

International Journal of Advanced Biochemistry Research



ISSN Print: 2617-4693
ISSN Online: 2617-4707
NAAS Rating (2026): 5.29
IJABR 2026; 10(4): 177-181
www.biochemjournal.com
Received: 08-01-2026
Accepted: 11-02-2026

Dr. Pooja Rani
MVSC, Department of
Livestock Products
Technology, Lala Lajpat Rai
University of Veterinary and
Animal Sciences Hisar,
Haryana, India

Dr. Ashok Malik
Senior Scientist, Department
of Livestock Products
Technology, Lala Lajpat Rai
University of Veterinary and
Animal Sciences Hisar,
Haryana, India

Dr. Sanjay Yadav
Professor & HOD, Department
of Livestock Products
Technology, Lala Lajpat Rai
University of Veterinary and
Animal Sciences Hisar,
Haryana, India

Dr. Rathod Rohit Kailasrao
Department of Livestock
Products Technology,
Indian Veterinary Research
Institute, Bareilly, Uttar
Pradesh, India

Dr. Shubham Dudi
Ph.D. Scholar, Department of
Livestock Products
Technology, Lala Lajpat Rai
University of Veterinary and
Animal Sciences Hisar,
Haryana, India

Dr. Pramod Kumar
Department of Livestock
Products Technology, Lala
Lajpat Rai University of
Veterinary and Animal
Sciences Hisar, Haryana, India

Corresponding Author:
Dr. Pooja Rani
MVSC, Department of
Livestock Products
Technology, Lala Lajpat Rai
University of Veterinary and
Animal Sciences Hisar,
Haryana, India

Evaluation of proximate and textural profiles of chicken meat rolls fortified with pearl millet and foxtail millet flours

Pooja Rani, Ashok Malik, Sanjay Yadav, Rathod Rohit Kailasrao, Shubham Dudi and Pramod Kumar

DOI: <https://www.doi.org/10.33545/26174693.2026.v10.i4c.8073>

Abstract

The primary objective of this research was to develop functional chicken meat rolls by incorporating pearl millet flour (PMF) and foxtail millet flour (FTMF), both individually and in combination, to enhance the dietary fibre and nutritional profile of poultry products. Based on preliminary sensory evaluations, three experimental formulations were selected for detailed analysis: 9% PMF, 6% FTMF, and a combination of 5% PMF and 3% FTMF. These treatments were compared against a control group formulated with 3% semolina. Proximate analysis revealed that the inclusion of millet flours significantly increased ($p \leq 0.05$) moisture retention, ash content, and crude fibre levels, among this 9% PMF treatment achieving the highest fibre enrichment. While a significant reduction ($p < 0.05$) in protein content was observed in the treated groups, no significant differences were noted in total fat content. Texture profile analysis (TPA) indicated that millet fortification significantly increased ($p \leq 0.05$) instrumental hardness, gumminess, chewiness as well as firmness and toughness. However, critical elasticity parameters, including springiness and cohesiveness, remained statistically comparable to the control. Instrumental color analysis further demonstrated that the incorporation of PMF and FTMF resulted in a significantly darker (L^*) and more intensely red (a^*) product without altering yellowness (b^*). The study concludes that pearl and foxtail millets are effective functional ingredients for producing nutrient-dense, fibre-enriched chicken rolls. These grains successfully improve the health-promoting properties of meat products while maintaining essential structural integrity and quality characteristics.

Keywords: Dietary fibre, foxtail millet, functional meat products, pearl millet, texture profile analysis

Introduction

In the global market, there is a surging demand for wholesome, minimally processed meat products as consumers become increasingly proactive about food safety and long-term health. Given the rise in chronic conditions like cardiovascular disease, obesity, and certain cancers, the development of "functional" meat products—those that offer health benefits beyond basic nutrition—has become a priority for the food industry (Hong *et al.*, 2021) [12].

