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Efficiency of Sesame Seeds as Fat Replacer to Develop Functional Chicken Sausage

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ABSTRACT

The present study was conducted to explore the efficacy of sesame seeds (ST1, ST2 and ST3) 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, product pH and moisture content increased whereas emulsion stability, product fat and emulsion fat content decreased significantly (P<0.05) with increased level of sesame seeds in chicken sausage. Fat retention, water activity and moisture retention values of treatments were significantly (P<0.05) higher than control, whereas a significant (P<0.05) decrease was observed among the treatments with increased level of sesame seeds. No significant difference was observed on protein as well as ash content between control and treatments. Among the textural and colour parameters, springiness, cohesiveness, gumminess, chewiness and resilience values increased significantly (P<0.05) whereas lightness values decreased significantly (P<0.05) in treatments. There was no significant difference in hardness, redness and yellowness values between control and treatments. The scores of all sensory attributes decreased significantly (P<0.05) in treatments, however there was no significant difference between ST1 and ST2 for many sensory attributes including overall acceptability. Therefore, ST2- chicken sausage incorporated with 1.50% sesame seeds were selected as the best treatment.

HIGHLIGHTS

- Study focused on the preparation of low fat chicken sausage.
- Sesame seeds used as fat replcer in preparation of low fat chicken sausage.
- Quality characteristics of low fat chicken sausage

Keywords: Chicken sausage, Sesame, emulsion pH, textural and colour parameters

Changes in eating habits arising from the development of society in recent decades have led people to search for affordable and healthier foods with satisfactory taste and acceptable appearance. Thus, continually seeks to adapt and develop new formulations designed to improve quality, food safety and shelf-life. A good strategy is to change the nutritional profile of traditional products by combining them with alternatives to those consumers that seek food with concept of health awareness. Awareness for adverse effects of excessive dietary fat intake is approaching universal. 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 Faria *et al.* (2015). The meat and

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meat products are highly nutritious, fat content in these products, are receiving bad publicity. High fat intake is associated with increased risk for obesity and some types of cancer and saturated fat intake is associated with high blood cholesterol, coronary heart disease and high risk of chronic diseases Popkin *et al.* (2012); Prince *et al.* (2013). Processing may enhance the fat content in meat product, hence reducing fat content with fat replacers in chicken meat products without affecting the sensory characteristics seems to be a significant challenge as well as area of work. Sesame seed is an ideal fat substitute for meat products, as it contains a high content of polyunsaturated fats. It is known to reduce cholesterol levels due to the high content of polyunsaturated fat in the oil, contains lignans, sesamine, sesamoline and sesamol which have antioxidant activity and is very stable against oxidation deterioration Peng *et al*. (2015); Zhuang *et al.* (2016). Sausages are among meat products, which are popular; they are usually produced by red meat and chicken. Knipe (2014) defined sausages as a mixture of ground meat, combined with spices and seasonings, often stuffed into some type of casing and linked. They were originally made as a means to salvage value from trimmings and lower value cuts of meat from all species.

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^{0} C till further use. Cellulose casings (C19×84ft.) were procured from Food Aiders$^{(R)}$, New Delhi Different spices viz. Caraway seed (Ajwain)- 6%, Cinnamon (Dalchini)- 6%, Black Cardamom (Badi elaichi)-6%, Red chilli-7%, clove- 5%, cumin-17%, coriander-20%, black papper-10%, dried ginger powder-6%, fennel seed (soanf)-5%, nutmeg (Jaifal)- 3%, mace (Javitri)- 3%, white pepper- 2%, green cardamom- 2% and star anise-2%. Condiments i.e. onion, ginger and garlic, salt of food grade (TATA salt ®), food grade refined oil (Fortune®), 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. 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.

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

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 chicken sausages is given in table 1.

Chicken sausages were incorporated with sesame seeds 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.

- ST1- chicken sausage incorporated with 0.75% sesame seeds,
- ST2- chicken sausage incorporated with 1.50% sesame seeds,
- ST3- chicken sausage incorporated with 2.25% sesame seeds.

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

$$\text{Cooking yield \%} = \frac{\text{Weight of cooked chicken sausages}}{\text{Weight of raw emulsion}}$$

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 × moisture in cooked patties)/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 patties × weight of cooked patties

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

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, Makdhoom. 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 sesame seeds on physico-chemical properties of chicken sausages are presented in table 2. The emulsion pH, product pH and moisture content of ST1, ST2 and ST3 were significantly ($P<0.05$) higher whereas emulsion stability, product fat and emulsion fat content were significantly ($P<0.05$) lower than C, however there was no significant difference among the treatments. Indumathi *et al.* (2020) found similar results of incorporation of ground sesame seed as fat replacer on the functionality of spent broiler breeder hen chicken sausages. Oluwamukomi (2015) also reported significantly ($P<0.05$) higher pH of sesame seeds incorporated Gari, a fermented semolina product than that of control. Lower product fat and emulsion fat content in treatments might be due to replacement of vegetable fat with sesame seeds at different levels. These findings might also be correlated with Castillo *et al.* (2018) in hamburger meat and Kumar (2011) in sesame seed paste incorporated turkey nuggets. There was no significant difference in cooking yield, protein and ash content between control and treatments. Sanjeewa *et al.* (2010) reported that moisture and protein content of sesame added fish nuggets were comparable with that of control. Fat retention, water activity and moisture

