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Research Article

Effect of cowpea (*Vigna unguiculata*) addition on the quality characteristics of oven roasted chicken *shish kabab*s

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Abstract

The present study was conducted to evaluate the effect of cowpea as an extender on the quality characteristics of chicken *shish kababs* prepared from spent hens meat by oven roasting method of cooking. Three levels of cowpea paste (hydrated 1:1 w/w) viz. 10, 15 and 20% were used as an extender replacing lean meat in the formulation. The chicken *shish kababs* formulated without cowpea paste served as control and were compared with *kababs* extended with different levels of cowpea for various physicochemical and sensory properties. pH, emulsion stability and cooking yield increased significantly (P<0.05) with increase in the extension level with highest value for the *kababs* extended with 20% cowpea. All the proximate parameters i.e. moisture, protein and fat percentage, except ash content, decreased significantly (P<0.05) with the increasing extension level for both raw as well as cooked *kababs*. Scores for the sensory parameters namely flavour, texture and overall acceptability decreased significantly (P<0.05) with increase in the level of extension. All the sensory parameters of the *kababs* extended with 15% cowpea were comparable with control *kababs*. Sensory scores and physicochemical properties indicated that 15% cowpea paste was the optimum extension level for the formulation of extended chicken *shish kababs*.

Keywords: *vanaraja*, additives, extender, quality parameters, *seekh kababs*, India.

Introduction

Shish kababs are one of the popular convenient ready to eat meat products usually prepared from lamb and beef, though particular styles of *shish kababs* can be made from meat of other animals like chicken, fish etc. These can be prepared in versatile forms suitable to different food patterns and cooking styles with several types of seasonings and flavourings. These are easy to prepare, take

least time for cooking, have a unique flavour and taste and can be served to a large number of customers in a relatively short period of time. Thus, *shish kababs* come under the category of fast food. However, the cost of these products is too high to be affordable to all the sections of society. Thus, its economic formulation keeping the sensory attributes to acceptable limit is a challenge and as such the addition of low cost non-meat proteins (like cowpea) to stretch the availability of *shish kababs* is an important research area.

Spent hens are old and culled chickens, which have completed their productive and reproductive phase of life and are considered as a byproduct of the egg industry [1]. Their meat is considered poor because of toughness and less juiciness which are due to high collagen content [2] and high degrees of cross linkages [3, 4] as compared to broiler meat. Problem of poor utilization can be resolved by development of further processed convenience products [5, 6] such as *kababs,* sausages, patties, etc. However, the products prepared from spent hen meat have comparatively poor sensory properties and lower yield. Emulsions with inferior emulsifying capacity due to high proportion of connective tissue and less salt soluble proteins [7], higher cooking loss because of high fat content and poor water binding capacity [8, 9], low emulsion stability due to low concentration of salt soluble proteins [10], are the shortcomings of using spent hens meat. This can in part be overcome by employing suitable food additives or extenders such as starch, legumes and milk proteins [11, 12].

Non-meat proteins from a variety of plant sources such as soy proteins [13, 14, 15], buck wheat protein [16], samh flour [17], common bean flour [18] and Bengal gram, black gram and green gram flours [19] and corn flour [20] have been used as binders and extenders in comminuted meat products. Stability, yield, textural palatability and cost of meat products are the major criteria for non-meat proteins [21]. Legumes provide energy, protein, minerals, vitamins and the most important i.e. dietary fibre required for human health. Several studies have proved that dietary fibres have the potential to reduce blood low density lipoprotein cholesterol [22], risk of diabetes mellitus type 2 [23], coronary heart disease [24], blood pressure [25], obesity [26] and colorectal cancer. Inclusion of legumes in daily diet has many physiological effects in controlling and preventing various metabolic diseases such as coronary heart disease and colon cancer [27]. A very few researchers have attempted the still inconclusive studies on legumes as extenders in *shish kababs*. Thus, the present study was envisaged to evaluate the effects of cowpea on the quality characteristics of chicken *shish kababs*.

Materials and Methods

Source of chicken meat
Vanaraja birds (irrespective of sex) of the age group of over 80 weeks were purchased from the State Animal Husbandry Department. The birds were slaughtered using ritual halal method. The body fat was trimmed and deboning of dressed chicken was done manually removing all tendons and separable connective tissue. The lean meat was packed in polythene bags and frozen at -20^0C until use.

Spice mixture
The spice mix formula used by Kumar and Sharma [28] was followed and is presented in Table 1.

Table 1. Composition of spice mixture.

