**EFFECT OF PEARL MILLET FLOUR ON QUALITY OF CHICKEN PATTIES**

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**ABSTRACT**

Though chicken is a nutrient-dense food, it is devoid of dietary fibre which performs various physiological activities in the human body. Consumption of foods with low dietary fibre is one of the major risk factors for the prevalence of many lifestyle diseases. Dietary fibre slows down the bowel movement and controls the blood sugar and cholesterol in the human body. The investigation was undertaken to optimize the level of pearl millet flour (PMF) for preparing chicken patties by replacing the chicken with PMF at 0, 3, 6 and 9 per cent in the product formulation. Moisture, crude fibre, and ash content of cooked chicken patties increased whereas, crude protein and fat contents decreased significantly with an increase in the proportion of PMF. The cooking yield, emulsion stability, and moisture retention percentage of chicken patties increased significantly with an increase in the proportion of PMF. Significantly higher sensory scores were recorded for the colour and appearance, flavour, texture and overall acceptability of the cooked chicken patties prepared by incorporating 3 and 6 per cent PMF. Juiciness of cooked chicken patties was not affected by various levels of PMF. It was concluded that the incorporation of 6 per cent PMF in the product formulation produced ground chicken patties of acceptability quality with higher dietary fibre content and lower production cost.

Keywords: Chicken patties, pearl millet, dietary fibre, sensory attributes

**ITRODUCTION:**

Though meat is a major source of extremely valuable biological proteins, certain essential fatty acids, vitamins, and minerals, it is devoid of dietary fiber, which performs various physiological activities in the human body. It has been reported that the intake of foods with low dietary fiber is one of the major risk factors for the prevalence of many life style diseases (Mishra *et al.,* 2023).Eating dietary fiber slows down the bowel movement and control blood sugar and cholesterol.Researchers are presently working on improving functional properties of various meat products by addition of beneficial ingredients, such as dietary fibers from diverse sources (Verma *et al.,* 2012). The products of soy, sunflower, wheat, maize, cottonseed, oats etc. have been used in various meat products (Keeton 1994). Other non-meat ingredients used as binder/fillers are cowpea and pea nut flour in chicken nuggets (Prinyawiwatkul*et al.,* 1997); wheat flour in chicken nuggets (Rao *et al.,* 1997), green and black gram flours in buffalo meat burgers (Modi *et al.,* 2003); finger millet flour in chicken patties (Naveena*et al.,* 2006), sorghum and finger millet flours in chicken nuggets (Das, 2015), and moringa seed flour in beef patties (Al-Juhaimi, 2016; Alugwu et al., 202)

Pearl millet (*Pennisetumglaucum*), locally known as bajra is grown in most of Asia and Africa's tropical and semi-arid regions.Annual global production of pearl millet grain exceeds 10 million tons (Vadez*et al.,* 2012).In addition to fiber, millets are a rich source of health supporting phytochemicals, including lignans, polyphenols, phytosterols, phytoestrogens, and phycocyanin which function as immune modulators, antioxidants, detoxifying agents, and so on, preventing age-related degenerative diseases such as diabetes, cancer, cardiovascular diseases etc. (Rao *et al.,* 2011).Pearl millet is used to treat constipation, a number of non-communicable diseases, and celiac disease. It is necessary to conduct the studies on the impact of pearl millet on certain medical conditions (Vanisha*et al.,*2011).

Chicken is preferred over other meats because of its higher palatability, higher protein and omega-3 fatty acids content, less fat, and higher digestibility. It is low in calories, is a good source of fatty acids specially saturated and unsaturated fatty acids and the proteins are a good source of amino acids. Unsaturated fatty acids are higher in chicken than red meat and also contains less cholesterol (Mountney*et al*., 2001). Patties are minced meat products containing added ingredients and seasoning which is pressed into a round, flat shape. Chicken patty is one of the most popular meat products that has shown industrial and economic relevance.It is commonly used as a filler for sandwiches or burger buns, or it is served with tomato sauce or chutney.Chicken patty is a homogenous mixture of proteins, fat particles, water, salt, and carbohydrates that is preparedby processing viz. blending, cooking, chopping, and so on.

