



## **Effect of Fortification of Ground Peanut Seed as Fat Replacer on the Fatty Acid and Fiber Profile of Spent Broiler Breeder Hen Chicken Sausages**

**Janagam Indumathi<sup>1\*</sup>, M. Shashikumar<sup>2</sup>, G. Vijaya Bhaskar Reddy<sup>3</sup>,  
A. Jagadeesh Babu<sup>4</sup> and M. Gnana Prakash<sup>5</sup>**

<sup>1</sup>*Sri Venkateswara Veterinary University, Tirupati-517502, Andhra Pradesh, India.*

<sup>2</sup>*Department of Livestock Products Technology, College of Veterinary Science, Hyderabad-500030, Telangana, India.*

<sup>3</sup>*Department of Livestock Products Technology, College of Veterinary Science, Tirupati-517502, Andhra Pradesh, India.*

<sup>4</sup>*Department of Veterinary Public Health, College of Veterinary Science, Tirupati-517502, Andhra Pradesh, India.*

<sup>5</sup>*Poultry Research Station, Rajendranagar, Hyderabad-500030, Telangana, India.*

### **Authors' contributions**

*This work was carried out in collaboration among all authors. Author JI designed the study, performed the analysis, wrote the protocol and wrote the draft of manuscript. Remaining authors guided the study as advisors and proof checked. All authors read and approved the final manuscript.*

### **Article Information**

DOI: 10.9734/IRJPAC/2020/v21i2330316

#### Editor(s):

(1) Dr. Wolfgang Linert, Vienna University of Technology, Austria.

#### Reviewers:

(1) Cristiane Ramos Vieira, University of Cuiabá, Brazil.

(2) José Américo Saucedo Uriarte, National University Toribio Rodríguez de Mendoza (UNTRM), Peru.

(3) Marco Aurélio Carneiro De Holanda, Federal Rural University of Pernambuco, Brazil.

Complete Peer review History: <http://www.sdiarticle4.com/review-history/63525>

**Original Research Article**

**Received 10 October 2020**  
**Accepted 16 December 2020**  
**Published 26 December 2020**

### **ABSTRACT**

**Aim:** The aims of this study were to develop and standardize the sausages prepared from meat of spent broiler breeder hens and also to improve the functionality by using ground peanut seed as partial animal fat substitute basing on physico-chemical, proximate and sensory properties of the product.

**Design of the Study:** Conducted six numbers of trails to develop and standardize the functional chicken sausages fortified with ground peanut seed by utilizing cheaply available meat from spent broiler breeder hens.

\*Corresponding author: E-mail: [indumathijanagam@gmail.com](mailto:indumathijanagam@gmail.com);

**Place and Duration of Study:** Work done at Department of Livestock Products Technology, College of Veterinary Science, Tirupati, Chittoor District, Andhra Pradesh India. The duration of study was 2 years (From 2018 to 2019).

**Methodology:** Ground peanut seed used at three different levels as fat replacer in order to study the influence of its addition on physico chemical, proximate, fatty acid composition and sensory evaluation of functional chicken sausages.

**Results:** Results showed that functional chicken sausages fortified with ground peanut seed at 10% level were found to have significantly ( $P < 0.05$ ) higher pH, cooking yield, emulsion stability, hardness, crude protein, crude fiber, total ash, PUFA/SFA ratio, mono and poly unsaturated fatty acids and significantly lower moisture, crude fat, cholesterol and saturated fatty acids when compared to the control and rest of the peanut seed fortified sausages with no significant difference was observed in sensory scores.

**Conclusion:** Replacing chicken fat with ground peanut seeds is possible to develop a healthy fatty acid profile and fiber-enriched chicken sausages.

*Keywords: Chicken sausages; fat replacer; functionality; ground peanut seed.*

## 1. INTRODUCTION

Consumption of meat from spent broiler breeder hens is limited by its poorer sensory quality, in particular poorer tenderness, compared to meat from broilers [1,2,3]. For these reasons, the disposal of spent broiler breeder hens is one of the main economical and environmental problems of the poultry industry [4]. The present study was undertaken keeping in view the necessity for proper utilization of less expensive meat from spent broiler breeder hens to produce cheaper and economically viable nutritious value added sausages.

Currently, consumers are constantly seeking foods with a lower content of fat and cholesterol and with a favorable fatty acid profile and high fiber content [5]. The fatty acid profile of meat and meat products can be changed by supplementing animal feeds with monounsaturated fatty acids (MUFAs) and polyunsaturated fatty acids (PUFAs) or by adding different lipids into meat products during processing [6,7]. Foods with higher amounts of MUFAs and PUFAs are recommended by health professionals because they are associated with lower risks of cancer of the breast, colon, coronary, and brain diseases [8]. However, Fat reduction render products unacceptable due to a number of problems including those associated with texture and water binding properties [9]. To counteract the problems caused by fat reduction, dietary fiber has been added to different meat products in the form the vegetable seeds [10,11].

Peanut (*Arachis hypogaea L.*) is generally considered as nut, has a desirable fatty acid

profile and is rich in polyphenols, antioxidants, vitamins, minerals and bioactive components [12]. Peanut consumption has been associated with improved overall diet quality and nutrient profile [13,14] as it contains high amount of protein (25%), oil (45-50%) and fiber (9-10%) [15]. According to the American peanut council, peanut fat profile contains about 50% monounsaturated fatty acids (MUFAs), 33% Poly unsaturated fatty acids (PUFAs) and 14% saturated fatty acids which is a heart friendly combination of fatty acids [16]. The high monounsaturated peanut fat diets lowered total body cholesterol by 11% and bad LDL cholesterol by 14%, while their good HDL cholesterol was maintained with reduction in triglycerides [17].