INGREDIENTS	PERCENTAGE
Aniseed	12%
Bay leaves	2%
Black pepper	12%
Cardamom	5%
Cinnamon	5%
Cloves	2%
Colored chilli	1%
Coriander	20%
Cumin seed	15%
Mace	2%
Nutmeg	2%
Red chilli	12%
Thymol	10%

Condiments
Onion, garlic and ginger in the ratio of 3:2:1 were ground in a mixer to the consistency of fine paste.

Refined wheat flour
Wheat flour was purchased from a local market.

Extender
Cowpea (*Vigna unguiculata*), also known as black eye bean/pea or cow gram, is one of the most ancient human food sources. The cowpea was obtained from a local market and converted to paste form after overnight soaking (1:1 w/w hydration). The paste of pulse was incorporated at 10%, 15% and 20% levels in the formulation replacing lean meat.

Fat
Refined cottonseed oil of brand name *'Ginni'* was purchased from a local market and used. The approximate composition of the oil is presented in Table 2.

Table 2. Composition of refined cottonseed oil (per 10 gram).

INGREDIENTS	(W/W)
Energy	900 k. cal
Carbohydrate	0 g
Proteins	0 g
Cholesterol	0 g
Saturated Fatty acids	24 g
Mono-unsaturated Fatty acids	22 g
Poly-unsaturated Fatty acids	54 g
Trans Fatty acids	0 g
(Above values are approximate)	

Preparation of shish kababs from meat of spent hens

Lean meat from spent hens was cut into smaller chunks and minced in a Sirman mincer (MOD-TC 32 R10 U.P. INOX, Marsango, Italy) with 6mm plate followed by common grind size, the 4mm plate. Common salt, vegetable oil, refined wheat flour (maida), nitrite, sodium tripolyphosphate, spice mixture and condiment mixture were added to weighed meat according to formulation. Meat emulsion for chicken *kababs* was prepared in Sirman Bowl Chopper [MOD C 15 2.8G 4.0 HP, Marsango, Italy]. Minced meat was blended with salt, sodium tripolyphosphate and sodium nitrite for 1.5 minutes. Water in the form of crushed ice was added and blending continued for 1 minute. This was followed by addition of refined vegetable oil and further blending for another 1 to 2 minutes. 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. Aliquots of raw emulsions from various treatments under each trial of the experiment were collected in plastic bottles for analysis. The various ingredients used in the formulation of the chicken *shish kababs* are presented in Table 3.

Table3. Formulation of *kababs* from meat of spent hens.

INGREDIENTS	PERCENT (W/W)
Lean meat	67.7
Added water	10.0
Vegetable oil	9.0
Condiment mixture	5.0
Refined wheat flour	4.0
Spice mixture	2.0
Table salt	1.5
Monosodium Glutamate	0.5
Sodium Tripolyphosphate	0.3
Sodium nitrite	120 ppm

Moulding of shish kababs

Kababs were moulded on steel skewers and cooked by oven roasting. The steel skewers of 10 mm diameter and of length sufficient to fit in the hot air oven were used for the purpose and typically, the skewer was a round rod with one end pointed and the other blunt.

Holding the skewer in one hand, an accurately weighed quantity (60 g) of meat mix/emulsion, in the form of a ball, was taken in the other hand, pierced through the pointed end and pressed on to middle of the skewer. With the help of moistened palm and fingers, it was gently spread evenly and moulded into a cigar shaped *kabab*. The length of the *kabab* was determined by the graduated scale and averaged 18 cm.

Cooking of shish kababs

Skewers with raw *kababs* on them were placed longitudinally on the two edges of a perforated oven tray in a convection oven (Yorco Sales Pvt. Ltd. India. Model-YS1-431, S. No. 02B2843). The moulded raw *kababs* were smeared with vegetable oil and cooked in a preheated hot air oven at 180 ± 2^0C for a total time of about 12 minutes. The internal temperature of *kababs* was monitored by a thermometer and cooked to an internal temperature of 78 ± 2^0C. The *kababs* were removed from the skewers, cooled to room temperature and weighed. Pooled sample of each treatment was assigned for analysis.

Analytical procedures
The pH of raw mix/emulsion soon after its preparation and cooked *kabab* was determined by the method of Keller, *et al* [24] with slight modifications using a digital meter (Systronics Digital pH Meter 803, serial No. 603). Emulsion stability of meat emulsion was determined as per procedure described by Tharanathan and Mahadevamma [29].

Proximate composition viz. moisture, fat, ash and crude protein content of chicken *kababs*, raw and cooked were determined by standard methods proscribed by AOAC [30].

