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Quality Evaluation of Low Fat Chicken Sausages Fortified with Dietary Fibre

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ABSTRACT

The experiment was conducted to optimize the level of dietary fibre sources *viz.* finger millet (ragi) flour RT1, RT2 and RT3 separately at 5.0, 10.0 and 15.0% level in formulation of low fat chicken sausages. In previous experiment replacement of refined oil upto 50% by using chia seed powder. The emulsion pH, emulsion stability, product pH, cooking yield, moisture, ash content, fat retention and moisture retention values increased significantly (P<0.05), whereas, protein, emulsion fat and product fat content decreased significantly (P<0.05) with increased level of ragi flour. There was no significant difference in water activity values between control and treatments. Among the textural and colour parameters, hardness, springiness, cohesiveness, gumminess, chewiness, resilience and redness the values increased significantly (P<0.05) but the parameters i.e. lightness and yellowness values decreased significantly (P<0.05) in treatments. The scores of all sensory attributes decreased significantly (P<0.05) at each level of ragi flour incorporation in low fat chicken sausage except saltiness. It was concluded that low fat chicken sausage with improved cooking yield, textural profile and acceptable sensory attributes, can be successfully developed with the incorporation of 5.0% ragi flour.

HIGHLIGHTS

- Study focuses on the preparation of fortified with dietary fibre chicken sausage.
- Finger millet (Ragi) used as dietary fibre in preparation of low fat chicken sausage.
- Quality characteristics of dietary fibre enriched chicken sausage.

Keywords: Dietary fibre, Finger millet, Low fat chicken sausages, Textural and colour parameters

Processed meat products somehow are proved to be affecting health of regular consumers and considered to be causative factor for many diseases on account of having less dietary fibers. Dietary fibers contribute to the regulation of the gastrointestinal tract, cholesterol excretion, lowering blood sugar levels. Dietary fiber deficiency in the diet leads to spread of various metabolic disorders of the population, which in turn led to an increase in the incidence of colon cancer, cholelithiasis and atherosclerosis. Fibers from different sources show different degree of water holding capacity and water binding (Anatasia and Eimear, 2012). Fiber (food fiber) contributes to accelerated excretion of harmful substances from the body, which is especially important in connection with the sharp deterioration of the environmental situation. Hence, meat products can be enriched by incorporation of dietary fiber from different sources to enhance their nutritional composition and desirability (Verma *et al.,* 2010). The functional and technological properties of dietary fibers do not alter the product but increase the cooking yield due to their water and fat binding property (Talukder and Sharma, 2010).

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Finger millet 'Ragi' (*Eleusine coracana*), is one of the traditional popular millets in India. It contains 72.0- 79.5% total carbohydrates, 18.6% dietary fiber, 3.7% crude fiber, 7.0% protein, 1.3-1.8% crude fat and 2.0- 2.7% total ash (Shobana *et al*., 2013). The range of iron content *i.e*. 3.61 to 5.42 mg/100 g in 16 finger millet varieties Singh and Srivastava (2006). Because of having proven health benefits Finger millet (*Eleusine coracana*) (Ragi), are becoming best choice for components of functional food. Rapid change in our overall lifestyle forced consumers to be dependent upon fast foods, which contain little amount of dietary fibre. Daily intake of dietary fiber helps in prevention of many nutritional disorders like gut related problems, cardiovascular diseases, type 2 diabetes, certain types of cancer and obesity. Generally, meat is lacking in this potential ingredient so that incorporation of appropriate fiber rich ingredient can improve the health image of meat product. Incorporation of non meat ingredient as a dietary fiber not only reduces the product cost but also improves nutritional and sensory quality of meat products. They improve cooking yield, fat binding, water binding, and flavor without impairing its sensory qualities. Finger millet is a powerful source of calcium, dietary fiber and antioxidant phenolic compounds including tannins. They also reported that the finger millet has highest amount of calcium which ranges from 162 to 487 mg% (Singh and Raghuvansi, 2012).