Dietary fiber-rich animal products make excellent meat alternatives due to their inherent nutritional and functional advantages (Hur*et al.,* 2009; Kumar *et al.,* 2010). Dietary fiber supplements not only improve health outcomes but also increase meat products bulk and decrease cooking loss with little to no impact on textural characteristics which is economically beneficial for manufacturers as well as consumers (Grigelmo-Miguel *et al.,* 1999).Therefore, including pearl millet flour into different food products will boost their nutritional value and utility.The functional properties of pearl millet flour and the low fat and cholesterol content of chicken have promptedfor undertaking this investigation to optimize the level of incorporation of pearl millet flour in the ground chicken patties.

**MATERIAL AND METHODS:**

**Materials:**Chicken obtained from healthy broiler chicken with an average of 2.0 kg live weight was procured hygienically on ice from approved meat shops in the local market.Spice ingredients were purchased from the local market and cleaned to remove any foreign stuff, dried in a hot air oven at 50ºC for 3 hours, ground in a grinder, and sieved through a fine mesh(455µm). The proportion of each ingredientwas employed as per Sakunde,2004 as a spice mix for preparing chicken patties.

**Table 1: Composition of spice mixture**

|  |  |  |
| --- | --- | --- |
| Sr. No. | Spice Ingredients | Quantity (% by wt) |
| 1 | Anniseed (Soanf) | 11.5 |
| 2 | Black pepper (Kali mirch) | 3.5 |
| 3 | Capsicum (Mirch powder) | 12 |
| 4 | Caraway seed (Ajwain) | 12 |
| 5 | Cardamom (Badielaichi) | 05 |
| 6 | Cinnamon (Dalchini) | 05 |
| 7 | Cloves (Laung) | 02 |
| 8 | Coriander (Dhania) | 21 |
| 9 | Cumin seeds (Zeera) | 20 |
| 10 | Nutmeg (Jaiphal) | 02 |
| 11 | Turmeric (Haldi powder) | 05 |
| 12 | Small cardamom (Sabzelaichi) | 01 |
| Total | 100 |

After removing the exterior covers, the condiments, such as onion and garlic, were chopped into small pieces, and a fine paste was made in a mixer grinder(Prestige Diva 500 W mixer grinder).Common salt, and refined sunflower oil required for the preparation of chicken patties were purchased from the local market.Borosilmakeglassware and Himediamake chemicals were used for conducting the experiments.Pouches made up of low-densitypolyethylene (LDPE) with a thickness of 55$μ$ were used for packaging of the samples of chicken patties.

**Methods:**

**Preparation of pearl millet flour:**The pearl millet flour was prepared as per the method of Filli*et al.*, 2012.

Pearl millet grains

Cleaning and washing

Oven drying (50ºC for 24h)

Weighing

Toasting in microwaving (80ºC for 15min)

Cooling

Winnowing

Milling

Sieving (455 µm)

Flour

Packaging & Storage

**Fig.1: Flow chart for preparation of pearl millet flour**

**Preparation of ground chicken patties:**Chicken patties were prepared as per the method followed by Sakunde (2004) by using the formulation given in Table 2.