Cooking yield
The weight of each *kabab* was recorded before and after cooking. The cooking yield was calculated and expressed as percentage by a formula:

$$\text{Cooking yield percent} = \frac{\text{Weight of cooked } kababs}{\text{Weight of raw } kababs} \times 100$$

Sensory evaluation
The sensory evaluation of the product was conducted for attributes such as appearance, flavour, juiciness, texture and the overall acceptability of samples by a panel of trained members composed of scientists and research scholars of the Division based on a 8-point hedonic scale, wherein 8 denoted "extremely desirable" and 1 denoted "extremely undesirable" [31]. The panels were trained for four basic tastes, i.e., recognition and threshold test and hedonic tests routinely performed in the Division. Panelists were seated in a room free of noise and odours and suitably illuminated. Coded samples for sensory evaluation were prepared and served warm to panelists. Water was provided for oral rinsing between the samples.

Statistical analysis
Means and standard errors were calculated for different parameters. Factorial design of experiment was followed. Analysis of variance was performed as per Sharma, *et al* [32]. In significant effects, least significant differences were calculated at appropriate level of significance for a pair wise comparison of treatment means.

Results and Discussion

The mean values of various parameters namely pH, emulsion stability and proximate composition of raw *shish kababs* from meat of spent hens extended with 0, 10, 15 and 20% levels of hydrated cowpea (1:1 w/w) paste are presented in Table 4.

pH and emulsion stability of raw chicken shish kababs
The mean values of pH of the raw *shish kababs* ranged from 6.07 to 6.14. An increase in pH with increase in the level of extension was recorded which was evident from significantly higher value (P<0.05) at 10% level (6.19) of extension as compared to control (6.07), while it was comparable at 10% (6.07), 15% (6.12) and 20% (6.14) levels. Gradual increase in pH with increase in extension level was expected because of neutral nature of extender and was in agreement with findings of other researchers [28, 33, 34, 35].

Table 4. Effect of cowpea paste extension on pH, emulsion stability and proximate composition of raw chicken *shish kababs*. (Mean ±SE)[*]

PARAMETERS	LEVELS OF COWPEA EXTENSION (%)			
	0	**10**	**15**	**20**
pH	6.07[a]±0.01	6.10[b]±0.01	6.12[b]±0.01	6.14[b]±0.01
Emulsion stability (%)	86.59[a]±0.29	90.70[b]±0.36	91.87[c]±0.45	93.86[d]±0.32
Moisture (%)	63.33[a]±0.52	62.13[ab]±0.52	60.83[b]±0.46	60.60[b]±0.45
Protein (%)	15.49[a]±0.36	14.86[ab]±0.38	14.15[bc]±0.35	13.55[c]±0.30
Fat (%)	13.63[a]±0.18	13.28[ab]±0.16	12.74[bc]±0.30	12.23[c]±0.21
Ash (%)	2.17[a]±0.01	2.43[b]±0.03	2.71[c]±0.03	2.81[d]±0.03
Moisture: Protein	4.10±0.10	4.19±0.11	4.31±0.13	4.49±0.15

[*]Mean ± SE with different superscripts in a row differs significantly (P<0.05).
 n = 6 for each treatment

The mean values of the emulsion stability ranged from 86.59% to 93.86%. A significantly higher (P<0.05) value for emulsion stability was recorded at all extension levels as compared to control. The mean value of emulsion stability for control *kababs* was recorded as 86.59%. The increase in emulsion stability with increase of extension level could be attributed to gelatinizing property of increasing starch component on heating, which stabilized the emulsion [36]. Gelatinization of this starch improves the binding properties of meat proteins [37] and was in agreement with the results reported by other researchers [28, 35, 38, 39]. Improvement of binding properties in meat products by addition of protein and starches of vegetable origin have also been reported in previous work [40, 41, 42]. Comer, *et al* [42] reported the possible interaction between soluble meat and vegetable proteins and stated that fillers appeared to increase fat agglomeration while improving stability. It may also be attributed to high emulsifying ability of cowpea paste. Serdaroglu and Degirmencioglu [43] reported that pea flour bound both fat and water and formed a stable dense foam.

Proximate composition of raw chicken shish kababs
The mean values of the moisture percentage of raw *shish kababs* ranged from 63.33% to 60.60%. A gradual decrease in moisture was recorded and was significantly low (P<0.05) at 15% (60.83%) and 20% (60.60%) level as compared to control, whereas at 10% (62.13%) extension level it was comparable to others. This decrease in moisture may be due to less moisture content in hydrated cowpea paste than that of lean chicken meat. Similar findings were reported in other work [28, 35] on chicken patties and chicken *shish kababs* respectively.