MATERIALS AND METHODS

Live birds were procured from local market of Mathura and were slaughtered in Meat Processing Laboratory of Department of Livestock Products Technology, DUVASU, Mathura. The meat was cleaned, deboned and trimmed in the laboratory. The deboned lean meat was stored at -18˚C till further use. Cellulose casings (C19×84ft.) were procured from Food Aiders(R), New Delhi. Different spices, condiments i.e. onion, ginger and garlic (3:1:1), salt of food grade (TATA salt ®), food grade refined oil (Fortune®), excellent quality of chia seeds and ragi were procured from local market, Mathura. These spices were cleaned thoroughly without any extraneous materials and kept for drying at 50ºC in a hot air oven for about 2-3 hrs to remove the moisture content followed by grinding into fine powder. Spice mix was formulated and stored for subsequent use. Condiments i.e. onion, ginger and garlic used in 3:1:1 ratio after peeling and proper chopping manually by a vegetable chopper. Chia seed and Finger millet seeds kept for drying at 65ºC for 2-3 hours in a hot air oven. After drying, chia seed ground into fine powder and finger millet ground into flour using mixer grinder and packaged in pre sterilized LDPE pouches. Low density Polyethylene (LDPE) bags were sourced from local market and sterilized by exposing to U.V. light for 30 minutes before use. All the chemicals and microbiological media used in the study were of analytical grade and procured from Hi Media Laboratories (P) Ltd, Mumbai.

Methodology of preparation of chicken sausages

Frozen chicken meat was thawed at refrigeration temperature overnight. The thawed chicken meat was cut into small chunks and then minced in a Sirmen mincer (MOD-TC 32 R10U.P. INOX, Marsango, Italy) with 6mm plate followed by 4mm plate. Other ingredients like common salt, vegetable oil, refined wheat flour, sodium tri polyphosphate, spice mixture and condiment mixture were weighed accurately according to formulation. Meat emulsion was prepared in Sirman Bowl Chopper (MOD C 15 2.8G 4.0 HP, Marsango, Italy). The minced meat was blended with salt, sodium tri polyphosphate for 1.5 minute. Water in the form of crushed ice was added and blending continued for 1 min. This was followed by addition of spice mixture, condiments and other ingredients and again mixed for 1.5 to 2 minutes to get the desired emulsion. Adequate care was taken to keep the end point temperature below 18ºC by preparing the emulsion in cool hours of morning, by addition of meat and other ingredients in chilled/partially thawed form and by addition of crushed ice or ice water. The emulsion was filled in to artificial casings using sausage filler and linked at about 12 cm intervals. Then these sausages were cooked using hot simmering water (>80ºC) for about 35 minutes. The formulation for low fat chicken sausages is given in table1.

Table 1: Formulation for the preparation of chicken sausage

Ingredients Percent	(%)
Chicken meat	71.2
Refined oil	5
Chia seed powder	1.5
Ice flakes	8

Refined wheat flour	4
Condiments	3
Spices	2
Salt	1.5
STPP	0.3
Chilled water	3.5
Total	**100**

Low fat chicken sausages were incorporated with finger millet flour (Ragi) flour separately at 5, 10 and 15 % level to replace lean meat in formulation. The following abbreviations were used for present experiment:

1. C- (control) chicken sausage incorporated without ragi flour.
2. RT1- chicken sausage incorporated with 5% ragi flour,
3. RT2- chicken sausage incorporated with 10% ragi flour,
4. RT3- chicken sausage incorporated with 15% ragi flour.

Physico- chemical properties

pH

The pH was determined by using digital pH meter (WTW, Germany, model pH 330i) as per the procedure of Troutt *et al.* (1992).

Emulsion stability

The Emulsion stability was determined as per the procedure of Baliga and Madaiach, (1970).

Cooking yield

The weight of chicken sausages was recorded before and after cooking. The cooking yield was calculated as under and expressed as percentage (Murphy *et al.,* 1975).

Cooking yield % =

$$\frac{\text{Weight of cooked chicken sausages}}{\text{Weight of raw emulsion}} \times 100$$

Water activity

Water activity of each sample was measured three times in duplicate using a water activity meter (AquaLab 3 TE, Inc. Pullman, WA).

Moisture Retention

Moisture retention value represents the amount of moisture retained in the cooked product per 100 g of sample and was determined according to equation by El-Magoli *et al.* (1996). Calculation of moisture retention is as below:

Moisture retention (%) = (% cooking yield x moisture in cooked sausage)/100

Fat retention

Fat retention was calculated according to method given by Murphy *et al.* (1975) with slight modifications.

$$\text{Fat retention (\%)} = (A/B) \times 100$$

A = Fat content in cooked sausage × weight of cooked sausage

B = Fat content in uncooked sausage × weight of uncooked sausage

Moisture content

Moisture was determined as per AOAC (1980) method. After cooling, the loss in weight was determined to calculate moisture content and expressed as %.

$$\text{Moisture \%} = \frac{\text{Fresh weight (g)} - \text{Dry weight (g)}}{\text{Fresh weight (g)}} \times 100$$

Protein content

The total protein content of chicken sausage was estimated as per method described in AOAC (1995) with suitable modifications using automatic digestion and distillation unit (Kel Plus-KES 12L, Pelican Industries, Chennai).

