeds—current state of knowledge. *Nutrients*, **11**(6): 1242.
- Kumar, P., Chatli, M.K., Mehta, N., Malav, O.P., Verma, A.K. and Kumar, D. 2016. Quality attributes and storage stability of chicken meat biscuits incorporated with wheat and oat bran. *J. Food Qual.*, **39**(6): 649–657.
- Kumar, P., Goswami, M., Mehta, N., Wagh, R.V., Sharma, A. and Hundal, J.S. 2021. Storage stability of chevon biscuits incorporated with peanut hull powder. *Indian J. Small Rumin.*, **27**(2): 248–252.
- Kumar, P., Verma, A.K., Kumar, D., Umaraw, P., Mehta, N. and Malav, O.P. 2019. Meat snacks: A Novel Technological Perspective. In: *Innovations in Traditional Foods*. (Galanakis, C.M. ed) pp. 293–321.
- Mehta, N., Ahlawat, S.S., Sharma, D.P. and Dabur, R.S. 2015. Novel trends in development of dietary fiber rich meat products—A critical review. *J. Food Sci. Technol.*, **52**(2): 633–647.
- Motyka, S., Skala, E., Ekiert, H. and Szopa, A. 2023. Health-promoting approaches of the use of chia seeds. *J. Funct. Foods*, **103**: 105480.
- Muñoz, L.A., Cobos, A., Diaz, O. and Aguilera, J.M. 2012. Chia seeds: Microstructure, mucilage extraction and hydration. *J. Food Eng.*, **108**(1): 216–224.
- Nogueira, A. de C. and Steel, C.J. 2018. Protein enrichment of biscuits: a review. *Food Rev. Int.*, **34**(8): 796–809.
- Oliveira, M.R., Novack, M.E., Santos, C.P., Kubota, E. and da Rosa, C.S. 2015. Evaluation of replacing wheat flour with chia flour (*Salvia hispanica* L.) in pasta. *Semina: Ciências Agrárias*, **36**(4): 2545–2553.
- Paula, M.M. de O., Silva, J.R.G., Oliveira, K.L. de, Massingue, A.A., Ramos, E.M., Benevenuto Júnior, A.A., Silva, M.H.L. and Silva, V.R.O. 2019. Technological and sensory characteristics of hamburgers added with chia seed as fat replacer. *Ciência Rural*, **49**(8).
- Rani, R., Kumar, S. and Yadav, S. 2021. Pumpkin and chia seed as dietary fibre source in meat products: A review. *Pharma Innov.*, **10**: 477–485.
- Senna, C., Soares, L., Egea, M.B. and Fernandes, S.S. 2024. The techno-functionality of chia seed and its fractions as ingredients for meat analogs. *Molecules*, **29**(2): 440.
- Singh, P.K., Kumar, S., Bhat, Z.F. and Kumar, P. 2015. Effect of sorghum bicolor and clove oil on the quality characteristics and storage quality of aerobically packaged chevon cutlets. *Nutr. Food Sci.*, **45**(1): 145–165.
- Singh, P.K., Kumar, S., Kumar, P. and Bhat, Z.F. 2014. Standardization of shredded potato and added water levels in the development of chevon cutlets. *J. Anim. Res.*, **4**(2): 251.
- Singh, P., Singh, R., Jha, A., Rasane, P. and Gautam, A. K. 2015. Optimization of a process for high fibre and high protein biscuit. *J. Food Sci. Technol.*, **52**(3): 1394–1403.
- Vera-Cespedes, N., Muñoz, L.A., Rincón, M.Á. and Haros, C. M. 2023. Physico-chemical and nutritional properties of chia seeds from latin american countries. *Foods*, **12**(16): 3013.
- Verma, A.K., Pathak, V., Singh, V.P. and Umaraw, P. 2014. Effects of replacement of refined wheat flour with chicken meat on the physicochemical and sensory properties of noodle. *Indian J. Poult. Sci.*, **49**(2): 193–197.