The mean values of the protein percentage of raw *shish kababs* ranged from 15.49% to 13.55%. A gradual decrease in protein was recorded and was significantly (P<0.05) low at 15% (14.15%) and 20% (13.55%) level as compared to control, whereas at 10% (14.86%) extension level it was comparable to control and 15% level (14.15%). This may be due to lower protein content of hydrated cowpea paste than that of chicken meat and is in agreement with the findings of other work [28, 35, 44].

The mean values of the fat percentage of raw *shish kababs* ranged from 13.63% to 12.23%. Fat percentage showed a significant decrease in alternate succession with highest value for control (13.63%) and lowest for *kababs* extended with 20% (12.23%) cowpea paste. This may be attributed to the dilution effect caused by incorporation of cowpea paste which is particularly low in fat content. Similar observations were reported in other work [28, 35] on chicken patties and chicken *shish kababs* respectively.

The mean values of the ash percentage of raw *shish kababs* ranged from 2.17% to 2.81%. A significantly (P<0.05) higher value for ash percentage was recorded at all extension levels as compared to control which may be attributed to the declining trend of moisture with increasing level of extension, resulting in an increasing dry matter content. Similar findings were observed by Bhat and Pathak [35] in chicken *shish kababs* extended with green gram. The mean values of moisture to protein ratio ranged from 4.10 to 4.49. Moisture to protein ratio showed a non-significant (P>0.05) increase with increasing level of extension. Similar findings were also observed by Bhat and Pathak [35].

Oven roasted chicken shish kababs

The mean values of various parameters namely pH, cooking yield and proximate composition of cooked *shish kababs* from meat of spent hens extended with 0, 10, 15 and 20% levels of hydrated cowpea paste (1:1 w/w) are presented in Table 5.

Table 5. Effect of cowpea paste extension on physicochemical properties of oven roasted chicken *shish kababs*. (Mean ±SE)[*]

PARAMETERS	LEVEL OF COWPEA EXTENSION (%)			
	0	10	15	20
pH	6.14[a]±0.01	6.18[b]±0.02	6.23[c]±0.03	6.27[c]±0.02
Cooking yield (%)	82.22[a]±0.62	85.72[b]±0.75	88.82[c]±0.75	92.69[d]±0.66
Moisture (%)	59.78[a]±0.40	58.58[ab]±0.48	58.25[b]±0.46	57.76[b]±0.61
Protein (%)	18.58[a]±0.31	17.93[ab]±0.26	17.31[bc]±0.20	16.79[c]±0.18
Fat (%)	14.48[a]±0.15	14.03[b]±0.24	13.68[b]±0.14	13.21[c]±0.10
Ash (%)	2.32[a]±0.05	2.60[b]±0.11	2.81[c]±0.06	2.93[c]±0.02
Moisture: Protein	3.22[a]±0.07	3.27[ab]±0.06	3.36[ab]±0.04	3.44[b]±0.04

[*]Mean ± SE with different superscripts in a row differs significantly (P<0.05).
n (Physicochemical parameters) = 6

pH and cooking yield of oven roasted chicken shishh kababs

The mean values of pH of the oven roasted *shish kababs* ranged from 6.14 to 6.27. A significant (P<0.05) influence on pH and cooking yield was recorded. The pH of cooked *kababs* at 15% (6.23) and 20% (6.27) extension levels were significantly higher (P<0.05) than control (6.14), whereas at 10% level (6.18), it was comparable to all. Gradual increase in pH with increase in extension level was expected because of the neutral nature of the extender and was in agreement with other findings [28, 33, 34, 35, 44].

The mean values of cooking yield of the oven roasted chicken *shish kababs* ranged from 82.22% to 92.69%. A significantly higher (P<0.05) value for cooking yield was recorded at all extension levels as compared to control. Increase in cooking yield along with increase in level of extender was as per the findings of other researchers [28, 33, 35, 38, 39, 44, 45]. However, here increase was not exactly as a result of increased moisture percentage but due to higher moisture and fat retention of chicken *kababs* extended with cowpea paste. This observation is in agreement with earlier research [46, 47]. Grinding of cowpea might have enhanced the absorptivity by increasing surface area, lowering drip losses and increasing cooking yield as suggested by Shabakov, *et al* [48]. Higher yields in comminuted meat products have also been reported in other work [36, 49, 50].

Proximate composition of oven roasted chicken shish kababs
The mean values of the moisture percentage of oven roasted *shish kababs* ranged from 59.78% to 57.76%. A gradual decrease in moisture was recorded and was significantly low (P<0.05) at 15% (58.25%) and 20% (57.76%) levels as compared to control, whereas at 10% (58.58%) extension level it was comparable to others. Similar findings have been observed in other work [28, 35, 44, 51, 52]. It may be due to less moisture content in cowpea paste than that of lean chicken meat.