Fat

The Soxhlet method was used for estimation of fat (AOAC 1995).

Ash

The total ash content of chicken sausage was estimated as per method described in AOAC (1995) using muffle furnace at 500 ± 15ºC for 4 hrs.

Texture profile analysis

The texture profile analysis of chicken sausages was done with the help of instrumental texture profile analyser (TA HD Plus Texture analyser) at department of Livestock Products Technology, DUVASU, Mathura. The procedure used for instrumental texture profile analysis was similar to those described by Bourne *et al.* (1978). The parameters determined were: The following parameters were determined viz; Hardness (N/cm^2) = maximum force required to compress the sample (H); Springiness (cm/mm) = ability of sample to recover its original form after a deforming force was removed (S); Cohesiveness (Ratio) = Extent to which samples could be deformed prior to rupture (A2/A1, A1 being the total energy required for first compression and A2 total energy required for second compression); Gumminess (N/cm^2 or g/mm^2) = force necessary to disintegrate a semi solid sample for swallowing (H × Cohesiveness); and Chewiness (N/cm or g/mm) = work required to the sample for swallowing (S × Gumminess)**.**

Instrumental colour analysis

The colour parameters of the chicken sausages were measured using Hunter colourimeter of ColourTech PCM+ (Colour Tec Associates Inc. Clinton NJ, USA) at department of Goat Products Technology, CIRG, Makdhum. The coin shaped lance of instrument attached to software was directly put on the surface of functional turkey meat cutlets at randomly chosen six different points (Hunter and Harold, 1987). CIE *L**, *a** and *b** values were determined as indicators of lightness, redness and yellowness, respectively.

Sensory evaluation

The sensory quality of samples was adjudged using 8 point descriptive scale (Keeton *et al.*, 1984) where 8 denoted extremely desirable and 1 denoted extremely poor. A sensory panel (semi trained) of seven judges drawn from post-graduate students and faculty of Veterinary College, DUVASU, Mathura were requested to adjudge the products for its different quality attributes *viz.,* color and appearance, flavor, texture, juiciness, saltiness mouth coating, meat flavor intensity and overall acceptability.

Statistical analysis

Data were analyzed statistically on 'SPSS-16.0' software package as per standard methods (Snedecor and Cochran 1994). Duplicate samples were drawn for each parameter and the experiment was replicated thrice (n=6). Sensory evaluation was performed by a panel of seven member judges three times, so total observations of each sensory attribute were 21 (n=21). Data were subjected to one way ANOVA, homogeneity test and Duncan's Multiple Range Test (DMRT) for comparing the means to find the effects between treatments at 5% level.

RESULTS AND DISCUSSION

Physico-chemical properties

The effects of finger millet flour on physico-chemical properties of chicken sausage are presented in table 2. The Emulsion pH, emulsion stability, product pH, ash content and fat retention values increased significantly ($P<0.05$) at each level of finger millet (ragi) flour (FMF) incorporation in chicken sausage. In general, pH was higher in cooked chicken sausage than emulsion pH irrespective to level of incorporation of Finger Millet Flour (FMF). It may be attributed to concentration of components in the cooked product and coagulation and deamination of proteins during cooking (Verma *et al.,* 2012). This result is broadly in agreement with observations of Chatli *et al.* (2015) and Abinayaselvi *et al.* (2018) who also observed significant increase in pH value of emu meat nuggets and chicken soup with increase in the level of addition of finger millet flour (*Eleusine coracana*). Higher emulsion stability and fat retention values of treatments might be due to fat retention and water absorption ability of ragi flour. The present findings are congruent with Anand (2018) who also reported an increase in emulsion stability of process standardization of Japanese quail meat nuggets using finger millet flour. Kumar *et al.* (2015) also reported an increase in emulsion stability of quality evaluation of

Table 2: Effect of finger millet flour on physico-chemical properties (Mean±SE) of chicken sausage