**Table2:Formulation of ground chicken patties**

|  |  |
| --- | --- |
| Ingredients | Proportion (Raw wt basis) |
| Control | T1 | T2 | T3 |
| Chicken (%) | 73.90 | 70.90 | 67.90 | 64.90 |
| Pearl millet flour (%) | 00 | 03.00 | 06.00 | 09.00 |
| Vegetable oil (%) | 09.00 | 09.00 | 09.00 | 09.00 |
| Ice water (%) | 10.00 | 10.00 | 10.00 | 10.00 |
| Salt (%) | 01.20 | 01.20 | 01.20 | 01.20 |
| Condiments (%) | 03.50 | 03.50 | 03.50 | 03.50 |
| Spice mix (%) | 02.00 | 02.00 | 02.00 | 02.00 |
| STPP (%) | 0.40 | 0.40 | 0.40 | 0.40 |
| Sodium Nitrite (ppm) | 100 | 100 | 100 | 100 |

Control: No PMF, T1: 3% PMF, T2: 6% PMF, T3: 9% PMF

Frozen deboned meatwas thawed at refrigeration (4±1ºC) temperature overnight. Thawed lean meat was cut into smaller chunks and minced in meat mincer with 6 mm plate followed by 4 mm plate.Salt, sodium nitrite, and sodium tripolyphosphate were added to minced meat and blended in a blender (bajajfx1000 ) for 1-2 minutes. Then condiments were added and blended for 30 sec, pearl millet flour was added and blended into the mix for 1 minute. Then vegetable oil and spice mix were added and blended for 1 minute. About 50 g of emulsion was moulded on steel plate with circular ring(55 mm dimeter and 20 mm height). The height and diameter of the patty was determined by vereniercallipers. Patties were cooked in a preheated convection hot air oven at 180°C and cooked for 10 minutes. Thereafter, the patties were turned up side down and cooked further for 10 minutes till the internal temperature reached to 82°C measured by digital probe thermometer(LabwareScintific, Inc.USA).Chicken patties were packed in pre sterilized LDPE bags. Prior to sealing the air is drained out from this package and stored at refrigeration temperature (4±1ºC) for further analysis.

Minced meat

Addition of NaNO2 and STPP

Chopping for 1 min

Addition of condiments

Chopping for 30 sec

Addition of pearl millet flour

Chopping for 1 min

Addition of vegetable oil

Addition of spice mix

Chopping for 1 min

Moulding and Cooking (85°C/20 min) Packaging Storage (4±1°C)



**Fig. 2 Flow chart for preparation of ground chicken patties**

**Analytical methods:**

**Proximate composition:** The moisture, fat, crude protein, ash and crude fiber content of cooked chicken patties were determined by following the standard method of AOAC (1995).

**Cooking yield:** The weight of the chicken patties was taken before and after cooking and expressed in percentage.

Weight of cooked patties

Cooking yield = ------------------------------------- x 100

 Weight of uncooked patties

**Moisture retention of percentage:** The moisture retention of patties was calculated as per the method of El-Magoli*et al. (*1996) using following formula.

|  |
| --- |
| Moisture retention (%)=(Cooking Yield % x Moisture% in cooked patties) ÷ 100 |

**SensoryAnalysis:** The sensory analysis of the cooked chicken patties samples was carried out by semi-trained panelists. The meat samples were served to the panelists to assess the sensory attributes viz. colour and appearance, flavour, texture, and overall acceptabilityusing 8 point hedonic scale (Keeton *et al.,* 1983).

Statistical Analysis: The experiment was repeated three times and the data generated during the study were analyzed by one-way ANOVA through the “SPSS-20.0” software package as per standard methods suggested by Snedecor and Cochran (1994).

**RESULTS& DISCUSSION:**

 Ground chicken patties were analyzed for proximate composition, physico chemical properties and sensory attributes with a view to select the best level of incorporation of PMF.