The goals of this study were to develop and standardize the sausages prepared from meat of spent broiler breeder hens and to improve the functionality by using ground peanut seed as partial animal fat substitute basing on physico-chemical, proximate and sensory properties of the product.

## 2. MATERIALS AND METHODS

### 2.1 Preparation of Raw Materials

Spent boiler breeder birds (females) of 72 weeks age were purchased from Chandragiri local market, transported and slaughtered at the Department of Livestock Products Technology, College of Veterinary Science, Tirupati. On the next day of the slaughter, spent broiler breeder hen chicken carcasses were deboned and meat was harvested. All subcutaneous fat and inter muscular fat was removed from the meat and

used as the fat source. Peanut seeds were purchased from local super market and were separately cleaned thoroughly, dry roasted in a pan and made in to paste after removing the outer skin. The paste was prepared freshly on the day of incorporation.

The spice ingredients purchased from local market were cleaned thoroughly and dried in a Microprocessor Controller Laboratory hot air oven (230V, single 15A, 4 kW 250 Degree C) at 50°C per 60 minutes. The ingredients were ground separately in a Blender (Model: Panasonic MX-AC 3005) and sieved through a fine mesh (2 mm). The powders were mixed in suitable proportions to obtain the spice mix and were stored at room temperature (28°C) in air tight container for further use.

Other non meat ingredients like sugar, salt, garlic, onions, binder were purchased from local super market. Onions and garlic were peeled off and made a fine paste in the ratio of 3:1 with help of mixer grinder. Meat and fat were separately subjected to thorough mincing a meat mincer (Continental CCE 89/189) through 6 mm diameter grinder plate to obtain a uniform mix and later through 4 mm diameter plate. Minced meat was chopped with salt, sugar, phosphate, fat, ice flakes, refine wheat flour, spices and condiments for 8 min in a bowl chopper (Schadfen 58452 written). The treatment and control batters were stuffed into synthetic cellulose casings (SCC21) using horizontal sausage stuffer (SIRMAN – V15, Italy) and then linked, tied and cooked at 80°C/40 min in moist heat. Functional chicken sausages were prepared by replacing the chicken fat with ground

peanut seed in three different levels along with control as per the formulation given in Table 1. Control sausages were prepared with inclusion of the % 15 chicken fat with no GPS where as T1 sausages were formulated with 10 % fat + 5% GPS, T2 sausages were formulated with 7.5% fat + 7.5% GPS and T3 sausages were formulated with 5%+ 10% GPS. Three treatments along with control were analyzed to select the optimum level of replacement of GPS in formulation of Functional sausages basing on the physico chemical, proximate, fatty acid profile, cholesterol and sensory evaluation.

## 2.2 Analysis

The pH of the samples was determined by following the procedure of Jay (1964). A 25 g meat sample was mixed with 100 ml of distilled water for one minute in a mechanical mixer. From the total homogenate a 50 ml aliquot portion was immediately used for determination of pH using a digital pH (Systronics  $\mu$  pH system 361) meter after standardizing the instrument with two standard buffers.

Percent cooking yield was estimated by recording the difference between the pre and post cooking weights of meat sausages and expressed in percentage. Percent Emulsion stability of the sample was determined by the method followed by Balinga and Madaiah [18]. Twenty five grams of emulsion was taken in a sealed polythene bag and cooked at 80°C for 30 min in a water bath. Cookout was drained, cooked mass was cooled and weighed, and same was expressed as percent emulsion stability.

**Table 1. Formulations of low fat chicken sausages fortified with ground peanut seed (GPS) as fat replacer at different levels**

Ingredient	Control	Low fat sausages incorporated with GPS		
		T1	T2	T3
Chicken Meat (%)	85	85	85	85
Chicken Fat (%)	15	10	7.5	5
Ground Peanut Seed (%)	0	5	7.5	10
Salt (%)	1.8	1.8	1.8	1.8
Sugar (%)	1	1	1	1
Polyphosphate (STPP) (%)	0.3	0.3	0.3	0.3
Ice (%)	10	10	10	10
Dry Spice mix (%)	2	2	2	2
Wet Condiment mix* (%)	3	3	3	3
Binder (Maida) (%)	3	3	3	3

*Onion: Garlic paste (3:1)*

The hardness of the product was measured in terms of penetration value (penetration value $\times 10^{-1}$  mm) with the help of cone Penetrometer as described by Dixon and Parekh [19]. Proximate composition including the per cent moisture, crude protein, crude fat and crude fibre were estimated as per the procedures outlined by AOAC [20]. Cholesterol was estimated as per the method described by Wybenga et al. [21] as modified by Rajkumar et al. [22]. Fatty acid composition was estimated by Folch et al. [23] and Lepage and Roy [24]. Sensory evaluation was done per the standardized formulations were oven cooked separately and subjected to sensory evaluation on a 9 point hedonic scale (1 is poor and 9 is excellent).

The data obtained in the present study was analyzed statistically as per the methods outlined by Snedecor and Cochran (1980). The data was analyzed by one way ANOVA.

### 3. RESULTS AND DISCUSSION

#### 3.1 Physico Chemical Parameters

Mean values of physico-chemical properties of ground peanut seed incorporated low fat chicken sausages are presented in Table 2.

##### 3.1.1 pH

The pH differed significantly ( $P < 0.05$ ) between low fat sausages and control. The pH of sausages increased with increased in the level of ground peanut seed incorporation and were significantly higher ( $P < 0.05$ ) at subsequent level of incorporation. This increase in pH might be attributed to the replacement of chicken fat with groundnut seed paste which has comparatively high pH (6.28-7.50 by Anon, [25]). The pH of the product with 10% ground peanut seed was significantly higher ( $P < 0.05$ ) than the rest of the formulations. These findings are correlated with Dima et al. [26] in beef meat product and Kumar et al. [27] in mutton nuggets.