Poultry, in particular, remains a preferred protein source due to its affordability, lean profile, and versatility in texture and flavor (Koblitz, 2000) [15]. On average, poultry meat provides approximately 18.4% to 23.4% protein, while maintaining a relatively low lipid content of 2% to 6% (Culioli *et al.*, 2003) [16].

Recently, dietary fibre has been utilized as a fat substitute in the production of low-fat meat products. Moreover, the inclusion of dietary fibres in muscle foods not only improves cooking yield by enhancing emulsion stability and viscosity but also enhances the rheological properties of meat emulsion. The increasing popularity of extended meat products can also be attributed to economic factors, as production costs can be significantly reduced. This highlights the need to develop functional meat products that are enriched with dietary fibres, natural antioxidants, antimicrobials, essential minerals, low fat, reduced sodium, and omega-3 and omega-6 fatty acids (Hygreeva *et al.*, 2014) [13].

Integrating millets into meat formulations offers a strategic solution to the fibre deficit in traditional animal products. Millets are nutrient-dense grains packed with dietary fibre, antioxidants, and essential minerals (Himanshu *et al.*, 2018) [11].

Furthermore, because millets are naturally gluten-free, they serve as an ideal functional ingredient for individuals managing celiac disease (Jukanti *et al.*, 2016) [14].

Pearl millet (*Pennisetum glaucum*), or bajra, is a drought-resilient staple providing 361 kcal/100 g and a robust nutritional profile of 13.6% protein, 7.8% fat, and up to 13.3% dietary fibre (Abdelrahman *et al.*, 2005; Ali *et al.*, 2003) [1, 2]. It is rich in essential minerals like phosphorus and iron, and its high tryptophan and threonine levels enhance its value as a cost-effective protein extender in meat products (Kulthe *et al.*, 2016; Yaro, 2020) [16, 35]. Furthermore, its phenolic content (1.2 µmol FAE/g) contributes vital antioxidant and anti-inflammatory properties (Sindhu *et al.*, 2019) [28].

Foxtail millet (*Setaria italica*) is a fast-growing annual crop adaptable to diverse climates, offering 351 kcal/100 g and a superior fibre content of 14% (FAO, 2011; Sharma & Niranjana, 2017) [8, 27]. It is a significant source of carotene and magnesium, which supports cardiovascular health and migraine management (Xue *et al.*, 2008) [34]. With a phenolic concentration of (1.28 µmol FAE/g) and high lecithin levels, foxtail millet provides strong antioxidant activity and nervous system support, making it an ideal functional ingredient (Sindhu *et al.*, 2019; Xue *et al.*, 2008) [28, 34].

By blending the high-quality protein of poultry with the fibre and antioxidant-rich profile of pearl and foxtail millets, manufacturers can create a "superfood" meat product. This hybrid approach addresses the modern consumer's need for a balanced diet that supports metabolic health while maintaining the sensory appeal of traditional meat (Kulthe *et al.*, 2016; Sharma & Niranjana, 2017) [16, 27].

The primary objective of this research was to fortify meat products with dietary fibre and enrich them with various health-promoting properties through the incorporation of pearl and foxtail millets.

Experimental details

The present study was conducted in the Department of Livestock Products Technology, College of Veterinary Sciences, LUVAS, Hisar.

Materials

Healthy broiler chickens, aged approximately 5 to 6 weeks and raised under uniform nutritional and management protocols, were sourced from the Livestock Farm at the College of Veterinary Sciences, LUVAS, Hisar, or the local Hisar market. The birds underwent slaughter and dressing following standardized procedures. After a thorough carcass wash, the meat was manually deboned, ensuring the removal of all visible adipose and connective tissues. The resulting deboned poultry was sealed in low-density polyethylene (LDPE) bags and maintained in a deep freezer until required for analysis.

Standardized proportions of sodium chloride, sodium tripolyphosphate (STTP), laboratory-developed spice blends, vegetable oils, water, whole egg liquid, and semolina were utilized alongside a condiments mix. To prepare the millet components, pearl and foxtail millet grains were sourced from the local Hisar market, rinsed thoroughly with clean water, and strained through muslin cloth to remove excess moisture. Following this, the grains were dehydrated in a hot air drier and ground into a fine powder before being stored in airtight containers.