**Effect of various levels of PMF on proximate composition and physico-chemical properties of cooked ground chicken patties:**

**Proximate composition:**

Moisture, ash and crude fibre content of cooked chicken patties increased significantly (p<0.01), whereas, crude protein and fat content decreased with increase in the proportion of PMF in chicken patties formulation (Table 3). Increase in moisture and ash content of chicken patties treated with finger millet flour has also been documented by Das *et al.,* (2013).Santhi and Kalaikannan (2014) reported significant (p<0.05) increase in the moisture, crude fiber and decrease inthe protein and fat content of cooked chicken nuggets incorporated with oat flour.Talukder and Shama (2010) also reported decrease in crude protein and fat content of chicken patties incorporated with wheat and oat bran.Increase in moisture content of cooked chicken patties with increase in the proportion of PMF could be attributed to good water absorption capacity and good swelling power of pearl millet reported by Thilagavathi*et al.* (2015) and Pawase*et al.* (2021) respectively. Decrease in the crude protein and fat content with increase in the level of PMF could be attributed to replacement of protein rich (21.69±2.84 %) chicken by the PMF with comparatively low protein (8.25±0.36 %) and high carbohydrate (73.54 %) content (Sachan and Shah, 2023) and increase in the moisture content of the cooked chicken patties with increase in the level of PMF (Table 3). Increase in the crude fiber content could be attributed to the high crude fiber (2.71±0.64 %) content of PMF (Sachan and Shah, 2023) and that of the other ingredients of chicken patties formulation.

**Table 3: Effect of various levels of PMFon proximate composition and physico-chemical**

**propertiesofcooked ground chicken patties.**

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Parameters | T0 | T1 | T2 | T3 | F value |
| Proximate composition |
| Moisture (%) | 60.02±0.05a | 63.45±0.64b | 65.02±0.65c | 67.01±0.32d | 37.072\*\* |
| Crude Protein (%) | 20.65±0.07c | 19.85±0.03b | 19.59±0.01a | 19.49±0.01a | 201.996\*\* |
| Fat (%) | 18.22±0.23d | 13.96±0.23c | 12.57±0.49b | 11.15±0.72a | 42.858\*\* |
| Ash (%) | 02.36±0.13a | 02.78±0.06b | 02.85±0.04bc | 03.04±0.01c | 15.227\*\* |
| Crude fiber (%) | 00.62±0.01a | 01.32±0.00b | 02.25±0.02c | 03.24±0.02d | 6146.221\*\* |
| Physicochemical properties |
| pH | 6.10±0.03a | 6.21±0.02b | 6.24±0.04b | 6.25±0.02b | 5.478\* |
| Cooking Yield (%) | 80.02±0.23a | 84.02±0.14b | 86.02±0.26c | 90.08±0.56d | 156.132\*\* |
| Emulsion stability(%) | 88.07±0.22a | 90.55±0.29b | 91.36±0.31bc | 92.11±0.41c | 30.834\*\* |
| Moisture retention(%) | 48.02±0.15a | 53.31±0.56b | 55.93±0.59c | 60.35±0.48d | 117.557\*\* |

n=6, Means ± S.E. bearing different superscripts within rows differ significantly. \* Significant value (p<0.05). \*\* Highly significant value (p<0.01). NS= Non-significant. T0: Control, T1: 3 % PMF, T2: 6% PMF, T3: 9% PMF.

**Physico-chemical properties:**

pH is a significant intrinsic component that affects how bacteria develop (ICMSF, 1980). The significantly (p<0.05) higher pH was recorded for all the treatments compared to the control samples of chicken patties. Thenon significant increase inpHof the samples was observed with increase in the proportion of PMF. The results were in agreement with those documented byYilmaz (2005) for meat balls with 5 and 10% of wheat bran, Para and Ganguly (2015) for chicken nuggets,and Das *et al.,* (2015) for chicken patties treated with carrageenan (0.5%), finger millet flour (10%), and sorghum flour (10%).

Cooking yield, emulsion stability and moisture retention of chicken patties increased significantly (p<0.01) with increase in the proportion of PMF in the chicken patties formulation (Table 3).Similar results for cooking yield and emulsion stability have been documentd by Talukder and Sharma (2010)for chicken patties incorporated with wheat bran, andPara and Ganguly (2015) for chicken nuggets with the inclusion of bajara flour. Osman *et al.,*2021 documented that the high moisture retention of Osan starch improved the sensory characteristics of the beef patties due to highly viscous gel with emulsifying power.