##### 3.1.2 Percent cooking yield

The mean percent cooking yield of low-fat chicken sausages was significantly ( $P < 0.05$ ) affected by addition of ground peanut seed. The cooking yield of the product improved with increase in the level of ground peanut seed and was significantly higher ( $P < 0.05$ ) at 10% level as compared to 5%, 7.5% incorporation and control.

The improvement in the cooking yield with increasing level of ground peanut seed coincided with the emulsion stability of respective products and better moisture retention. Findings of the present study are in agreement with Kumar et al. [27] in mutton nuggets, Riernersman and Ana [28] in chia flour added fish burger and Soher et al. [29] in chicken burger incorporated with defatted peanut flour.

##### 3.1.3 Percent emulsion stability

The mean percent emulsion stability of low-fat chicken sausages was significantly ( $P < 0.05$ ) affected by different formulations. The emulsion stability increased in treated sausages with increased addition of ground peanut seed as compared to that of control. Low fat sausages replaced with 10% peanut seed paste (T3) had significantly ( $P < 0.05$ ) higher percent emulsion stability values than rest of treatments and control. The increase in emulsion stability might be due to increase in total emulsifying protein content in the formulation after substitution. Peanut proteins have been reported to possess good emulsifying property [30,31]. The results are in agreement with Baek et al. [32] in sausages with canola oil, Choi et al. [33] in sausages with rice bran fiber and Kumar et al. [27] in mutton nuggets added with peanut paste.

##### 3.1.4 Hardness

All the formulations of low-fat chicken sausages recorded significantly ( $P < 0.05$ ) lower penetration values compared to control and significant difference was also observed among three the low-fat formulations. Mean penetration values of low fat formulations decreased with increased level of addition of ground peanut seed with the T3 having least value penetration values than rest of treatments and control. This increase in hardness might be due to reduced fat and moisture percent. Similar trend was reported by Kumar et al. [27] peanut incorporated products and Soher et al. [29] in defatted peanut flour supplemented chicken burger. These results are in contrast to Das et al. [34] who noticed slight decrease in shear force values with increased incorporation of non- meat additives.

#### 3.2 Proximate Composition

Mean values of proximate composition of ground peanut seed incorporated low fat chicken sausages are presented in Table 3. Effect of partial replacement of chicken fat with ground

peanut seed on proximate composition of low fat chicken sausages is represented in Chart 1. Effect of partial replacement of chicken fat with ground peanut seed on cholesterol of low fat chicken sausages is represented in Chart 2.

Proximate composition of low-fat chicken sausages was significantly ( $P<0.05$ ) affected by addition of ground peanut seed. Control sausages recorded significantly higher percent moisture and lower percent crude fiber than treatments. The percent moisture of the ground peanut seed added sausages was significantly lower ( $P<0.05$ ) than control. The moisture percent significantly ( $P<0.05$ ) decreased at subsequent level of incorporation with lowest at 10% level of incorporation. Backes et al. [35] reported decreased fat and increased moisture content of Italian-type salami by substituting 15% and 30% of pork back fat with emulsified canola oil.

Ground peanut seed addition significantly ( $P<0.05$ ) affected the protein content of the sausages with the highest protein content determined in sausages having 10% ground peanut seed than rest of treatments and control. Decrease in moisture and increase in protein in the product might be due to replacement of chicken fat with ground peanut seed which had comparatively low moisture and high protein content (25.72%). Similar pattern of findings is reported by Kumar et al. [27] in mutton nuggets and Soher et al. [29] in low-fat chicken burger containing defatted peanut flour.

The percent crude fat of treatment and control sausages was significantly ( $P>0.05$ ) affected. Control sausages had significantly ( $P>0.05$ ) higher fat content than treated sausages. Low fat sausages replaced with 5% ground peanut seed (T1) had significantly ( $P<0.05$ ) lower percent crude fat than rest of treatments and control. These findings are correlated with Dima et al.

[26] in beef products and Hudayi and Tugba [36] in sucuk added with walnut paste.

Low fat sausages replaced with 10% ground peanut seed (T3) had significantly ( $P<0.05$ ) higher percent total ash (6.5%) and crude fiber (13%) than rest of treatments and control. This might be attributed to the high total ash and fiber contents of ground peanut seed [37]. Similar trend is reported by Kumar et al. [27] in mutton nuggets, Prinyawiwatkul et al. [38] in nuggets added with fermented partially defatted peanut flour, Santhi and Kalaikannan, [39] in low fat chicken nuggets with oat flour and Soher et al. [29] in low fat chicken burger.

The mean cholesterol values of low-fat chicken sausages was significantly ( $P<0.05$ ) affected by different formulations. Cholesterol content was decreased with increased addition of ground peanut seed and higher cholesterol content was observed in control with 15% fat. Low fat sausages replaced with 10% ground peanut seed (T3) had significantly ( $P<0.05$ ) lower cholesterol than rest of treatments and control. A decrease in cholesterol content in treatment sausages was obvious because of substitution of cholesterol rich animal fat with peanut based lipids which are devoid of cholesterol. Similar trend was reported by Cengiz and Gokoglu, [40] in citrus fiber and soy protein concentrate added frankfurters, Hudayi and Tugba, [36], Kayaardi and Gok, [41] in sucuk added with walnut and olive oil and Kumar et al. [27] in mutton nuggets.

### 3.3 Fatty Acid Composition of Low Fat Chicken Sausages

Mean values of fatty acid composition of ground peanut seed incorporated low fat chicken sausages are presented in Table 3. Effect of partial replacement of chicken fat with ground peanut seed on fatty acid composition of low fat chicken sausages is represented in Chart 3.