Table 2: Effect of sesame seeds on physico-chemical properties (Mean±SE) of chicken sausage (n=6)

Parameter	C	ST1	ST2	ST3	Treatment Mean
Emulsion pH	6.01^{b}±0.02	6.08^{a}±0.02	6.10^{a}±0.01	6.12^{a}±0.05	6.07±0.01
Emulsion stability (%)	94.95^{a}±0.11	94.05^{b}±0.08	94.35^{b}±0.12	94.48^{b}±0.09	94.45±0.09
Emulsion fat (%)	11.79^{a}±0.04	6.71^{b}±0.07	7.34^{b}±0.08	7.89^{b}±0.05	8.43±0.05
Product pH	6.08^{b}±0.01	6.13^{a}±0.02	6.16^{a}±0.03	6.18^{a}±0.01	6.13±0.01
Cooking yield (%)	90.10±0.04	91.96±0.07	91.47±0.05	91.01±0.07	91.14±0.05
Moisture (%)	66.18^{b}±0.08	69.98^{a}±0.10	69.01^{a}±0.06	68.23^{a}±0.09	68.35±0.07
Protein (%)	16.95±0.05	17.10±0.08	17.29±0.07	17.42±0.09	17.19±0.06
Fat (%)	10.46^{a}±0.04	6.19^{b}±0.07	6.57^{b}±0.05	6.94^{b}±0.03	7.54±0.05
Ash (%)	2.52±0.03	2.55±0.02	2.58±0.01	2.61±0.01	2.56±0.01
Fat retention (%)	79.73^{d}±0.06	84.33^{a}±0.11	81.87^{b}±0.09	80.05^{c}±0.05	81.49±0.07
Water activity (a_w)	0.973^{d}±0.01	0.981^{a}±0.01	0.979^{b}±0.01	0.976^{c}±0.01	0.977±0.01
Moisture retention (%)	59.62^{d}±0.07	64.35^{a}±0.05	63.12^{b}±0.04	62.09^{c}±0.09	62.29±0.06

Overall means bearing different superscripts in a row (a, b, c, d.......) differ significantly (P<0.05); n = no of observations.

Table 3: Effect of sesame seeds on textural parameters (Mean±SE) of chicken sausage (n=6)

Parameter	C	ST1	ST2	ST3	Treatment mean
Hardness (N/cm^2)	12.25±0.06	12.31±0.04	12.37±0.06	12.43±0.08	12.34±0.05
Springiness (mm)	26.03^{b}±0.07	26.29^{a}±0.03	26.47^{a}±0.09	26.67^{a}±0.08	26.36±0.07
Cohesiveness (Ratio)	0.62^{d}±0.02	0.66^{c}±0.03	0.71^{b}±0.04	0.77^{a}±0.04	0.69±0.02
Gumminess (N/cm^2)	7.28^{d}±0.06	7.56^{c}±0.07	7.84^{b}±0.10	8.31^{a}±0.09	7.74±0.06
Chewiness (N/cm)	131.71^{d}±0.07	133.59^{c}±0.08	135.43^{b}±0.06	138.27^{a}±0.05	134.75±0.05
Resilience (Ratio)	0.55^{b}±0.02	0.64^{a}±0.03	0.66^{a}±0.03	0.69^{a}±0.03	0.63±0.02

Overall means bearing different superscripts in a row (a, b, c, d.......) differ significantly (P<0.05); n = no of observations.

retention values of ST1 were significantly (P<0.05) higher than ST2 followed by ST3 and least values were observed in C, which might possibly due to addition of extra water in treatments to maintain the formulation as well as due to water absorption capacity of sesame seeds (Onsaard, 2012; Elleuch *et al.,* 2012).

Textural parameters

The effects of sesame seeds on textural parameters of chicken sausages are presented in table 3. There was no significant difference in hardness values between control and treatments. Springiness and resilience values of ST1, ST2 and ST3 had significantly (P<0.05) higher values than C; however there was no significant difference between among the treatments. Cohesiveness, gumminess as well as chewiness values increased significantly (P<0.05) at each level of sesame seeds incorporation in chicken sausage. Higher textural values of treatments than control might be due to higher viscosity and gel forming properties of sesame seeds. Knag *et al.* (2017) also observed significantly (P<0.05) higher hardness, springiness, cohesiveness and chewiness values in cooked batters added with 50% pre-emulsified sesame oil than cooked batters with 100% pork back-fat. Youssef and Barbut (2011) also reported that replacing beef fat with pre-emulsified canola oil significantly (P<0.05) increased hardness values, when pre-emulsified canola oil contents were 10% and 17.5%, and the treatment of 17.5% pre-emulsified canola oil contents had a better texture than the 10%.