All supplementary chemicals, analytical standards, and culture media required for the study were obtained from reputable suppliers, including Qualigens, CDH, Hi-Media, and Sigma-Aldrich.

Preparation of control chicken rolls

To prepare the control meat rolls, 77 g of minced poultry was blended with a precise mixture of sodium chloride (1.75 g), sodium tripolyphosphate (0.3 g), and a 1:1 ratio of ginger-garlic condiments (3.25 g). The formulation was further supplemented with a laboratory-developed spice mix (1.75 g), semolina flour (3 g), and refined vegetable oil (7 g), using ice flakes (2.7 g) to maintain temperature during the process. These ingredients were homogenized for 4 to 5 minutes to ensure the formation of a stable emulsion. This mixture was then transferred to beakers, sealed with aluminum foil, and subjected to low-heat steam cooking for 35 minutes. Once the internal temperature stabilized, the rolls were cooled to ambient temperature, packaged in polyethylene bags, and maintained under refrigeration at 4±1 °C for subsequent analysis.

Levels of pearl millet flour (PMF) and foxtail millet flour (FTMF) were selected on the basis of sensory evaluation.

Final treatments

- **Control:** Chicken roll with incorporation of 3% semolina flour (3 gm SF/100 gm emulsion)
- **T₁:** Chicken roll with incorporation of 9% pearl millet flour (3 gm PMF/100 gm emulsion)
- **T₂:** Chicken roll with incorporation of 6% foxtail millet flour (6 gm FTMF/100 gm emulsion)
- **T₃:** Chicken roll with incorporation of 5% pearl millet flour + 3% foxtail millet (5 gm PMF + 3 gm FTMF/100 gm emulsion)

Proximate composition

Proximate composition was determined by following the standard methods of AOAC (2005) [3].

Shear press value (Firmness and toughness)

Force needed to shear 1 cm³ piece of chicken meat rolls was recorded by using Warner Bratzler Shear Press (Salter Model No. 235 6S). Values were expressed in kg/cm³.

Texture profile analysis (TPA)

The texture of both control and treated rolls was assessed using the Texture Analyser (TAHD plus) from Stable Micro Systems Ltd., based in Surrey, England, utilizing the Texture Exponent Prog. A compression platform with a diameter of 70 mm was employed as a probe, following the method outlined by Bourne (1978) for Texture Profile Analysis (TPA). Samples measuring 20 mm in diameter and 15 mm in height were compressed to 50% of their original height, with a 5-second interval between the two compression cycles. Force-time deformation curves were generated using a 50 kg load cell at a cross-head speed of 2 mm/sec. Various textural attributes such as hardness, springiness, cohesiveness, gumminess, and chewiness were evaluated.

Instrumental colour analysis

Colour of chicken rolls was measured using a Konica Minolta chroma meter CR-400 (Konica Minolta Sensing, Inc., Japan) with 8 mm aperture for measurement. The

instrument was calibrated with a white standard plate. Colour scores were expressed as CIE Lab L* (lightness), a* (redness) and b* (yellowness).

Statistical analysis

Data obtained from above test were subjected to statistical analysis using Tukey test by using SPSS-16.0 (SPSS Inc., Chicago, II USA) software to find out the significant difference at 5% significance level in the mean values.

Result and Discussion

Proximate composition

Incorporation of PMF and FTMF to chicken meat rolls resulted in significant increase in moisture content of chicken rolls compared to control. Similar finding observed by Reddy *et al.* (2017b) [23] were reported an increase in moisture content in sausages with higher levels of foxtail millet flour, particularly at 9% incorporation, compared to the control. Addition of PMF and FTMF resulted in a significant increase in crude fibre content compared to control. Increase in crude fibre content in treated rolls was due to higher dietary fibre content in PMF and FTMF. Pushparaj and Urooj (2011) [21] found that the pearl millet had dietary fibre content approximately 11.9%-13.3%. Sharma and Niranjana (2017) [27] also noticed that the total