**Table 2. Effect of partial replacement of chicken fat with ground peanut seed (GPS) paste on physico-chemical properties of low fat chicken sausages**

Parameter	Control	T1	T2	T3
pH	6.23±0.01 <sup>a</sup>	6.27±0.005 <sup>b</sup>	6.28±0.004 <sup>c</sup>	6.30±0.006 <sup>d</sup>
Cooking yield (%)	87.2±0.04 <sup>a</sup>	88.89±0.11 <sup>b</sup>	90.04±0.08 <sup>c</sup>	91.06±0.06 <sup>d</sup>
Emulsion stability (%)	87.0±0.22 <sup>a</sup>	88.93±0.14 <sup>b</sup>	90.02±0.05 <sup>c</sup>	91.58±0.08 <sup>d</sup>
Hardness	26.05±0.17 <sup>a</sup>	22.26±0.02 <sup>b</sup>	21.89±0.06 <sup>c</sup>	21.24±0.05 <sup>d</sup>

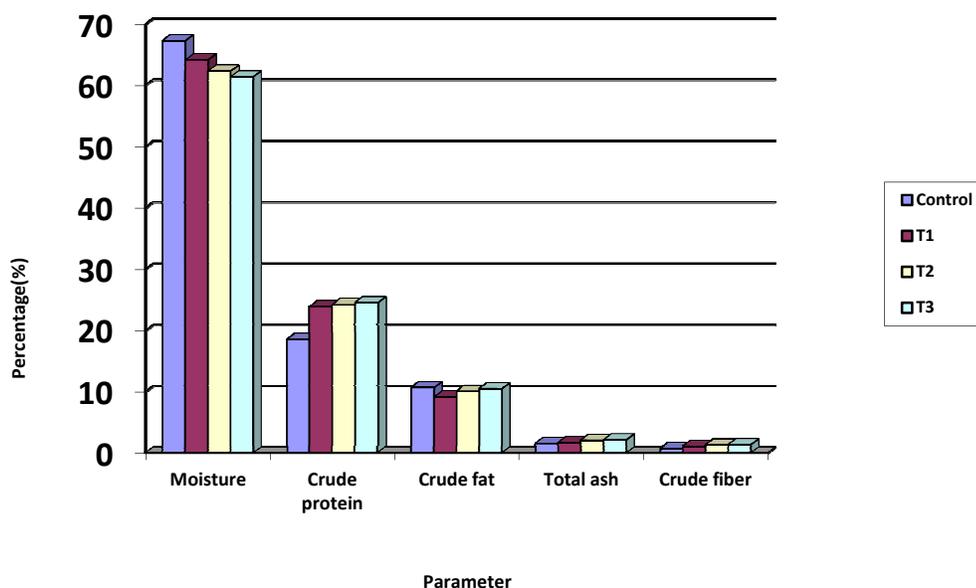
Control -15 % Chicken fat (CF); T1 - 10 % CF + 5% GSP; T2 - 7.5% CF + 7.5% GSP; T3 - 5% CF + 10% GSP.

Note: Mean values bearing at least one common superscript do not differ significantly

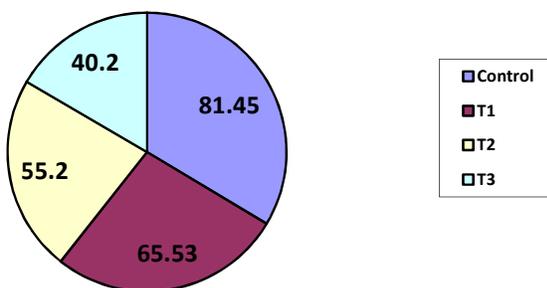
**Table 3. Effect of partial replacement of chicken fat with ground nut seed on proximate composition of low fat chicken sausages**

Parameter	Control	T1	T2	T3
Moisture(%)	67.25±0.12 <sup>a</sup>	64.16±0.20 <sup>b</sup>	62.33±0.05 <sup>c</sup>	61.35±0.12 <sup>d</sup>
Crude protein(%)	18.52±0.05 <sup>a</sup>	23.84±0.06 <sup>b</sup>	24.16±0.02 <sup>c</sup>	24.52±0.06 <sup>d</sup>
Crude fat(%)	10.65±0.06 <sup>a</sup>	9.11±0.07 <sup>b</sup>	10.04±0.01 <sup>c</sup>	10.45±0.04 <sup>d</sup>
Total ash(%)	1.53±0.05 <sup>a</sup>	1.66±0.01 <sup>b</sup>	2.05±0.02 <sup>c</sup>	2.10±0.007 <sup>c</sup>
Crude fiber(%)	0.68±0.03 <sup>a</sup>	1.06±0.01 <sup>b</sup>	1.27±0.01 <sup>c</sup>	1.32±0.008 <sup>d</sup>
Cholesterol(mg)	81.45±0.08 <sup>a</sup>	65.53±0.06 <sup>b</sup>	55.20±0.04 <sup>c</sup>	40.20±0.06 <sup>d</sup>

Control -15 % Chicken fat (CF); T1 - 10 % CF + 5% GSP; T2 - 7.5% CF + 7.5% GSP; T3 - 5% CF + 10% GSP.  
 Note: Mean values bearing at least one common superscript do not differ significantly



**Chart 1. Effect of partial replacement of chicken fat with ground peanut seed on proximate composition of low fat chicken sausages**



**Chart 2. Effect of partial replacement of chicken fat with ground peanut seed on cholesterol content of low fat chicken sausages**