The mean values of the protein percentage of oven roasted *shish kababs* ranged from 18.58% to 16.79%. Protein percentage showed a significant (P<0.05) decrease in alternate succession and was significantly (P<0.05) low at 15% (17.31%) and 20% (16.79%) levels as compared to control, whereas at 10% (17.93%) extension level it was comparable to control and 15% level (14.15%). Similar findings were observed with the incorporation of chickpea paste by Nag, *et al* [52], with barley flour and pressed rice flour [28, 44], in chicken patties and with green gram paste by Bhat and Pathak [35] in chicken *shish kababs*. The probable reason may be due to lower protein content of cowpea paste than that of chicken meat.

The mean values of the fat percentage of oven roasted *shish kababs* ranged from 13.21% to 14.48%. Fat percentage was significantly (P<0.05) low at all extension levels as compared to control. However, at 10% (14.03%) level it was comparable to 15% (13.68%) extension level. Similar findings have been reported in other work [28, 35, 44, 52] and may be attributed to the dilution effect caused by incorporation of cowpea paste which is particularly low in fat content.

The mean values of the ash percentage of oven roasted *shish kababs* ranged from 2.32% to 2.93%. Ash percentage showed a significant increase (P<0.05) at all extension levels as compared to control whereas at 15% (2.81%) level it was comparable to 20% (2.93%) level. This may be attributed to the declining trend of moisture with increasing percentage of extension, resulting in increasing dry matter content with level of extension. Jindal and Bawa [53] also reported an increased ash content of cooked sausages with an increase in soy flour levels. Similar findings were reported other researchers [35, 54]. The mean values of the moisture to protein ratio of oven roasted *shish kababs* ranged from 3.22 to 3.44. Moisture to protein ratio showed an increase along with level of extension which was evident from significantly higher value (P<0.05) at 20% level of extension as compared to control. Slightly higher values were observed at 10 and 15% levels which were comparable to all.

Sensory attributes of oven roasted chicken shish kababs
The mean values of various sensory parameters of oven roasted *shish kababs* from meat of spent hens extended with 0, 10, 15 and 20% levels of hydrated cowpea paste (1:1 w/w) are presented in Table 6.

Extension with hydrated cowpea paste had a significant influence (P<0.05) on flavour, texture and overall acceptability. The mean values of appearance scores of oven roasted *shish kababs* from meat of spent hens ranged from 6.97 to 7.09. The appearance scores showed a declining trend with increase in percentage of extension level, though the decline was non-significant (P>0.05). Decline in appearance could be attributed to dilution of meat pigment. Similar results have been reported in other work [28, 35, 44, 55].

Table 6. Effect of cowpea paste extension on sensory attributes of oven roasted chicken *shish kababs*. (Mean ±SE)[*]

SENSORY ATTRIBUTES	LEVELS OF COWPEA EXTENSION (%)			
	0	**10**	**15**	**20**
Appearance	7.09±0.12	7.00±0.09	7.00±0.12	6.97±0.10
Flavour	6.93[a]±0.11	6.84[a]±0.09	6.64[ab]±0.11	6.45[b]±0.10
Juiciness	6.97±0.10	6.88±0.08	6.83±0.11	6.69±0.14
Texture	6.95[a]±0.10	6.76[ab]±0.10	6.59[ab]±0.12	6.57[b]±0.15
Overall acceptability	7.08[a]±0.12	6.94[a]±0.08	6.90[ab]±0.10	6.59[b]±0.15

[a]Mean ± SE with different superscripts in a row differs significantly (P<0.05). Mean values are scores on 8 point descriptive scale where 1- extremely poor and 8- extremely desirable.
n = 21 for each treatment

Flavour and overall acceptability of *kababs* showed similar patterns. The scores were significantly lower (P<0.05) at 20% extension level (6.45, 6.59) as compared to control (6.93, 7.08) and 10% level (6.84, 6.94), whereas these were comparable to scores at 15% level (6.64, 6.90). Flavour score deceased as a result of dilution of meaty flavour with increase in extension level. Padda, *et al* [49] observed a decline in flavour scores of goat meat balls extended with roasted *Besan*. Similar findings in the flavour of other extended meat products have also been reported [28, 35, 44]. The scores for juiciness of *shish kababs* showed a non-significant (P>0.05) decreasing trend with the increasing extension level. As the moisture retention increased with increase in extension it might have led to less preference by sensory panelists and therefore, a lower score for juiciness. Huan-Jen Chieh, *et al* [21] reported similar results for juiciness in beef patties. The decrease in juiciness with increase in extension level has also been reported by other researchers [28, 35, 44, 48].

