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**Research Article**

# EFFECT OF FLAXSEEDS ON PHYSICO-CHEMICAL AND SENSORY CHARACTERSTICS OF CHICKEN SAUSAGES AS FUNCTIONAL FOOD

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## ABSTRACT

The present study was conducted to explore the efficacy of flaxseeds (FT1, FT2 and FT3) on quality characteristics of chicken sausages replacing 50% vegetable fat (refined oil) at 0.75, 1.50 and 2.25% level. The formulation of emulsion was maintained by addition of water accordingly. The emulsion pH, emulsion stability, product pH, product fat and emulsion fat content of FT1, FT2 and FT3 were significantly lower than control. Cooking yield, moisture content, fat retention, water activity and moisture retention values of treatments were significantly higher than control, whereas a significant decrease was observed among the treatments with increased level of flaxseeds. Protein content increased at each level of flaxseeds incorporation in chicken sausage, but no significant difference was observed on ash content between control and treatments. Among the textural and colour parameters, cohesiveness, gumminess, resilience and redness values increased significantly whereas lightness values decreased significantly in treatments. The scores of all sensory attributes decreased significantly ($P<0.05$) in treatments. FT1 had significantly higher sensory scores than FT2 and FT3. FT1 had higher protein and fat retention values than other treatments, therefore, FT1- chicken sausage incorporated with 0.75% flaxseeds were selected as the best treatment.

**Keywords:** Flaxseeds, Sausage, pH, textural and colour parameters

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Nowadays, special attention of consumers for healthy and nutritious intake has led to the development of "functional foods" which is a new approach to accomplish a healthier status and reducing the risk of various nutritional diseases. The use of fat in meat products improves its sensory and physicochemical properties and quality characteristics. Therefore, its reduction may cause problems, including the loss of texture and juiciness, in addition to cooking weight losses due to decreased water retention. Such problems may be minimized by adequately choosing the fat replacer and the level of fat reduction used in meat products. The composition and health benefits of flaxseed (*Linum sitatissimum* L.), it is classified as a functional food became noteworthy for its use in reformulated meat products. The benefits of flaxseed consumption are due to high levels of α-linolenic fatty acid C18:3 n-3 (23%), lignans (26 mg 100 $g^{-1}$) and dietary fiber (28 g 100 $g^{-1}$). It contains high levels of polyunsaturated fatty acids (PUFA) 73% and monounsaturated fatty acid (MUFA) 18%. Also having low levels of saturated fatty acids (SFA) 9%, this is beneficial for health. Sausages as comminuted meat products which are usually spiced or seasoned to obtain various flavor intensities and profiles. The presence of high content of n-3 fatty acid make it more useful and having many health benefits also, thus flaxseed can be incorporated in production of low fat meat products.

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## 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 ºC till further use. Cellulose casings (C19×84 ft.) were procured from Food Aiders (R), New Delhi. Different spices, condiments, salt of food grade (TATA salt®), food grade refined oil (Fortune®) and excellent quality of flaxseeds 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. Flaxseeds kept for drying at 65ºC for 2-3 hours in a hot air oven. After drying, ground into fine powder using mixer grinder and packaged in pre sterilized LDPE pouches. All the chemicals used in the study were of analytical grade and procured from Hi Media Laboratories (P) Ltd., Mumbai. Chicken sausages were prepared as per standard procedure with the formulation given in table 1. Chicken sausages were incorporated with flaxseeds powder separately at 0.75, 1.50 and 2.25% level to replace 50% vegetable oil in

formulation. The formulation of emulsion was maintained by addition of water accordingly. The following abbreviations were used for present experiment: C- (control) chicken sausage incorporated without flaxseeds; FT1- chicken sausage incorporated with 0.75% flaxseeds, FT2- chicken sausage incorporated with 1.50% flaxseeds and FT3- chicken sausage incorporated with 2.25% flaxseeds.