The free fatty acid composition of low fat chicken sausages and control was significantly (P<0.05) affected by addition of ground peanut seed. Groundnut seed paste addition as animal fat

replacer changed ( $P<0.05$ ) the fatty acid composition with decreased saturated fatty acid (SFA) concentration and increased ( $P<0.05$ ) the mono unsaturated fatty acid (MUFA), poly unsaturated fatty acid (PUFA) concentration and ratio of PUFA/SFA. Control sausages had significantly ( $P<0.05$ ) higher percent of total saturated fatty acids concentration than low fat treatments. Among the low fat treatments T3 sausages had significantly ( $P<0.05$ ) higher percent of total mono unsaturated fatty acids (MUFA), poly unsaturated fatty acids (PUFA), ratio of PUFA/SFA and lowest saturated fatty acid (SFA) when compared to the other treatments and control. This might be due to peanuts have high concentration of mono unsaturated fatty acid (50%) and poly unsaturated fatty acid (33%) and low saturated fatty acids (14%). These results are in conformity with Arya et al. [37] and Settaluri et al. [42]. Karwowska et al. [43] found significantly higher percentage of polyunsaturated fatty acids (PUFAs) for meat product sample containing 0.5% of mustard seed compared to control.

Ground peanut seed addition resulted in increased linoleic acid and oleic acid content and decreased myristic, palmitic acid and stearic acid contents in low fat sausages than control. Linoleic and oleic acid percent of low fat chicken sausages increased with increased level of addition of ground peanut seed and highest value was recorded in T3 sausages. This might be due to high concentration of oleic, linoleic acid

in groundnut seed [44], Talcott et al. 2005 and Ozcan [45]. The changes in fatty acid composition of ground peanut seed added chicken sausages are correlated with Baek et al. [32] in spent layer sausages, Hudayi and Tugba [36] in walnut added sucuk, Marquez et al. [46] in peanut oil added frankfurters and Saldana et al. [47] in mortadella type products.

### 3.4 Sensory Evaluation

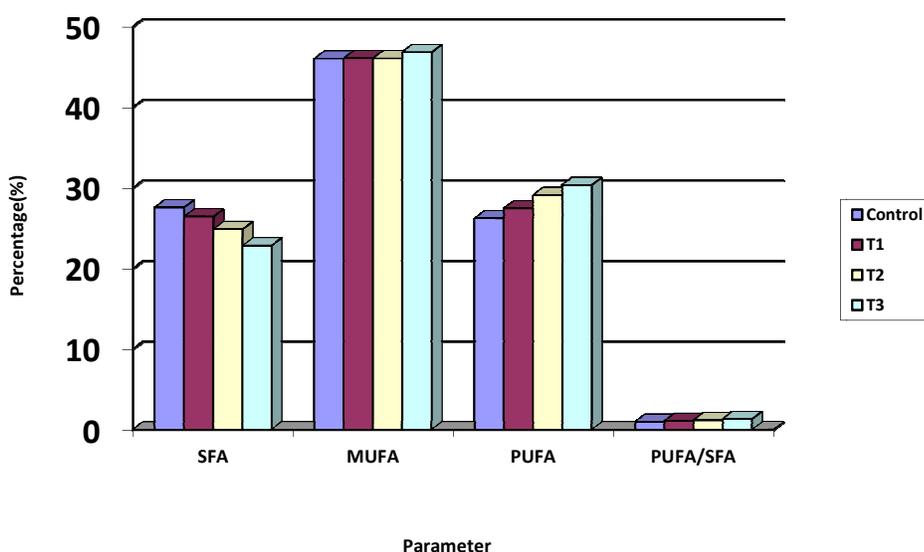
Overall mean values of sensory parameters of ground peanut seed incorporated low fat chicken sausages are presented in Table 5. The sensory parameters of low fat chicken sausages and control were not affected significantly by addition of ground peanut seed. T3 sausages scored uniformly higher scores for all sensory parameters than other treatments and control. These findings are in accordance with Keefe and Wang [48] who showed no effect on sensory aroma of beef products added with peanut extracts. Scores of all sensory parameters for three treatments of sausages were in the range of 7.47-7.79 which indicating acceptability of low fat chicken sausages. These results are in agreement with Jo et al. [49] in low-salt chicken sausages, Kumar et al. [27] in mutton nuggets, Olusola et al. [50] in kilishi, is a ready to eat intermediate moisture meat traditionally prepared from beef infused with spices and defatted ground peanut seed and Prinyawiwatkul et al. [38] in chicken nuggets incorporated with peanut paste.

**Table 4. Effect of partial replacement of chicken fat with ground nut seed paste on fatty acid composition (%) of low fat chicken sausages**