Colour parameters

The effects of sesame seeds on colour parameters of chicken sausages are presented in table 4. Lightness (*L**) values decreased significantly (P<0.05) in treatments than control, however there was no significant difference between ST1 and ST2. Lower lightness values in treatments might be due to dark brown colour of sesame seeds providing darkness to finished product. Hsu and Yu (2002) found that decreasing fat addition level and adding water generally decreased red and yellow colour values of meat balls. There was no significant difference in redness (*a**) and yellowness (*b**) values between control and treatments. Queiroga *et al.* (2020) also reported no significant difference in redness and yellowness values of freshly prepared black sesame seed extract added goat hamburger and control.

Sensory evaluation

The effects of sesame seeds on sensory score of chicken sausages are presented in table 5. Colour and appearance, flavour, juiciness, mouth coating and meat flavour intensity scores of C had significantly (P<0.05) higher score than ST1, ST2 and ST3; however there was no significant difference between scores of ST1 and ST2. Kumari (2013) also observed significant (P<0.05) decrease in colour and appearance scores of sesame seeds treated chicken cutlets from 2.0-8.0% due to dark colour of seeds. These findings might also be correlated with lower lightness values of treatments observed during instrumental colour analysis of products. Texture and saltiness scores for C had significantly (P<0.05) higher score than ST3; however scores of ST1 and ST2 were comparable to C and ST3. The overall acceptability scores decreased significantly (P<0.05) in treatments; however there was no significant difference between ST1 and ST2. In contrast to present study, Indumathi *et al.* (2020) observed no significant difference in sensory scores of chicken sausage incorporated with sesame seeds paste upto 10% level. In present study, sensory scores decreased significantly (P<0.05) with increased level of sesame seeds, however there was no significant difference between ST1 and ST2 for any sensory attribute. Therefore, ST2- chicken sausage incorporated with 0.75% sesame was selected as the best treatment.

Table 4: Effect of sesame seeds on colour parameters (Mean±SE) of chicken sausage (n=6)

Parameter	C	ST1	ST2	ST3	Treatment mean
Lightness (*L**)	44.17^{a}±0.07	43.10^{b}±0.09	43.41^{b}±0.11	41.64^{c}±0.04	43.08±0.06
Redness (*a**)	9.39±0.09	9.26±0.08	9.36±0.06	9.56±0.04	9.39±0.05
Yellowness (*b**)	7.97±0.06	8.02±0.09	8.09±0.09	7.93±0.05	8.00±0.07

Overall means bearing different superscripts in a row (a, b, c, d.......) differ significantly (P<0.05); n = no of observations.

Table 5: Effect of sesame seeds on sensory scores (Mean±SE) of chicken sausage (n=21)

Attribute	C	ST1	ST2	ST3	Treatment mean
Colour and appearance	7.32^{a}±0.07	7.11^{b}±0.06	7.07^{b}±0.06	6.93^{c}±0.06	7.10±0.03
Flavour	7.38^{a}±0.07	7.01^{b}±0.05	6.96^{b}±0.06	6.82^{c}±0.07	7.04±0.03
Texture	7.35^{a}±0.07	7.27^{ab}±0.06	7.19^{ab}±0.06	7.05^{b}±0.06	7.21±0.03
Juiciness	7.36^{a}±0.05	7.13^{b}±0.06	7.09^{b}±0.05	6.89^{c}±0.06	7.11±0.03
Saltiness	7.25^{a}±0.06	7.22^{ab}±0.06	7.19^{ab}±0.05	7.08^{b}±0.06	7.18±0.03
Mouth coating	7.30^{a}±0.05	6.97^{b}±0.06	6.91^{b}±0.06	6.74^{c}±0.05	6.98±0.03
Meat flavour intensity	7.34^{a}±0.06	6.96^{b}±0.06	6.89^{b}±0.05	6.74^{c}±0.06	6.98±0.03
Overall acceptability	7.36^{a}±0.04	7.12^{b}±0.04	7.05^{b}±0.05	6.84^{c}±0.05	7.09±0.02

Overall means bearing different superscripts in a row (a, b, c, d.......) differ significantly (P<0.05); n = no of observations.

CONCLUSION

Low fat chicken sausage was prepared with incorporating of 1.5% sesame seeds powder as fat replacer which replaces the 50% vegetable fat from the product without much affecting the physiochemical, texture parameters, colour parameters as well as sensory attributes of chicken sausages.

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