Comparatively higher moisture retention in the treatment samples may be ascribed to good water absorption capacity and good gelation capacity and consistency of pearl millet reported by Thilagavathi*et al.* (2015) and Pawase*et al.* (2021) respectively. Ability of PMF to retain moisture in the patty matrix during cooking may be the reason for increase in thee cooking yield. Pietrasik and Janz (2010) reported that the non-meat ingredients, such as macromolecular hydrocolloids, starches, and fibers, are known to have water binding properties which might have resulted in an improvement in the product's ability to hold water and an increase in the cooking yield.An increase in the emulsion stability of chicken patties batter with increasing levels of PMF could be attributed to the water absorption capacity, swelling power, and gelation capacity of pearl millet (Comer, 1979; Thilagavathi*et al*., 2015; Pawase*et al.,* 2021). According to Puolanne and Ruusunen (1983), the gelatinization of starch improves the binding properties of meat proteins.

**Effect of various levels of PMF on sensory attributes of cooked ground chicken patties:**

The incorporation of 3 and 6% PMF had no any significantly adverse effect on any of the sensory attributes of cooked chicken patties. However, the scores of appearance and colour, flavour, texture and overall acceptability of cooked chicken patties incorporated with 9% PMF were significantly (p<0.01) reduced but they were within the acceptable limit. The incorporation of PMF had no any significant effect on the juiciness of cooked chicken patties compared to the control. The results indicated that incorporating 3% and 6% PMF in the product formulation produced the chicken patties with acceptable quality compared to the control (Table 4).

**Table 4: Effect of various levels ofPMF on sensory attributes of cooked groundchicken**

**patties**

|  |  |
| --- | --- |
| Treatment | Sensoryscore |
| Appearance&Colour | Flavour | Juiciness | Texture | Overall Acceptability |
| T0 | 7.30±0.13 ab | 7.08±0.12b | 6.90±0.13 | 6.90±0.13b | 7.01±0.14ab |
| T1 | 7.37±0.12b | 7.07±0.12b | 7.13±0.12 | 7.17±0.12b | 7.12±0.12b |
| T2 | 7.07±0.13ab | 6.96±0.14b | 6.85±0.15 | 6.83±0.13b | 7.04±0.12ab |
| T3 | 6.84±0.15a | 6.50±0.16a | 6.59±0.17 | 6.38±0.16a | 6.58±0.15a |
| F value | 3.319\* | 4.099\*\* | 2.359NS | 5.627\*\* | 3.169\* |
| P value(Sig) | 0.021 | 0.008 | 0.074 | 0.001 | 0.026 |

n=6, Means ± S.E. bearing different superscripts within columns differ significantly.\* Significant value (p<0.05). \*\* Highly significant value (p<0.01). NS= Non-significant. T0: Control, T1: 3 % PMF, T2: 6% PMF, T3: 9% PMF.

Similar results have been documented by Naveena*et al.* (2006) and Das *et al.* (2015) for appearance and colour; Sakunde (2004) andWadpalliwar (2015) for flavour; and Kumar and Sharma (2006), Das *et al.*(2013) and Para and Ganguly (2015) for juiciness, texture and overall acceptability. However, the contradictory results have been recorded by Santhi and Kalaikannan (2014) and Wadapalliwar (2015) for colour and appearance; andAl-Juhaimi*et al.* (2016) for juiciness, texture and overall acceptability.

 The decrease in the score for appearance and colourof patties samples with increased levels of PMF may be because of the comparatively dark colour of PMF (Thilagavathi*et al.* 2015) imparted to the patties samples. The decrease in the flavour score may be ascribed to the development of bitterness as a sequel of Maillard browning reactions (Kumar *et al.,*2015). Decrease in the texture score by incorporation of 9% PMF in the chicken patties formulation could be ascribed to the considerable replacement of chicken with the PMF.