Parameter	Control	T1	T2	T3
Myristic acid (C14)	0.64±0.004 <sup>a</sup>	0.63±0.01 <sup>a</sup>	0.53±0.003 <sup>b</sup>	0.53±0.007 <sup>b</sup>
Palmitic acid (C16)	21.4±0.06 <sup>a</sup>	21.05±0.02 <sup>b</sup>	19.57±0.03 <sup>c</sup>	18.18±0.03 <sup>d</sup>
Stearic acid (C18)	5.09±0.004 <sup>a</sup>	4.39±0.02 <sup>b</sup>	4.40±0.04 <sup>b</sup>	3.49±0.03 <sup>c</sup>
Behenic acid (C22)	0.42±0.005 <sup>a</sup>	0.37±0.009 <sup>b</sup>	0.36±0.007 <sup>c</sup>	0.61±0.01 <sup>d</sup>
Oleic acid (C18:1)	40.77±0.06 <sup>a</sup>	41.46±0.03 <sup>b</sup>	42.06±0.02 <sup>c</sup>	43.55±0.09 <sup>d</sup>
Palmitoleic acid (C16:1)	5.26±0.01 <sup>a</sup>	4.60±0.03 <sup>b</sup>	3.99±0.01 <sup>c</sup>	3.26±0.02 <sup>d</sup>
Linoleic acid (C18:2)	24.25±0.015 <sup>a</sup>	25.91±0.03 <sup>b</sup>	28.01±0.02 <sup>c</sup>	29.99±0.01 <sup>d</sup>
Linolenic acid(C18:3)	1.36±0.006 <sup>a</sup>	1.39±0.007 <sup>a</sup>	0.09±0.01 <sup>b</sup>	0.28±0.008 <sup>c</sup>
Arachidonic acid (C20:4)	0.16±0.004 <sup>a</sup>	0.15±0.008 <sup>a</sup>	0.12±0.007 <sup>b</sup>	0.07±0.005 <sup>c</sup>
Ecosapentaenoic acid (C20:5)	0.35±0.006 <sup>a</sup>	---	---	---
Docosahexaenoic acid (C22:6)	0.13±0.005 <sup>a</sup>	---	---	---
Others	0.12±0.001 <sup>a</sup>	---	---	---
SFA	27.55±0.07 <sup>a</sup>	26.44±0.04 <sup>b</sup>	24.86±0.01 <sup>c</sup>	22.82±0.01 <sup>d</sup>
MUFA	46.03±0.009 <sup>a</sup>	46.07±0.01 <sup>a</sup>	46.05±0.01 <sup>a</sup>	46.81±0.01 <sup>b</sup>
PUFA	26.23±0.01 <sup>a</sup>	27.45±0.01 <sup>b</sup>	29.09±0.07 <sup>c</sup>	30.34±0.01 <sup>d</sup>
PUFA/SFA	0.95±0.002 <sup>a</sup>	1.04±0.001 <sup>b</sup>	1.17±0.001 <sup>c</sup>	1.33±0.0005 <sup>d</sup>

Control -15 % Chicken fat (CF); T1 - 10 % CF + 5% GSP; T2 - 7.5% CF + 7.5% GSP; T3 - 5% CF + 10% GSP.

Note: Mean values bearing at least one common superscript do not differ significantly



**Chart 3. Effect of partial replacement of chicken fat with ground peanut seed on of Fatty acid composition low fat chicken sausages**

**Table 5. Effect of partial replacement of chicken fat with ground peanut seed (GPS) on sensory parameters of low fat chicken sausages**

Parameter	Control	T1	T2	T3
Appearance	7.63±0.14 <sup>a</sup>	7.62±0.10 <sup>a</sup>	7.61±0.19 <sup>a</sup>	7.61±0.13 <sup>a</sup>
Flavour	7.54±0.16 <sup>a</sup>	7.50±0.14 <sup>a</sup>	7.52±0.14 <sup>a</sup>	7.52±0.17 <sup>a</sup>
Juiciness	7.44±0.11 <sup>a</sup>	7.43±0.10 <sup>a</sup>	7.42±0.16 <sup>a</sup>	7.41±0.11 <sup>a</sup>
Tenderness	7.48±0.13 <sup>a</sup>	7.47±0.10 <sup>a</sup>	7.45±0.15 <sup>a</sup>	7.44±0.15 <sup>a</sup>
Overall acceptability	7.45±0.10 <sup>a</sup>	7.45±0.13 <sup>a</sup>	7.44±0.15 <sup>a</sup>	7.43±0.14 <sup>a</sup>

Control -15 % Chicken fat (CF); T1 - 10 % CF + 5% GPS; T2 - 7.5% CF + 7.5% GPS; T3 - 5% CF + 10% GPS.  
 Note: Mean values bearing at least one common superscript do not differ significantly

#### 4. CONCLUSION

Functional chicken sausages incorporated with 10% ground peanut seed recorded significantly better scores in all physico chemical, proximate, fatty acid profile and sensory analysis. The functional chicken sausages had higher cooking yield and better Emulsion stability than control sausages. The functional chicken sausages recorded higher crude protein, crude fiber, total ash, PUFA/SFA ratio and poly unsaturated fatty acids and lower moisture, crude fat, cholesterol and saturated fatty acids compared to the control sausages. Even though control sausages recorded little higher sensory scores than functional sausages but found no significant difference between them. Thus concluding that the ground peanut seed will be the better alternative to replace the chicken fat to develop functional chicken sausages with healthy fatty

acid profile and rich fiber content without affecting the consumer acceptability.

#### ACKNOWLEDGEMENTS

The present research work was funded by Sri Venkateswara Veterinary University, Tirupathi, Andhra Pradesh, India.

#### COMPETING INTERESTS

Authors have declared that no competing interests exist.

#### REFERENCES

1. Grabowski W. Slaughter material. In: Meat and Poultry Products Technology. Higiene Quality. (In Polish) WN-T Warszawa. 2000;16-39.