The mean values of texture scores of the oven roasted *shish kababs* from meat of spent hens ranged from 6.57 to 6.95. The texture scores were significantly lower (P<0.05) at 20% (6.57) level as compared to control (6.95) while at 10% (6.76) and 15% (6.59) levels it was comparable to all. The decrease in texture scores at higher levels of extender may be due to replacement of structural meat proteins by extender as reported by Townsend, *et al* [56]. Such decline in texture was also supported by findings of other research [28, 33, 35, 44].

A declining trend in overall acceptability was reflective of change in scores of flavour and texture with increased extension levels and similar findings were reported by other researchers [28, 35 44, 52]. The sensory scores of *kababs* for all attributes at 15% extension were quite comparable to control. Hence, 15% extension with cowpea paste was taken as optimum extension level for the formulation of extended chicken *shish kababs*.

Conclusions

Chicken *shish kababs* from meat of spent hens can be successfully extended with cowpea and on the basis of analysis of different physicochemical and sensory parameters, 15% level of extension was adjudged as optimum for oven roasting method of cooking. Chicken *shish kababs* of very good acceptability and nutritive value could be prepared by extension with cowpea paste substituting lean chicken meat from spent hen in formulation. There is also a significant reduction in cost of the products developed without compromising the quality which will ensure the nutritional security of

the people in developing countries especially the rural areas. It will also provide a potential outlet for the poultry industry byproduct (spent hens) and thereby increasing the profit margins of the poultry industry. Further research should be focused on the use of higher amounts and different legumes in *kababs* particularly *shish kababs*.

References

1.   Mahapatra C.M. (1992). Poultry Products Technology—Prospects and Problems. ***Poultry Guide,*** 29, 69-70.

2.   Abe Hirta A., Kimura T. and Yamuchi K. (1996). Effects of collagen on the toughness of meat from spent laying hens. ***Journal of Japanese Society of Food Science and Technology,*** 43(7), 831-34.

3.   Verma M.M., Ldward D.A. and Lawrie R.A. (1984). Lipid oxidation and Metmyoglobin formation in sausages containing chickpea flour. ***Meat Science,*** 11, 171-189.

4.   Bailey A.J. (1984). The chemistry of intra molecular collagen. The Royal Society of Chemistry, Burlington House. Recent Advances in Chemistry of Meat, 22-47.

5.   Kondaiah N. (1990). Poultry meat and its place in market. ***Poultry Guide,*** 27, 41- 45.

6.   Choudhury J., Kumar S. and Keshari R.C. (1992). Physicochemical and organoleptic properties of chicken patties incorporating texturised soy proteins. In. Proc. National Meeting of Food Scientists and Technologists, CFTRI, Mysore (10th April). M.F.P.I., P.53.

7.   Huspeth J.P. and May K.N. (1969). Emulsifying capacity of salt soluble protein of poultry meat. II. Heart, gizzard, and skin from broilers, turkeys, hens and ducks. ***Food Technology,*** 23, 3733-74.

8.   Acton J.C. and Dick R.L. (1985). Functional properties of raw materials. ***Meat Industry,*** 31, 32-36.

9.   Buyck M.J., Seideman S.C., Quenzer N.M. and Donnelly L.S. (1982). Physical and sensory properties of chicken patties made with various levels of fat and skin**.** ***Journal of Food Protection,*** 45, 214-17.

10.   Hargus G.L., Froning G.W., Mebus C.A., Neelakantan S. and Hartung T.E. (1970). Effect of processing variables on stability and protein extractability of turkey meat emulsion. ***Journal of Food Science,*** 35, 682-92.

11.   Chung S., Bechtel P. and Villota R. (1989). Production of meat based intermediate moisture snack foods by twin-screw extrusion. 49th annual Meeting, Institute of Food Technologists, Chicago, IL. June 25-29.

12.   Streppel M.T., Arends L.R., Veer P.V., Grobbee D.E., Geleijnse J.M. (2005). Dietary Fiber and Blood Pressure. A Meta-analysis of Randomized Placebo-Controlled Trials. ***Archives of Internal Medicine,*** 165, 150-156.

13.   Gujral H.S., Kaur A., Singh N. and Sodhi S.N. (2002). Effect of liquid whole egg, fat and textured soy protein on the textural and cooking properties of raw and baked patties from goat meat. ***Journal of Food Engineering,*** 53, 377-385.

14.   Pietrasik Z. and Duda Z. (2000). Effect of fat content soy protein carragenan mix on the quality characteristics of communited scalded sausages. ***Meat Science,*** 56, 181-188.