dietary fibre content of foxtail millet is 14 g/100 g. Similar finding observed by Reddy *et al.* (2017b) [23] who reported increased crude fibre content with higher levels of foxtail millet flour in sausages. Crude protein content of control was found significantly higher than treated rolls. Similar findings were also reported by Reddy *et al.* (2017b) [23] who observed a significant decrease in protein content in both raw and cooked chevon sausages with foxtail millet flour. Shinde *et al.* (2019) [28] also reported lower protein content in Japanese quail meat nuggets treated with finger millet flour at a 6% level compared to the control. No significant difference was noticed in fat content of control and treated chicken rolls. Pushparaj and Urooj (2011) [21] found that the pearl millet had dietary crude fat content approximately 7.8% crude fat. Sharma and Niranjana (2017) [27] also noticed that the crude fat content of foxtail millet is (4.3 g/100 g). Similar finding was observed by Dahriya *et al.* (2024) [7] who reported that the fat level increased slightly with the addition of kodo millet flour in chicken meat nuggets. Ash content was significantly higher in treated rolls in comparison to control. Similar finding was reported by Gamit *et al.* (2020) [9] who observed increased ash content in chicken meat cutlets with finger millet flour at various incorporation levels.

Table 1: Effect of incorporation of selected level of millet on proximate composition (Mean $\pm$ SD)

Treatments	Moisture (%)	Crude Fibre (%)	Fat (%)	Protein (%)	Ash (%)
Control	64.32 $\pm$ 0.57	0.61 ^a $\pm$ 0.03	9.05 $\pm$ 0.15	20.92 $\pm$ 1.1	2.82 ^a $\pm$ 0.15
T ₁	67.19 $\pm$ 0.85	2.17 ^c $\pm$ 0.03	9.23 $\pm$ 0.27	16.63 ^a $\pm$ 0.44	3.05 ^b $\pm$ 0.03
T ₂	65.59 $\pm$ 0.51	2.10 ^b $\pm$ 0.03	9.10 $\pm$ 0.09	17.98 ^b $\pm$ 0.13	3.01 ^b $\pm$ 0.02
T ₃	65.83 ^b $\pm$ 0.54	2.14 ^{bc} $\pm$ 0.04	9.16 $\pm$ 0.03	17.47 ^{ab} $\pm$ 0.40	3.03 ^b $\pm$ 0.04

Mean with different small letter superscripts in a column differ significantly ($p \leq 0.05$) ($n = 6$)

Control-Chicken rolls with 3% semolina, T₁-Chicken rolls with 9% pearl millet flour, T₂-Chicken rolls with 6% foxtail millet flour, T₃-Chicken rolls with 5% pearl millet flour + 3% foxtail millet flour

Firmness, toughness and texture profile analysis

The firmness and toughness values were found significantly higher in all treated rolls comparison to control. Similar results were observed by Santhi *et al.* (2019) [25], who

observed an enhancement in textural attributes of treated rolls such as firmness, toughness and hardness compared to control sample.

Table 2: Effect of incorporation of selected level of millet flour on firmness and toughness of chicken meat rolls (Mean $\pm$ SD)

Treatments	Firmness (Kg/cm ³)	Toughness (Kg-sec)
Control	0.77 ^a $\pm$ 0.05	7.69 ^a $\pm$ 0.16
T ₁	0.95 ^b $\pm$ 0.06	9.44 ^d $\pm$ 0.30
T ₂	0.87 ^{ab} $\pm$ 0.07	8.43 ^c $\pm$ 0.17
T ₃	0.83 ^a $\pm$ 0.08	8.11 ^b $\pm$ 0.10

Mean with different small letter superscripts in a column differ significantly ($p \leq 0.05$)

Control-Chicken rolls with 3% semolina, T₁-Chicken rolls with 9% pearl millet flour, T₂-Chicken rolls with 6% foxtail millet flour, T₃-Chicken rolls with 5% pearl millet flour + 3% foxtail millet flour

Texture profile analysis of control and treated rolls revealed a significant increase in hardness in all treated rolls. Higher hardness values in these treatments might be due to their

high fibre content. No any significant difference was noticed in springiness and cohesiveness value of control and treated rolls.