2. Komiyama CM, Mendes AA, Sanfelice C, Canizares MC, Roca RO, Takahashi SE, Rodriguez L, Canizares GIL, Paz ICLA, Cordoso KFG. Physical, chemical and sensorial breast meat quality of spent hens. *Ciencia Rural, Santa Maria*. 2010;40:1623-1629.
3. Lyon CE, Lyon BG, Savage EM. Effect of postchill deboning time on the texture profile of broiler breeder hen breast meat. *Journal of Applied Poultry Research*. 2003;12:348-355.
4. Lyons JJ. Spent hen utilization. In: *Midwest Poultry Federation Egg Production Workshop*, St. Paul; 2001.
5. Ospina EJC, Sierra CA, Ochoa O, Perez-Álvarez JA, Fernández-Lopez J. Substitution of saturated fat in processed meat products: A review. *Critical Reviews in Food Science and Nutrition*. 2012;52(2):113-122. DOI: 10.1080/10408398.2010.493978
6. Arihara K. Strategies for designing novel functional meat products. *Meat Science*. 2006;74(1):219-229. DOI: 10.1016/j.meatsci.2006.04.028
7. Fruet AP, Stefanello FS, Rosado Junior AG, Souza AN, Tonetto CJ, Nörnberg JL. Whole grains in the finishing of culled ewes in pasture or feedlot: Performance, carcass characteristics and meat quality. *Meat Science*. 2016;113(14):97-103.
8. Nettleton JA, Lovegrove JA, Mensink RP, Schwab U. Dietary fatty acids: Is it time to change the recommendations? *Annals Nutrition & Metabolism*. 2016;68(4):249-257. DOI: 10.1159/000446865
9. Jimenez Colmenero F. Relevant factors in strategies for fat reduction in meat products. *Trends in Food Science and Technology*. 2000;11(2):56-66. DOI: 10.1016/S0924-2244(00)00042-X
10. Anonymous. The definition of dietary fiber. AACC Report. *Cereal Foods World*. 2001;46:112-126.
11. Trowell H. Definition of dietary fiber and hypotheses that it is a protective factor in certain diseases. *American Journal of Clinical Nutrition*. 1976;29:417-422. DOI: 10.1093/ajcn/29.4.417
12. Maria L, Francisco DL, Resurreccion AVA. Functional components in peanuts. *Critical Reviews in Food Science Nutrition*. 2008;48:715-746. DOI: 10.1080/10408390701640718
13. Griel AE, Eissenstat B, Juturu V, Hsieh G, Kris-Etherton PM. Improved diet quality with peanut consumption. *Journal of American College of Nutrition*. 2004;23:660-668. DOI: 10.1080/07315724.2004.10719408
14. Singh B, Singh U. Peanut as a source of protein for human foods. *Plant Foods for Human Nutrition*. 1991;41:165-177.
15. Suchoszek-Łukaniuk K, Jaromin A, Korycinska M, Kozubek A. Health benefits of peanut (*Arachis hypogaea L.*) seeds and peanut oil consumption. In *Nuts & Seeds in Health and Preedy V R and Watson R R, Patel V B, Eds. Disease Prevention*, (Academic Press is an Imprint of Elsevier, London, Burlington, and San Diego) 1<sup>st</sup> Ed. 2011;str:873-880.
16. Feldman EB. Assorted monounsaturated fatty acids promote healthy hearts. *American Journal of Clinical Nutrition*. 1999;70:953-954. DOI: 10.1093/ajcn/70.6.953
17. Pelkman CL. Effects of moderate-fat (from monounsaturated fat) and low-fat weight-loss diets on the serum lipid profile in overweight and obese men and women. *American Journal of Clinical Nutrition*. 2004;79(2):204-212. DOI: 10.1093/ajcn/79.2.204
18. Balinga BR, Madaiah N. Quality of sausage emulsion prepared from mutton. *Journal of Food Science*. 1970;35:383-385. DOI: 10.1111/j.1365-2621.1970.tb00937.x
19. Dixon BD, Parekh JV. Use of the cone penetrometer for testing the firmness of butter. *Journal of Food Science*. 1979;10:421-434. DOI: 10.1111/j.1745-4603.1980.tb00868.x
20. Association of Official Analytical Chemistry (AOAC). Official methods of analysis of the Association of Official Analytical Chemists, Vols. I & II, Association of Analytical Chemists, Arlington. 1994;1298.
21. Wybenga DR, Pileggi V, Dirstine J, John Di Giorgio PH. Direct manual determination of serum total cholesterol with a single stable reagent. *Clinical Chemistry*. 1970;16(12):980-984. PMID: 4098216
22. Rajkumar Vincentraju, Agnihotri M. Kand, Sharma N. Quality and shelf-life of vacuum and aerobic packed chevon patties under refrigeration. *Asian Australasian Journal of Animal Sciences*. 2004;17(4):548-553.