Parameters	C	RT1	RT2	RT3	Treatment mean
Emulsion pH	5.99^{d}±0.03	6.07^{c}±0.01	6.16^{b}±0.01	6.21^{a}±0.01	6.10±0.03
Emulsion stability (%)	91.12^{d}±0.08	92.52^{c}±0.05	94.02^{b}±0.06	95.41^{a}±0.03	93.27±0.05
Emulsion fat (%)	6.79^{a}±0.01	6.64^{b}±0.01	6.51^{c}±0.01	6.37^{d}±0.03	6.57±0.05
Product pH	6.04^{d}±0.03	6.12^{c}±0.01	6.18^{b}±0.01	6.25^{a}±0.01	6.14±0.03
Cooking yield (%)	90.12^{c}±0.09	92.52^{b}±0.06	94.02^{ab}±0.08	95.41^{a}±0.07	93.01±0.08
Moisture (%)	63.61^{c}±0.06	68.10^{b}±0.06	68.54^{ab}±0.09	69.50^{a}±0.05	67.43±0.05
Protein (%)	17.94^{a}±0.03	17.33^{b}±0.02	16.66^{c}±0.04	15.98^{d}±0.03	16.97±0.05
Product fat (%)	6.37^{a}±0.01	6.22^{b}±0.01	6.10^{c}±0.01	5.96^{d}±0.01	6.16±0.03
Ash (%)	2.58^{d}±0.02	2.81^{c}±0.01	3.01^{b}±0.02	3.22^{a}±0.01	2.91±0.05
Fat retention (%)	84.54^{d}±0.08	86.77^{c}±0.12	88.09^{b}±0.20	89.24^{a}±0.18	87.16±0.17
Water activity (a_w)	0.983±0.01	0.982±0.04	0.980±0.03	0.978±0.02	0.980±0.02
Moisture retention (%)	57.32^{c}±0.17	63.01^{b}±0.11	64.44^{ab}±0.16	66.31^{a}±0.21	62.77±0.10

Note: Overall means bearing different superscripts in a row (a, b, c, d.....) differ significantly (P<0.05).

Table 3: Effect of finger millet flour on textural parameters (Mean±SE) of chicken sausage

Parameters	C	RT1	RT2	RT3	Treatment mean
Hardness (N/cm^2)	13.37^{d}±0.06	17.22^{c}±0.04	19.36^{b}±0.05	22.07^{a}±0.05	18.05±0.05
Springiness (mm)	23.32^{d}±0.05	24.33^{c}±0.05	25.20^{b}±0.03	26.48^{a}±0.04	24.83±0.04
Cohesiveness (Ratio)	0.70^{b}±0.03	0.81^{a}±0.04	0.84^{a}±0.03	0.88^{a}±0.03	0.80±0.02
Gumminess (N/cm^2)	6.57^{c}±0.03	7.11^{b}±0.06	7.51^{b}±0.04	8.04^{a}±0.06	7.30±0.05
Chewiness (N/cm)	134.40^{d}±0.03	137.12^{c}±0.08	139.53^{b}±0.08	141.21^{a}±0.07	138.07±0.06
Resilience (Ratio)	0.57^{c}±0.03	0.62^{b}±0.03	0.66^{b}±0.04	0.71^{a}±0.03	0.64±0.02

Note: Overall means bearing different superscripts in a row (a, b, c, d.....) differ significantly (P<0.05).

chevon patties fortified with dietary fibre. Bhagwanrao (2015) also reported an increase in emulsion stability of quality of chicken nuggets incorporated with Finger millet flour. Cooking yield, moisture content and moisture retention values of RT3 were significantly (P<0.05) higher than C and RT1, however values of RT2 were comparable to RT1 and RT3. Kumar *et al.* (2015) also reported significant (P<0.05) increase in moisture content for FMF patties than control chicken patties. Product fat, protein and emulsion fat content decreased significantly (P<0.05) with increased level of ragi flour in chicken sausage due to replacement of lean meat with FMF containing lower protein and fat content in the formulation. Almost similar decreasing trend for fat content was also observed by Sakunde (2004) and Kumar *et al.* (2015) for finger millet (ragi) flour added chicken and chevon patties respectively. There was no significant difference in water activity values between control and treatments.

Textural parameters

The effects of finger millet flour on textural parameters of chicken sausages are presented in table 3. Texture is one of the major components of foods that affect their acceptability. The values of all textural parameters increased significantly (P<0.05) with FMF incorporation on low fat chicken sausage, however there was no significant difference among the treatments for cohesiveness values. Again, no significant difference was observed between RT1 and RT2 in gumminess and resilience values. Higher textural values of treatments might be due to interaction of water and pectin present in ragi flour resulting into

more chewiness and gumminess in product. Huang *et al.* (2005) reported that chewiness values of emulsified pork meatballs was increased significantly (P<0.05) with an increase in the levels of rice bran. Sudha *et al.* (2007) and Yanniotis *et al.* (2007) observed the similar increase in textural hardness and breaking strength when cereal fibers were added to baked and extruded snacks, respectively.