Table 3: Effect of incorporation of selected level of millet flour (on texture profile analysis of chicken meat rolls (Mean $\pm$ SD)

Treatments	Hardness (N)	Springiness	Cohesiveness	Gumminess (N)	Chewiness (N)
Control	65.81 ^a $\pm$ 0.64	0.83 $\pm$ 0.10	0.46 $\pm$ 0.05	24.47 ^a $\pm$ 0.07	25.25 ^a $\pm$ 1.01
T ₁	74.72 ^d $\pm$ 0.68	0.88 $\pm$ 0.10	0.50 $\pm$ 0.07	26.99 ^b $\pm$ 0.06	28.08 ^b $\pm$ 1.02
T ₂	70.94 ^b $\pm$ 0.83	0.85 $\pm$ 0.08	0.48 $\pm$ 0.08	30.73 ^d $\pm$ 0.07	26.82 ^{ab} $\pm$ 2.47
T ₃	72.45 ^c $\pm$ 0.40	0.86 $\pm$ 0.07	0.49 $\pm$ 0.12	29.24 ^c $\pm$ 0.23	26.54 ^{ab} $\pm$ 1.54

Mean with different small letter superscripts in a column differ significantly ($p \leq 0.05$)

Control-Chicken rolls with 3% semolina, T₁-Chicken rolls with 9% pearl millet flour, T₂-Chicken rolls with 6% foxtail millet flour, T₃-Chicken rolls with 5% pearl millet + 3% foxtail millet flour

Gumminess and chewiness are secondary parameters. Values of gumminess depend on the values of hardness and cohesiveness. Chewiness depends on gumminess and springiness. Addition of PMF and FTMF resulted in a significant increase in gumminess value compared to control. Addition of PMF (T₁) resulted in a significant increase in chewiness value compared to control. In a similar type of study on low fat chicken meat ball Santhi *et al.* (2019) [25], observed an enhancement in textural attributes such as hardness, gumminess and chewiness compared to the control samples by addition of pearl millet up to 10% in low fat chicken meat balls.

Instrumental colour analysis

Colour is considered as a crucial factor in indicating the quality and freshness of meat and is often considered the primary determinant of its shelf life (Smith *et al.*, 2000) [29]. As such, it plays a significant role in influencing consumer preferences. The lightness (L*) values of treated chicken rolls was found significantly lower in comparison to control. Results indicate that incorporation of PMF and FTMF contributed to increase in darkness of chicken rolls. Similar finding was observed by Naveena *et al.* (2006) [18] who concluded that the addition of Ragi flour (RF) resulted in a significant reduction in the Lightness (L*) values of the patties compared to the control group. Incorporation of PMF and FTMF individually as well as their combination resulted in enhancement of redness compared to control.

Table 4: Effect of incorporation of selected level of millet flour on instrumental colour analysis of chicken meat rolls (Mean ± SD)

(n = 12)			
Treatments	L* (Lightness)	a* (Redness)	b* (Yellowness)
Control	52.41 ^c ±1.26	3.87 ^a ±0.18	9.37±0.22
T ₁	46.47 ^a ±0.52	4.40 ^b ±0.15	9.31±0.07
T ₂	49.28 ^b ±0.78	5.00 ^d ±0.06	9.34±0.11
T ₃	47.01 ^a ±0.32	4.78 ^c ±0.08	9.32±0.07

Mean with different small letter superscripts in a column differ significantly ($p \leq 0.05$)

Control-Chicken rolls with 3% semolina, T₁-Chicken rolls with 9% pearl millet flour, T₂-Chicken rolls with 6% foxtail millet flour, T₃-Chicken rolls with 5% pearl millet + 3% foxtail millet flour

No significant difference was noticed in yellowness of control and treated chicken rolls. This trend may be due to darker colour of millets and their polyphenol component which found in PMF and FTMF treated rolls. Gorachiya *et al.* (2022) [10] also reported a significant decrease in lightness (L*) and yellowness (b*) values with increasing levels of ragi flour, while the redness (a*) values significantly increased ($p < 0.05$) when ragi flour was added to chicken sausage.