**Production cost of ground chicken patties:**

The production cost of the cooked ground chicken patties decreased with increase in the level of incorporation of PMF in the product formulation. Production cost of the control patties and the patties with 3, 6 and 9% PMF was Rs. 249.56, 235.54, 220.99 and 205.83 respectively.

**CONCLUSION:**

Incorporation of 3% and 6% pearl millet flour in the product formulation produced the ground chicken patties of acceptable quality with higher dietaryfiber content and loweredthe cost of production by 5.62% and 11.44 % respectively than the control.

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**REFERENCES:**

Al-Juhaimi Fahad, Ghafoor Kashif, Havashin Majed D., Alsawmahi Omer N. &BabikerElfadil E. (2016). Effects of different levels of moringa (*Moringa oleifera*) seed flour on quality attributes of beef burgers, CyTAJoumal of Food.**14**(1):1-9.

AOAC, 1995. Official Methods of Analysis. 16th edition. Washington DC, USA.

Comer, F.W. (1979). Functionality of fillers in comminuted meat products. Can. Inst. J. Food Sci. Technol., **12**:157-165.

Das, S. K., Prabhakaran, P., Tanvar, V. K. and Biswas S. (2015). Effect of some plant starches and carrageenan as fat substitutes in chicken patties. J. Anim. Sci 93: 3704—3712.

El-Magoli S. B., Laroia S., and Hansen P.T.M. *(*1996). Flavour and texture characteristics of low fat ground beef patties formulated with whey protein concentrate. Meat Science. 42:179-192

Filli, K. B., Nkama, I., Jideani, V. A., & Abubakar, U. M. (2012). The effect of extrusion conditions on the physicochemical properties and sensory characteristics of millet–cowpea based fura. Eur. J. Food Res. Rev, **2**(1), 1-23.

Grigelmo-Miguel N, M. Abadias-Seros, O.Martin-Belloso.(1999). Characterization of low fat high-dietary fiber frankfurters. Meat Sci.**52**:247-256.

Hur S.J., B.O. Lim, G.B. Park, S.T. Joo.(2009). Effect of various fiber additions on lipid digestion during in vitro digestion of beef patties. J. Food Sci., **74**(9): C653-C657.

International Commission on Microbiological Specifications for Foods (ICMSF). (1980). Factors affecting life and death of microorganisms. Microbial Ecology of Foods. Edn Academic Press, London. **1**:221-231.

Keeton, J. T. (1994). Low-fat meat products — technological problems with processing. Meat Science.**36**: 261-276.

Kumar D., M.K. Chatli, N. Mehta, A.K. Verma, and P. Kumar.(2015). Quality evaluation of chevon patties fortified with dietary Fibre. The Indian Journal of Small Ruminants. **21:** 85-91.

Kumar V., A.K. Biswas, M.K. Chatli, J. Sahoo.(2010). Effect of banana and soyabean hull flours on vacuum packaged chicken nuggets during refrigeration storage. Int. J. Food Sci. Technol.

Mishra B. P., J. Mishra, B. Paital, P.K. Rath, M.K. Jena, B.V.V. Reddy, P.K. Patil, S.K. Panda, and D.K. Sahoo. (2023). Properties and physiological effects of dietary fiber-enriched meat products: a review. Front. Nutr. 10:1275341.

Modi V.K., N.S. Mahendrakar, D. Narasimha Rao, and N.M. Sachindra.(2003). Quality of buffalo meat burger containing legume flours as binders, Meat Sci. **66**, 143-149.

Mountney, J., George, P. and Carmen, R. (2001). Poultry Products Technolou, Third Edition. The Haworth Press Inc. Binghamton, USA.

Naveena B.M., M. Mut, A.R. Sen, Y. Babji, and T.R.K. Murthy.(2006). Quality Charachteristics and storage stability of chicken patties formulated with finger millet flour (Eleusinecoracana) Journal of Muscle Foods, 17:92104.