**Physico- chemical properties**

The pH was determined by using digital pH meter (WTW, Germany, model pH 330i) as per the procedure of Troutt *et al.* (1992), whereas emulsion stability was determined as per the procedure of Baliga and Madaiach, (1970). The cooking yield was calculated as under and expressed as percentage (Murphy *et al.*, 1975). Water activity of sample was measured three times in duplicate using a water activity meter (AquaLab 3 TE, Inc. Pullman, WA). Moisture retention value represented 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). Fat retention was calculated according to method given by Murphy *et al.* (1975). Proximate analysis i.e. moisture, protein, fat and ash content was calculated as per AOAC (1980) and (AOAC, 1995). Texture profile analysis (hardness, springiness, cohesiveness, gumminess, chewiness) of chicken sausages was done with instrumental texture profile analyser (TA HD Plus Texture analyser) following method given by Bourne *et al.* (1978). The parameters determined were: The colour parameters of chicken sausages were measured using Hunter colourimeter of Colour Tech PCM+ (Colour Tec Associates Inc. Clinton NJ, USA) for lightness (L*), redness ( a*) and yellowness (b*) values, respectively. 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 DISCUSSIONS

**Physico- chemical properties**

The effects of flaxseeds on physico-chemical properties of chicken sausages are presented in table 2. The emulsion, emulsion stability, product pH, product fat content and emulsion content of treatments were significantly ($P<0.05$) lower than control; however there was no significant difference among the treatments. Cooking yield and moisture content values of FT1 were significantly ($P<0.05$) higher than FT2 followed by FT3, whereas control had significantly ($P<0.05$) lower values than treatments. Higher moisture content and cooking yield values might be due to addition of extra chilled water in treatments to maintain the formulation. Chen *et al.* (2004) also reported that higher cooking yield values of flaxseed flour incorporated meat products were significantly ($P<0.05$) higher due to water holding capacity. Protein content increased significantly ($P<0.05$) at each level of flaxseed powder incorporation in chicken sausages, however there was no significant difference in ash content between control and treatments. Similar results were obtained by Turhan *et al.* (2005; 2007) in low fat beef burgers and low fat beef patties, respectively. As per Ishag *et al.* (2020) flaxseed contained 8.50% moisture, 21.00% protein, 43.17% fat, 20.23% fiber, 5.14% carbohydrate and 1.96% ash, respectively. Fat retention, moisture retention and water activity values of FT1 were significantly ($P<0.05$) higher followed by FT2, FT3 and then C, where higher moisture retention and water activity values in FT1 might be related to extra water addition than FT2 and FT3 to maintain the formulation.

**Textural parameters**

The effects of flaxseedson textural parameters of chicken sausages are presented in table 3. There were no significant difference in hardness, springiness and chewiness values between control and treatments as very less amount of fat replacer was added to the product and formulation was maintained with water. Cohesiveness, gumminess and resilience values increased significantly ($P<0.05$) at each level of flaxseed incorporation in chicken sausage except no significant difference was observed between FT2 and FT3 for gumminess values. Higher textural values of treatments might be due to gums present in flaxseed resulting into higher viscosity of final products while cooking. Chen *et al.* (2004) reported that higher viscosity of flaxseed gum in aqueous solutions was due to interaction between meat proteins and flaxseed gum (Chen *et al.*, 2006). The major forces responsible for this

**Table 1. Formulation for the preparation of chicken sausage**

| Ingredients Percent | (%) |
|---|---|
| Chicken meat | 71.2 |
| Refined oil | 10 |
| Ice flakes | 8 |
| Refined wheat flour | 4 |
| Condiments | 3 |
| Spices | 2 |
| Salt | 1.5 |
| STPP | 0.3 |
| Total | 100 |

interaction are electrostatic in nature (Bernal *et al.*, 1987) and are involved in the formation of salt soluble meat protein and flaxseed gum mixture gels. Polysaccharides used as water binders in meat products have been found to affect the thermal transition temperature of meat proteins.

**Colour parameters**

The effects of flaxseeds on colour parameters of chicken sausages are presented in table 4. Lightness (L*) values decreased whereas redness (a*) values increased significantly with increase in flaxseed powder in chicken sausages, however no significant difference was observed in yellowness (b*) values between control and treatments. C and FT1 had significantly (P<0.05) higher lightness and significantly (P<0.05) lower redness values than FT3; however values of FT2 were comparable to C, FT1 and FT3. Yogesh *et al.* (2015) also observed significantly (P<0.05) lower lightness and significantly (P<0.05) higher redness values of cold milled flaxseed powder incorporated raw and cooked meat batter. Baek *et al.* (2016) also observed significantly (P<0.05) lower lightness and yellowness values in flaxseed oil treated spent hen meat batter than control.