15.   Porcella M.I., Sanchez G., Vaudonga S.R., Zanelli ML., Descalzo A.M., Meichtri L.H., et al. (2001). Soy protein isolate added to vacuum packaged chorizos effect on drip loss, quality characteristics and stability during storage. ***Meat Science,*** 57, 437-443.

16.   Bejesano F.P. and Corke H. (1998). Amarantus and buck wheat protein concentrate effects on an emulsion-type meat product. ***Meat Science,*** 50(30), 343-353.

17.   Elgasim E.A and Al-Wesali M.S. (2000). Water activity and hunter colour values of beef patties extended with samh (*Mesembryanthemum forsskalei* Hochst) flour. ***Food Chemistry,*** 69, 181-185.

18.   Dzudie T., Joel Scher J. and Hardy J. (2002). Common bean flour as an extender in beef sausages. ***Journal of Food Engineering,*** 52 (2), 143-147.

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

20.   Semen D.L., Moody W.G., Fox J.D. and Gay N. (1987). Influence of hot and cold deboning on the palatability, textural and economic traits of restructured beef steaks. ***Journal of Food Science,*** 52, 879-882, 889.

21.   Kumar R.R. and Sharma B.D. (2005). Evaluation of the efficacy of pressed rice flour as extender in Chicken Patties. ***Indian Journal of Poultry Science,*** 40(2), 165-168.

22.   Brown L., Rosner B., Willet W.W., Sacks F.M. (1999). Cholesterol-lowering effects of dietary fiber: a meta-analysis. ***American Journal of Clinical Nutrition,*** 69(1), 30-42.

23.   Wenham L.N., Fairbain K. and McLeod W. (1973). Eating quality of mutton compared with lamb and its relationship to freezing practices. ***Journal of Animal Science,*** 36: 1081.

24.   Bazzano L.A., He. J., Ogden L.G., Loria C.M. and Whelton P.K. (2003). Dietary fiber intake and reduced risk of coronary heart disease in US men and women: the National Health and Nutrition Examination Survey I Epidemiologic Follow-up Study. ***Archives of Internal Medicine,*** 163(16), 1897-1904.

25.   Snedecor G.W. and Cochran W.G. (1980). In: Statistical Methods. 7thEdn. Oxford and IBH Publishing Co., Calcutta.

26.   Liu S. (2003). Relation between changes in intakes of dietary fiber and grain products and changes in weight and development of obesity among middle-aged women. ***American Journal of Clinical Nutrition,*** 78(5), 920-927.

27.   Tarte R., Molin R.A. and Koymazadeh M. (1989). Development of beef/corn extruded snack model product. Proc. 50th Annual Meeting, Institute of Food Technologists, Chicago, IL. June 25-29.

28.   Kumar R.R. and Sharma B.D. (2005). Evaluation of the efficacy of pressed rice flour as extender in Chicken Patties. ***Indian Journal of Poultry Science,*** 40(2),165-168.

29.   Tharanathan R.N. and Mahadevamma S. (2003). Grain legumes-a boon to human nutrition. ***Trends in Food Science and Technology,*** 14, 507-518.

30.   AOAC. (1995). Official methods of analysis. 16th edn. Association of Official Analytical Chemists, Washington, DC, USA.

31.   Schatzkin A., Mouw T., Park Y., Subar A.F., Kipnis V., Hollenbeck A., Leitzmann M.F., and Thompson F.E. (2007). Dietary fiber and whole-grain consumption in relation to colorectal cancer in the NIH-AARP Diet and Health Study. ***American Journal of Clinical Nutrition,*** 85(5), 1353-1360.

32.   Sharma B.D., Kumar S. and Nanda P.K. (1998). Development of low cost high value formulations for convenience meat products utilizing non-conventional extenders. Annual Report, Indian Vet. Research Institute, Izatnagar, Bareilly (U.P.). Sub Project-III, Div of L.P.T. Page-65-66.

33.   Huan-Jen-Chieh., Zayas J.F. and Bowers J. (1996). Functional properties of Sorghum flour as an extender in ground beef patties. IFT annual meeting: book of abstracts, p. 63-64 ISSN 1082-1236.

34.   Prabhakara Reddy K. and Janardhana Rao B. (2000). Effect of binders and precooking meat on quality of chicken loaves. ***Journal of Food Science and Technology,*** 37(5), 551-553.

35.   Bhat Z.F. and Pathak V. (2009). Effect of mung bean (*vigna radiata*) on quality characteristics of oven roasted chicken *seekh kababs*. ***Fleischwirtschaft International,*** 06, 58-60.

36.   Comer F.W. (1979). Functionality of fillers in comminuted meat products. ***Journal of Canadian Institute of Food Science and Technology,*** 12, 157-165.