Osman M F E, A A Mohamed, M S Alamri, I A M Ahmed, S Hussain, M I Ibraheem and A AQasem. (2021). Quality Characteristics of Beef Patties Prepared with Octenyl-Succinylated (Osan) Starch. Foods. **10**(6):1157..

Para, P. A. and Ganguly, S. (2015). Effect of bajra flour (Pearl millet) on some quality and sensory attributes of chicken nuggets. Asian J. Animal sci **10**(2): 107-114.

Pawase, P. A., U. D. Chavan, and P. M. Kotecha. (2021). Evaluation of functional properties of different pearl millet cultivars. The Pharma Innovation Journal  2021:10(6): 1234-1240.

Pietrasik, Z. &Janz, J.A.M. (2010). Utilization of pea flour, starchrich and fiber-rich fractions in low fat bologna. Food Research International. **43**: 602—608.

Prinyawiwatkul., W., K.H. MCWatters, L.R. Beuchat, and R.D. Phillips.(1997).Physicochemical and sensory properties of chicken nuggets extended with fermented cowpea and peanut flours. J. Agric. Food Chem. **45**: 1891-1899.

Puolanne, E. J**.** and Ruusunen, M.(1983). Effect of potato flour and dried milk on the water binding capacity and consistency of Brushwurst sausages. Fleishchwirtschaft.**63**: 631-633.

Rao K.H., R.R.B. Singh, A.S.R. Anjaneyulu, Rao, K.V.S.S. and P.L. Yadav.(1997). Effects of caseinases and refined wheat flour on the quality of chicken nuggets from spent hens. Indian J Anim Sci.**67:**1004-1006.

Sachan, N., & Shah, P. (2023). Analysis of the proximate composition, mineral content and antioxidant compound of pearl millet flour.

Sakunde, D.T. (2004). Studies on production and shelf life of chicken patties using various binders, M.V.Sc. thesis submitted to Maharashtra Animal and Fishery Sciences University, Nagpur.

Santhi, D. and Kalaikannan, A. 2014. The Effect of the Addition ofOat Flour in Low-Fat Chicken Nuggets. J. Nutr. Food Sci **4** (1):260

Snedecor, G. W., and W. G. Cochran, 1994. Statistical Method. 8th edn. The lowa State College Press. Inc. Amer. lowa USA, 950.

Talukder, S. and Sharma, D. P. 2010. Development of dietary fiber rich chicken meat patties using wheat and oat bran. J Food Sci Technol **47**(2): 224-229.

Thilagavathi, T., (2015)"Effect of heat moisture treatment on functional and phytochemical properties of native and modified millet flours.": 15-21.

Vadez, V.,Hash, T., Bidinger, F.R. and Kholova, J. 2012.Phenotyping pearl millet for adaptation to drought. Front Physiol**3**(3);1₋12.

Vanisha S Nambiar, JJ Dhaduk,NehaSaren,ToshaShahu,Rujuta Desai2011 Potentional functional implications of pearl millet( pennisteumglaucam) in health and disease . Journal of Applied Pharmaceutical Science,62₋67.

Verma A.K., V. Pathak and V.P. Singh 2012 Incorporation of chicken meat in rice flour based noodles and its effects on physicochemical and sensory qualities. International Journal of Current Research Vol.4, Issue, 12, pp. 461-466.

Wadpalliwar 2015 Quality of chicken nuggets incorporated with finger millet flour (ragi flour). M. V. Sc. Thesis submitted to MAFSU, Nagpur.

Yilmaz, I. 2005. Physicochemical and sensory characteristics of low fat meat balls with added wheat bran. J. Food Eng. **69:** 369—373.

Alugwu, S. U., T. M. Okonkwo, and M. O. Ngadi. 2022. “Effect of Different Frying Methods on Cooking Yield, Tenderness and Sensory Properties of Chicken Breast Meat”. Asian Food Science Journal 21 (10):1-14. <https://doi.org/10.9734/afsj/2022/v21i1030469>.

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