**Sensory evaluation**

The effects of flaxseeds on sensory scores of chicken sausages are presented in table 5. Colour and appearance, flavour, juiciness, mouth coating and overall acceptability scores decreased significantly (P<0.05) at each level of flaxseed powder incorporation in chicken sausage. Lower sensory scores of treatments might be due to specific flavour, dark colour of flour and dilution of meaty flavour. Baek *et al.* (2016) also reported significantly (P<0.05) lower appearance, flavour and overall acceptability scores of flaxseed oil incorporated spent layer meat emulsion sausage than control and canola oil treated sausage. Texture and meat flavour intensity scores of treatments were also significantly (P<0.05) lower than control, however no significant difference was observed between FT2 and FT3. Saltiness scores of C were significantly (P<0.05) higher than FT3, however scores of FT1 and FT2 were comparable to C and FT3. Sharma *et al.* (2014)

**Table 2. Effect of flaxseeds on physico-chemical properties (Mean±SE) of chicken sausage**

| Parameter | C | FT1 | FT2 | FT3 | TreatmentMean |
|---|---|---|---|---|---|
| Emulsion pH | $6.01^{a}$±0.02 | $5.96^{b}$±0.02 | $5.93^{b}$±0.01 | $5.90^{b}$±0.02 | 5.95±0.01 |
| Emulsion stability (%) | $95.15^{a}$±0.08 | $93.95^{b}$±0.09 | $94.05^{b}$±0.04 | $94.18^{b}$±0.09 | 94.33±0.11 |
| Emulsion fat (%) | $11.65^{a}$±0.12 | $6.60^{b}$±0.10 | $7.06^{b}$±0.14 | $7.43^{b}$±0.13 | 8.18±0.17 |
| Product pH | $6.05^{a}$±0.02 | $5.99^{b}$±0.01 | $5.96^{b}$±0.01 | $5.94^{b}$±0.02 | 5.98±0.01 |
| Cooking yield (%) | $90.13^{c}$±0.03 | $93.21^{a}$±0.06 | $91.52^{b}$±0.07 | $91.12^{b}$±0.05 | 91.49±0.05 |
| Moisture (%) | $65.85^{c}$±0.07 | $70.88^{a}$±0.08 | $69.01^{b}$±0.06 | $68.23^{b}$±0.05 | 68.49±0.05 |
| Protein (%) | $16.88^{d}$±0.09 | $17.21^{c}$±0.06 | $17.71^{b}$±0.05 | $18.09^{a}$±0.07 | 17.47±0.06 |
| Fat (%) | $10.52^{a}$±0.08 | $6.12^{b}$±0.10 | $6.42^{b}$±0.14 | $6.72^{b}$±0.13 | 7.44±0.18 |
| Ash (%) | 2.49±0.03 | 2.54±0.01 | 2.56±0.01 | 2.58±0.01 | 2.54±0.01 |
| Fat retention (%) | $81.59^{d}$±0.17 | $85.26^{a}$±0.17 | $83.22^{b}$±0.11 | $82.33^{c}$±0.07 | 83.10±0.20 |
| Water activity ($a_w$) | $0.971^{d}$±0.01 | $0.979^{a}$±0.01 | $0.975^{b}$±0.01 | $0.973^{c}$±0.01 | 0.974±0.01 |
| Moisture retention (%) | $59.35^{d}$±0.08 | $65.51^{a}$±0.12 | $63.15^{b}$±0.17 | $62.17^{c}$±0.09 | 62.54±0.13 |

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

**Table 3. Effect of flaxseeds on textural parameters (Mean±SE) of chicken sausage**

| Parameter | C | FT1 | FT2 | FT3 | Treatment mean |
|---|---|---|---|---|---|
| Hardness ($N/cm^2$) | 13.22±0.07 | 13.28±0.10 | 13.37±0.08 | 13.44±0.09 | 13.33±0.06 |
| Springiness (mm) | 26.13±0.13 | 26.37±0.08 | 26.73±0.05 | 26.91±0.08 | 26.53±0.11 |
| Cohesiveness (Ratio) | $0.52^{d}$±0.02 | $0.58^{c}$±0.02 | $0.65^{b}$±0.03 | $0.72^{a}$±0.03 | 0.61±0.02 |
| Gumminess ($N/cm^2$) | $6.42^{c}$±0.08 | $6.52^{b}$±0.04 | $6.61^{a}$±0.12 | $6.69^{a}$±0.09 | 6.56±0.06 |
| Chewiness (N/cm) | 132.68±0.07 | 133.54±0.06 | 134.42±0.08 | 134.69±0.05 | 133.83±0.04 |
| Resilience (Ratio) | $0.45^{d}$±0.03 | $0.52^{c}$±0.04 | $0.59^{b}$±0.04 | $0.68^{a}$±0.04 | 0.56±0.02 |