23. Folch J, Lees M, Sloane Stanley GH. A simple method for isolation and purification of total lipids from animal tissue. *Journal of Biological Chemistry*. 1957;226:497–509. PMID: 13428781
24. Lepage G, Roy CC. Direct transesterification of all classes of lipids in a one-step reaction. *Journal of Lipid Research*. 1986;27:114-120. PMID: 3958609
25. Anon. pH values of food products. *Food Engineering*. 1962;34:98–99.
26. Dima F, Vizireanu C, Istrati D. Effects of vegetal oils on the quality characteristics of beef meat products with low animal fat. Series D. *Animal Science*. 2014;LVII:228-236.
27. Kumar RR, Sharma BD, Mendiratta SK, Malav O, Talukder S, Irshad A. Efficacy of peanut paste as functional component in premium mutton nuggets. *Journal of Food Processing and Preservation*. 2016;41(3):1-12.
28. Riemersman CN, Ana MR. Whole Chia flour as yield enhancer, potential antioxidant and input of n-3 fatty acid in a meat product. *Food and Nutrition Sciences*. 2016;7(10):855-865. DOI: 10.4236/fns.2016.710085
29. Soher EA, El-Faham S, Ibrahim MA, Hathout AS, Sabry BA. Characterization and microbiological quality of low-fat chicken burger containing defatted peanut flour. *Journal of Applied Sciences Research*. 2013;9(11):5599-5608.
30. Xiao H, Jiaoyan R, Mouming Z, Chun C, Pengchen H. Emulsifying properties of the transglutaminase-treated crosslinked product between peanut protein and fish (*Decapterus maruadsi*) protein hydrolysates. *Journal of Science of Food and Agriculture*. 2011;91:578–585. DOI: 10.1002/JSFA.4229
31. Xiao H, Mouming Z, Laihao L, Bao Y, Xianqing Y, Haiyan W, Jiaoyan R. Emulsifying properties of cross-linking between proteins extracted from cold/hot pressed peanut meal and hydrolysed fish (*Decapterus maruadsi*) proteins. *International Journal of Food Properties*. 2013;17(8):1750-1762. DOI: 10.1080/10942912.2012.724755
32. Baek Ki Ho, Dicky Tri Utama, Seung Gyu Lee, Byoung Ki An, Sung Ki Le. Effects of replacing pork back fat with canola and flaxseed oils on physicochemical properties of emulsion sausages from spent layer meat. *Asian Australian Journal Animal Science*. 2016;29(6):865-871. DOI: 10.5713/ajas.15.1050
33. Choi YS, Youn JJ, Choi CJ, Han DJ, Kim HY, Lee MA, Kim HW, Paik HD, Kim CJ. Effects of dietary fiber from rice bran on the quality characteristics of emulsion-type sausages. *Korean Society for Food Science of Animal Resources*. 2008;28(1):14-20.
34. Das AK, Anjaneyulu ASR, Kondaiah N. Development of reduced beany flavour full fat soy paste for comminuted meat products. *Journal of Food Science*. 2006;71:395–400. DOI: 10.1111/j.1750-3841.2006.00045.x
35. Backes Angela Maria Carlos Pasqualin Cavalheiro, Flávia Santi Stefanello, Fernanda Luísa Lüdtkke, Nelcindo Nascimento Terra, Leadir Lucy Martins Fries. Chemical composition, microbiological properties and fatty acid profile of Italian-type salami with pork back fat substituted by emulsified canola oil. *Ciencia Rural*. 2017;47(8). DOI: 10.1590/0103-8478cr20160688
36. Hudayi E, Tugba DE. Walnut as fat replacer and functional component in sucuk. *Journal of Food Quality*. 2009;33(5):646–659. DOI: 10.1111/j.1745-4557.2010.00341.x
37. Arya SS, Salve AR, Chauhan S. Peanuts as functional food: A review. *Journal of Food Science and Technology*. 2016;53(1):31-41. DOI: 10.1007/s13197-015-2007-9
38. Prinyawiwatkul W, Mcwatters K, Hbeuchat LR, Phillips RD. Optimizing acceptability of chicken nuggets containing fermented cowpea and peanut flours. *Journal of Food Science*. 1997;62(4):889-893,905.
39. Santhi D, Kalaikannan A. The effect of the addition of oat flour in low-fat chicken nuggets. *Journal of Food Science and Nutrition*. 2014;4:2-4. DOI: 10.4172/2155-9600.1000260
40. Cengiz E, Gokoglu N. Changes in energy and cholesterol contents of frankfurter-type sausages with fat reduction and fat replacer addition. *Food Chemistry*. 2005;91:443-447. DOI: 10.1016/j.foodchem.2004.06.025
41. Kayaardi S, Gok V. Effect of replacing beef fat with olive oil on quality characteristics of Turkish soudjouk (sucuk). *Meat Science*. 2003;66:249–257. DOI: 10.1016/S0309-1740(03)00098-6

42. Settaluri VS, Kandala CVK, Puppala N, Sundaram J. Peanuts and their nutritional aspects - A review. *Food and Nutrition Sciences*. 2012;3:1644-1650.  
DOI: 10.4236/fns.2012.312215
43. Karwowska M, Dolatowski J, Bigniew Z. Antioxidant effects of ground mustard seed in model sausage type product. *Food Science and Technology Research*. 2013;19(1):23–28.  
DOI: 10.3136/fstr.19.23
44. Beare-Rogers J, Dieffenbacher A, Holm JV. Lexicon of lipid nutrition (IUPAC Technical Report). *Pure and Applied Chemistry*. 2001;73(4):685-744.  
DOI: 10.1351/pac200173040685
45. Ozcan MM. Some nutritional characteristics of kernel and oil of peanut (*Arachis hypogaea L.*). *Journal of Oleo Science*. 2010;59(1):1-5.  
DOI: 10.5650/jos.59.1
46. Marquez EJ, Ahmed EM, West RL, Johnson DD. Emulsion stability and sensory quality of beef frankfurters produced at different fat or peanut oil levels. *Journal of Food Science*. 1989;54(4):867-870,873.  
DOI: 10.1111/j.1365-2621.1989.tb07901.x
47. Saldana E, da Silva Correa Lemos AL, Selani MM, Spada FP, De Almeida MA, Contreras-Castillo CJ. Influence of animal fat substitution by vegetal fat on Mortadella-type products formulated with different hydrocolloids. *Science and Agriculture*. 2015;72(6):495-503.  
DOI: 10.1590/0103-9016-2014-0387
48. Keefe SFO, Wang H. Effects of peanut skin extract on quality and storage stability of beef products. *Meat Science*. 2006;73:278–286.  
DOI: 10.1016/j.meatsci.2005.12.001
49. Jo Kyung, Lee Juri, Jung Samooel. Quality characteristics of low-salt chicken sausage supplemented with a winter mushroom powder. *Korean Journal of Food Science*. 2018;38(4):768-779.  
DOI: 0.5851/kosfa.2018.e15
50. Olusola OO, Okubanjo AO, Omojola AB. Nutritive and organoleptic characteristics of Kilishi as affected by meat type and ingredient formulation. *Journal of Animal Production Advances*. 2012;2(5):221-232.

© 2020 Indumathi et al.; This is an Open Access article distributed under the terms of the Creative Commons Attribution License (<http://creativecommons.org/licenses/by/4.0>), which permits unrestricted use, distribution, and reproduction in any medium, provided the original work is properly cited.

*Peer-review history:*

*The peer review history for this paper can be accessed here:*  
<http://www.sdiarticle4.com/review-history/63525>