Colour parameters

The effects of finger millet flour on colour parameters of chicken sausages are presented in table 4. Lightness (*L**) and yellowness (*b**) values decreased whereas redness *(a*)* values increased significantly (P<0.05) with ragi flour incorporation in chicken sausage, however no significant difference was observed in redness values between C and RT1. The decrease in lightness and yellowness values might be due to the innate dark coloration of FMF due to high contents of tannins, polyphenols etc. which turned dark on cooking (Kumar *et al.,* 2015). Mitsumoto *et al.* (2005) also reported discoloration of chicken meat patties resulting into lower lightness and higher redness values with the addition of natural antioxidants like tea catechins. Similar results were reported by Yılmaz and Daglıoglu (2003) on addition of natural fibres in meat products.

Sensory evaluation

The effects of finger millet flour on sensory scores of chicken sausages are presented in table 5. The scores of all sensory attributes decreased significantly (P<0.05) at each level of ragi flour incorporation in low fat chicken sausage. Lower sensory scores of treatments might be due to dark brownish appearance of product, powdery mouth feel, hard consistency and masking of meat flavour with increased level of ragi flour (Cody *et al.,* 2007). Abinayaselvi *et al.* (2018) also reported significant (P<0.05) decrease in colour and appearance scores with increasing the inclusion of finger millet flour in chicken soup as a thickening agent. Similarly, Pathak *et al.* (2009) noticed a gradual decline in the appearance score of the patties extended with porridge flour which was attributed to the dilution of the meat pigment. Das *et al.* (2015) also observed that 10% finger millet addition in chicken patties caused a marginal decrease in flavour score. Similar findings were also reported by Nandhini *et al.* (2018) in chicken cutlets, Para and Ganguly (2015) in chicken nuggets and Santhi and Kalaikannan (2015) in chicken meat balls respectively with incorporation with various cereal based natural fibers. Therefore, RT1- chicken sausage incorporated with 5.0% finger millet was selected as the best treatment.

Table 4: Effect of finger millet flour on colour parameters (Mean±SE) of chicken sausage

Parameters	C	RT1	RT2	RT3	Treatment mean
Lightness (*L**)	41.34^{a}±0.03	37.14^{b}±0.05	34.20^{c}±0.03	32.93^{d}±0.04	35.65±0.05
Redness (*a**)	7.35^{c}±0.02	7.05^{c}±0.03	8.02^{b}±0.04	8.52^{a}±0.03	7.73±0.04
Yellowness (*b**)	8.47^{a}±0.02	6.79^{b}±0.03	6.17^{c}±0.03	5.04^{d}±0.05	6.37±0.05

Note: Overall means bearing different superscripts in a row (a, b, c, d.....) differ significantly (P<0.05).

Table 5: Effect of finger millet flour on sensory scores (Mean±SE) of chicken sausage

Attributes	C	RT1	RT2	RT3	Treatment mean
Colour and appearance	7.28^{a}±0.05	7.02^{b}±0.04	6.84^{c}±0.03	6.55^{d}±0.03	6.92±0.03
Flavour	7.26^{a}±0.05	7.05^{b}±0.05	6.86^{c}±0.04	6.56^{d}±0.03	6.93±0.05
Texture	7.32^{a}±0.05	7.09^{b}±0.05	6.93^{c}±0.03	6.72^{d}±0.03	7.01±0.04
Juiciness	7.22^{a}±0.04	7.11^{b}±0.03	6.85^{c}±0.03	6.68^{d}±0.05	6.96±0.03
Saltiness	7.34±0.05	7.29 ±0.05	7.21±0.04	7.23±0.07	7.26±0.05
Mouth coating	7.36^{a}±0.03	6.99^{b}±0.05	6.87^{c}±0.04	6.77^{d}±0.07	6.95±0.05
Meat flavour intensity	7.29^{a}±0.05	6.97^{b}±0.07	6.80^{c}±0.05	6.68^{d}±0.04	6.93±0.05
Overall acceptability	7.35^{a}±0.06	7.01^{b}±0.03	6.89^{c}±0.04	6.67^{d}±0.05	6.98±0.07

Note: Overall means bearing different superscripts in a row (a, b, c, d.....) differ significantly (P<0.05).

CONCLUSION

From this study, it can be concluded that FMF at 5% can be successfully utilized in the formulation of low fat chicken sausages without affecting the physicochemical, textural and sensory attributes. Low fat chicken sausages with FMF had higher dietary fibre which makes it healthier and enhanced functionality for consumers. Incorporation of finger millet flour also increased the emulsion stability and cooking yield which indicated its commercial importance as it will ultimately reduce the cost of production. Low fat chicken sausages with good to very good acceptability and nutritive value could be prepared by incorporating 5% finger millet flour.

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