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

**Table 4. Effect of flaxseeds on colour parameters (Mean±SE) of chicken sausage**

| Parameter | C | FT1 | FT2 | FT3 | Treatment mean |
|---|---|---|---|---|---|
| Lightness (L*) | 45.34$^{a}$±0.11 | 44.90$^{a}$±0.12 | 44.77$^{ab}$±0.09 | 43.27$^{b}$±0.06 | 44.57±0.09 |
| Redness (a*) | 9.84$^{b}$±0.04 | 9.87$^{b}$±0.05 | 10.12$^{ab}$±0.07 | 10.37$^{a}$±0.08 | 10.05±0.06 |
| Yellowness (b*) | 8.41±0.09 | 8.36±0.06 | 8.46±0.04 | 8.42±0.08 | 8.41±0.07 |

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

**Table 5. Effect of flaxseeds on sensory scores (Mean±SE) of chicken sausage**

| Attribute | C | FT1 | FT2 | FT3 | Treatment mean |
|---|---|---|---|---|---|
| Mean colour and appearance | 7.33$^{a}$±0.06 | 7.05$^{b}$±0.05 | 6.88$^{c}$±0.05 | 6.72$^{d}$±0.05 | 6.99±0.03 |
| Flavour | 7.35$^{a}$±0.07 | 7.12$^{b}$±0.05 | 6.95$^{c}$±0.07 | 6.78$^{d}$±0.06 | 7.05±0.03 |
| Texture | 7.32$^{a}$±0.06 | 7.16$^{b}$±0.04 | 6.95$^{c}$±0.05 | 6.84$^{c}$±0.05 | 7.06±0.02 |
| Juiciness | 7.38$^{a}$±0.05 | 7.08$^{b}$±0.06 | 6.95$^{c}$±0.06 | 6.73$^{d}$±0.06 | 7.03±0.03 |
| Saltiness | 7.31$^{a}$±0.06 | 7.25$^{ab}$±0.06 | 7.22$^{ab}$±0.07 | 7.05$^{b}$±0.06 | 7.20±0.03 |
| Mouth coating | 7.35$^{a}$±0.04 | 7.16$^{b}$±0.06 | 7.01$^{c}$±0.05 | 6.87$^{d}$±0.05 | 7.09±0.03 |
| Meat flavour intensity | 7.37$^{a}$±0.06 | 7.11$^{b}$±0.06 | 7.01$^{c}$±0.05 | 6.92$^{c}$±0.06 | 7.07±0.03 |
| Overall acceptability | 7.32$^{a}$±0.06 | 7.09$^{b}$±0.04 | 6.92$^{c}$±0.05 | 6.79$^{d}$±0.06 | 7.03±0.03 |

Overall means bearing different superscripts in a row (a, b, c, d) differ significantly (P<0.05)
C- (control) chicken sausage incorporated without flaxseeds. FT1- chicken sausage incorporated with 0.75% flaxseeds; FT2- chicken sausage incorporated with 1.50% flaxseeds; FT3- chicken sausage incorporated with 2.25% flaxseeds.

developed extended restructured mutton chops with incorporation of 0.5, 1.0 and 1.5% flaxseed flour and observed significant (P<0.05) decrease in flavour and mouth coating scores. In present study also, scores of various sensory attributes including overall acceptability decreased significantly (P<0.05) at each level of flaxseed flour incorporation in chicken sausage. Therefore, FT1-chicken sausage incorporated with 0.75% flaxseeds was selected as the best treatment.

## CONCLUSION

Low fat chicken sausage was prepared with incorporating of 0.75% flaxseeds powder as fat replacer which replaces the 50% vegetable fat from the product without much affecting the physico-chemical, texture parameters, colour parameters as well as sensory attributes of low fat chicken sausages.

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