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

38.   Sharma B D, Padda G S, Keshri R C and Sharma N. 1988. Acceptability studies of different stuff binders in chevon samosas. ***Indian Journal of Science and Technology,*** 1, 32-36.

39.   Bond J.M., Marchello M.J. and Slanger W.D. (2001). Physical-chemical and self-life characteristics of low-fat ground beef patties formulated with waxy hull-less barley. ***Journal of Muscle Foods,*** 12(1), 53-69.

40.   Price J.F. and Schweighert B.S. (1971). In: Science of Meat and Meat Products. Freeman and Co., San Franscisco.

41.   Shaner K.M. and Baldwin R.E. (1979). Sensory properties, proximate analysis and cooking losses of meat loaves extended with chickpea meal or textured soy protein. ***Journal of Food Science,*** 44, 1191-1193.

42.   Comer F.W., Chew N., Lovelock L and Allan-wojtas P. (1986). Comminuted meat products: Functional and microstructural effects of fillers and meat ingredients. ***Journal of Canadian Institute of Food Science and Technology,*** 19(2), 68-74.

43.   Serdaroglu M. and Degirmencioglu O. (2004). Effects of fat level (5%, 10%, 20%) and corn flour (0%, 2%, 4%) on some properties of Turkish type meatballs (koefte). ***Meat Science,*** 68 (2), 291-296.

44.   Kumar R.R. and Sharma B.D. (2006). Efficacy of Barley Flour as Extender in Chicken Patties from Spent hen meat. ***Journal of Applied Animal Research****, (30), 53-55.

45.   Huan-Jen-Chieh., Zayas J.F. and Bowers J. (1999). Functional properties of Sorghum flour as an extender in ground beef patties. ***Journal of Food Quality,*** 22(1), 51-61.

46.   McWaters K.H. (1977). Performance of defatted pea nut, soybean and field pea meals as extenders in ground beef patties. ***Journal of Food Science,*** 42, 1492-1495.

47.   Mitsyk V.E. and Mikhailovskii V.S. (1981). Minced meat semi-manufactured products incorporating pea-meal and sunflower seed meal protein. ***Tovarovedenie,*** 14, 44-46. (c.f. FSTA, 14: 7 s 1311).

48.   Shabakov M.S., Starodubtseva L.A. and Vakhrameev V.K. (1983). Some functional properties of proteinaceous pea meal. ***Pishchevaya Tekhnologiya,*** No.6, 40-42. (c.f. FSTA, 18: 2 J 146).

49.   Padda G.S., Sharma N. and Bisht G.S. (1989). Effect of some vegetative extenders on organoleptic and physico-chemical properties of goat meat balls. ***Indian Journal of Meat Science and Technology,*** 2, 116-122.

50.   Minerich P.L., Addis P.B., Epley R.J. and Bingham C. (1991). Properties of wild rice/ground beef mixtures. ***Journal of Food Science,*** 56, 1154-1157.

51.   Abo Bakr T.M. (1987). Nutritional evaluation of sausages containing chick peas and faba beans as meat proteins extenders. *Food Chemistry,* 23, 143-150.

52.   Nag S., Sharma B.D. and Kumar S. (1998). Quality attributes and shelf life of chicken nuggets extended with rice flour. *Indian Journal of Poultry Science,* 33(2), 182-186.

53.   Jindal V. and Bawa A.S. (1988). Utlization of spent hens and soy flour in the preparation of sausages. *Indian Journal of Meat Science and Technology,* 1, 23-27.

54.   Nayak N.K. and Tanwar V.K. (2004). Effect of tofu addition on physico-chemical and storage properties of cooked chicken meat patties. *Indian Journal of Poultry Science,* 39(2), 142-146.

55.   Willet W., Manson J. and Liu S. (2002). Glycemic index, glycemic load, and risk of type 2 diabetes. *American Journal of Clinical Nutrition,* 76, 274S-280.

56.   Townsend W.E., Witnauer L.P., Riloff J.A. and Swift C.E. (1968). Comminuted meat emulsions. Differential thermal analysis of fat transition. *Food Technology,* 22, 319.323.

57.   Keller J.E., Skelley G.C. and Acton J.C. (1974). Effect of meat particle size and casing diameter on summer sausage properties during. *Journal of Milk Food Technology,* 37, 297-300.

58.   Roberts L.H. (1974). Sausage emulsion–functionality of non-meat proteins during emulsification. In proceedings, Meat industry research conference, American Meat Institute, Washington, DC.

59.   Zyl H.V. and Zayas J.F. (1996). Effect of three levels of sorghum flour on the quality characteristics of frankfurters. IFT annual meeting**:** Book of Abstracts, p. 64 ISSN 1082-1236.