Conclusion

The investigation demonstrated that the incorporation of 9% pearl millet flour (PMF) and 6% foxtail millet flour (FTMF) individually and their combination 5% PMF and 3% FTMF significantly enhanced the dietary fibre, moisture, and mineral content of chicken meat rolls compared to semolina-based controls. Although millet fortification increased firmness, toughness, instrumental hardness, gumminess, and chewiness while, critical quality parameters such as fat content, springiness, and cohesiveness remained statistically comparable across all treatments. Furthermore, the inclusion of PMF and FTMF resulted in a darker, more intensely red

product, confirming the efficacy of these grains as functional ingredients for the development of nutrient-dense, fibre-enriched poultry products.

Reference

1. Abdelrahman SM, Elmaki HB, Idris WH, Babiker EE, Tinay AHE. Antinutritional factors content and minerals availability of pearl millet (*Pennisetum glaucum*) as influenced by domestic processing methods and cultivation. J Food Sci Technol. 2005;3:397-403.
2. Ali MAM, Tinay EL, Abdalla HA. Effect of fermentation on the *in vitro* protein digestibility of pearl millet. Food Chem. 2003;80:51-54.
3. AOAC. Official methods of analysis. 18th ed. Washington (DC): Association of Official Analytical Chemists; 2005.
4. Baliga BR, Madaiah N. Quality of sausage emulsion prepared from mutton. J Food Sci. 1970;35:383-385.
5. Chandrasekara A, Shahidi F. Antioxidant phenolics of millet control lipid peroxidation in human LDL cholesterol and food systems. J Am Oil Chem Soc. 2011;89(2):275-285.
6. Culioli J, Berri C, Mourot J. Muscle foods: consumption, composition and quality. Sci Aliment. 2003;23:13-34.
7. Dahriya S, Das K, Verma SK, Patyal A. Development and evaluation of shelf life of kodo millet added chicken meat nuggets. J Meat Sci. 2024;18(2):47-53.
8. FAO. Grassland index: a searchable catalogue of grass and forage legumes. Rome: FAO; 2011.
9. Gamit M, Gupta S, Savalia CV. Quality characteristics of chicken meat cutlets incorporated with finger millet (*Eleusine coracana*) flour. J Anim Res. 2020;10(1):111-116.
10. Gorachiya PR, Bais B, Pathak V, Goswami M, Basant. Quality evaluation of low fat chicken sausages fortified with dietary fibre. J Anim Res. 2022;12(3):421-428.
11. Himanshu K, Sonawane SK, Arya SS. Nutritional and nutraceutical properties of millets: a review. Clin J Nutr Diet. 2018;1(1):1-10.
12. Hong TK, Shin DM, Choi J, Do JT, Han SG. Current issues and technical advances in cultured meat production: a review. Food Sci Anim Resour. 2021;41(3):355-372.
13. Hygreeva D, Pandey M, Radhakrishna K. Potential applications of plant based derivatives as fat replacers, antioxidants and antimicrobials in fresh and processed meat products. Meat Sci. 2014;98(1):47-57.
14. Jukanti AK, Laxmipathi G, Rai KN, Manga VK, Bhatt RK. Pearl millet (*Pennisetum glaucum*): an important source of food security, nutrition and health in the arid and semi-arid tropics. Food Sec. 2016;8:307-329.
15. Koblitiz MGB. Materias-primas alimenticias: composicao e controle de qualidade. Rio de Janeiro: Grupo Gen-Guanabara Koogan; 2000.
16. Kulthe A, Thorat SS, Lande SB. Characterization of pearl millet cultivars for proximate composition, minerals and anti-nutritional contents. Int J Adv Life Sci. 2016;5(11):4672-4675.
17. Liu BY, Peng JY, Zeng XM, Zheng HY, Zhong G. Characterization of dietary fibre from millet bran. Appl Mech Mater. 2011;140:278-285.

18. Naveena BM, Muthukumar M, Sen AR, Babji Y, Murthy TRK. Quality characteristics and storage stability of chicken patties formulated with finger millet flour (*Eleusine coracana*). J Muscle Foods. 2006;17:92-104.
19. Para PA, Subha G. Effect of bajra flour (pearl millet) on quality and sensory attributes of chicken nuggets. Asian J Anim Sci. 2015;10(2):107-114.
20. Pushparaj FS, Urooj A. Nutrients, antinutrients and bioaccessible mineral content (in vitro) of pearl millet as influenced by milling. J Food Sci Technol. 2014;51:756-761.
21. Pushparaj FS, Urooj A. Influence of processing on dietary fibre, tannin and *in vitro* protein digestibility of pearl millet. Food Nutr Sci. 2011;2:895-900.
22. Reddy DM, Babu JA, Rao EB, Moorthy P, Vani S. Process optimization for the development of value added chicken meat sausages. Chem Sci Rev Lett. 2017;6(21):274-278.
23. Reddy GV, Mallika N, Reddy B, Veena D, Naik A. Effect of foxtail millet flour on quality and storage stability of functional chevon sausages. Indian J Small Rumin. 2017;23:61-61.
24. Sanchez-Zapata E, Munoz CM, Fuentes E, Fernandez-Lopez J, Sendra E, Sayas E, *et al.* Effect of tiger nut fibre on quality characteristics of pork burger. Meat Sci. 2010;85:70-76.
25. Santhi D, Kalaikannan A, Natarajan A. Characteristics and composition of emulsion based functional low-fat chicken meat balls fortified with dietary fibre sources. J Food Process Eng. 2019;43(3):13333-13333.
26. Scalbert A, Manach C, Morand C, Remesy C, Jimenez L. Dietary polyphenols and the prevention of diseases. Food Sci Nutr. 2005;45:287-306.
27. Sharma N, Niranjana K. Foxtail millet: properties, processing, health benefits, and uses. Food Rev Int. 2017;34(4):329-363.
28. Shinde PSV, Choudhary C, Bhumre P, Nemade A. Assessment of shelf life of Japanese quail meat nuggets using finger millet flour (*Eleusine coracana*) during refrigerated storage. Chem Sci Rev Lett. 2019:883-890.
29. Smith GC, Belk KE, Sofos JN, Tatum JD, Williams SN. Economic implications of improved colour stability in beef. In: Decker EA, Faustman C, Lopez-Bote CJ, editors. Antioxidants in muscle foods: nutritional strategies to improve quality. New York: Wiley; 2000. p. 297-426.
30. Sripriya G, Chandrasekharan K, Murthy VS, Chandra TS. ESR spectroscopic studies on free radical quenching action of finger millet (*Eleusine coracana*). Food Chem. 1996;57:537-540.
31. Trout ES, Hunt MC, Johnson DE, Claus JR, Castner CL, Kroff DH. Characteristics of low fat ground beef containing texture modifying ingredients. J Food Sci. 1992;57:19-24.
32. Verma AK, Sharma BD, Banerjee R. Effect of sodium chloride replacement and apple pulp inclusion on the physicochemical, textural and sensory properties of low fat chicken nuggets. Food Sci Technol. 2010;43(4):715-719.
33. Wardlaw FR, McCaskill LH, Acton JC. Effects of postmortem changes on poultry meat loaf properties. J Food Sci. 1973;38:421-423.
34. Xue YY, Li P, Lin QB. Research evolution on chemical component and physical character of foxtail millet. J Chin Cereals Oils Assoc. 2008;22:51-56.
35. Yaro J. Nutritional composition and sensory properties of beef sausages prepared using pearl millet (*Pennisetum glaucum*) flour as extender [dissertation]. 2020.