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Mir Rovida
Division of Livestock Products Technology, Faculty of Veterinary Sciences and Animal Husbandry, SKUAST-Kashmir, Jammu and Kashmir, India

Sheikh Rafeh Ahmad
Division of Livestock Products Technology, Faculty of Veterinary Sciences and Animal Husbandry, SKUAST-Kashmir, Jammu and Kashmir, India

Tahir Nazir
Division of Livestock Products Technology, Faculty of Veterinary Sciences and Animal Husbandry, SKUAST-Kashmir, Jammu and Kashmir, India

Tarique Ahmad Padder
Division of Livestock Products Technology, Faculty of Veterinary Sciences and Animal Husbandry, SKUAST-Kashmir, Jammu and Kashmir, India

Heena Jalal
Division of Livestock Products Technology, Faculty of Veterinary Sciences and Animal Husbandry, SKUAST-Kashmir, Jammu and Kashmir, India

Irshad Qurieshi
Division of Livestock Products Technology, Faculty of Veterinary Sciences and Animal Husbandry, SKUAST-Kashmir, Jammu and Kashmir, India

Correspondence
Tahir Nazir
PhD Scholar at Division of Livestock Products Technology, Faculty of Veterinary Sciences & Animal Husbandry, SKUAST-Kashmir, Jammu and Kashmir, India

A study on the development of mutton nuggets extended with walnut kernel paste

Mir Rovida, Sheikh Rafeh Ahmad, Tahir Nazir, Tarique Ahmad Padder, Heena Jalal and Asma Irshad Qurieshi

Abstract
The study was carried out at SKUAST-Kashmir during year 2015-16 and involved development of mutton nuggets extended with walnut kernel paste. The study was devised to explore the feasibility of using fresh walnut kernels on quality characteristics of mutton nuggets. The products prepared consisted of mutton nuggets with 0%, 5%, 10% and 15% fresh walnut kernel paste (WKP) which were analyzed for proximate composition, physicochemical and sensory parameters. It was found that there was a significant (P<0.05) increase in pH, cooking yield and emulsion stability of mutton nuggets with increase in levels of WKP. The moisture and ash content of WKP extended mutton nuggets (62.36% and 3.26% respectively) was significantly (P<0.05) higher than control (60.17% and 2.71% respectively). There was a significant (P<0.05) decrease in the protein content (22.63% vs 17.06%) whereas fat content (7.90% vs 17.02%) increased significantly (P<0.05) with increase in levels of WKP. However, non-significant (P>0.05) difference was observed in sensory cores including overall acceptability between control and 15 percent WKP extended mutton nuggets. Based on the above findings, 15 percent WKP extended mutton nuggets was found optimum for the development of functional mutton nuggets. Therefore, WKP up to 15% level could be used for quality improvement in mutton nuggets without affecting its sensory and nutritive values.

Keywords: Mutton nuggets, physicochemical property, proximate composition, sensory characteristics, walnut kernel paste

1. Introduction
Meat products are being consumed all over the world including India and the proportion of meat eating consumers has increased considerably during past few years [10]. People in Kashmir valley are voracious eaters of meat products and with the rapid urbanization where in both male and female partners are working in offices, progressive commercialization of ready-to-eat meat products has taken place [11]. As such, a number of meat products such as chicken rolls, meat patties, meat balls, meat nuggets, fried chicken, barbeques and grill chicken are now available in the market for their use. Mutton nuggets are one such ready-to-eat convenient meat products obtained by cutting pre-cooked meat loaves into meat cubes of about 1-2 cm size each [3].

There is a growing concern among consumers of modern age over various diseases associated with excessive meat consumption. These concerns are mainly due to the consumption of saturated fat, excess salt and calories which are directly related with the diseases like coronary heart disease, hypertension and obesity [12]. Thus, the researchers and meat processors have developed interests to develop functional food products, which are natural towards taste, nutritional in composition and more importantly functional in their characteristics. Hence, the concept of functional food products has been exploited for the development of functional meat products [6].

In general, functional foods are those foods which provide some health benefits beyond their basic nutrition or in broader sense, a food is regarded as functional if it beneficially affects one or more target functions in the body, over and above adequate nutritional effects, in a way so as to improve the state of health and well-being and/or reduce the risk of disease [21]. The functionality of meat products can be enhanced through different interventions like enhancing dietary fibre content, improving omega-3 to omega-6 fatty acid ratio, reducing salt level, improving antioxidant potential etc. [7].

There are different sources of functional ingredients (synthetic as well as natural) available in the market. Natural sources are preferred now-a-days because of the negative health effects associated with synthetic sources [16]. Fruits, vegetables, different herbs and spices have been tried throughout the world [18]. Among fruits, walnut is one of the most important locally available sources in Kashmir. Walnuts (*Juglans regia* L.) are widely distributed all over the world, and they are common in China [9]. On a global basis, walnuts rank second behind almonds in tree nut production. China leads the world production of walnuts, followed by the US. In 2010, China accounted for 33.33% of global walnut production [9]. Walnuts are receiving increasing interest as a healthy foodstuff because their regular consumption has been reported to decrease the risk of coronary heart disease [14]. Walnut (*Juglans regia* L.) has been used worldwide for pharmaceutical and food purpose, due to its wide range of biological activities. Walnut can be utilized as an ingredient in many foodstuffs to enhance their nutritive value and sensory properties [15]. Other proposed benefits of walnuts include their high content of protein, magnesium, copper, folic acid, potassium, fiber and vitamin E [1]. The main functional properties of walnut include anti-bacterial activity, anti-fungal activity, anti-viral activity, anti-diabetic activity, anti-helminthic activity, anti-inflammatory activity, anti-depressant activity, anti-tyrosinase activity, hepato-protective activity and anti-cancer activity [20]. Keeping in view the above mentioned facts, the study was devised with the objective of exploring the feasibility of using fresh walnut kernels on quality characteristics of mutton nuggets.

2. Material and Methods

The study was carried out during 2015-2016. Mutton was procured from local market in the vicinity of SKUAST-Kashmir and was deboned manually. The lean meat obtained after deboning and trimming the fat manually, was packed in LDPE pouches and stored at standard freezing temperature (-18 ± 2 ^{0}C) until it was used. Commercially available refined vegetable oil, table salt and whole egg were used in emulsion preparation. Condiment paste used contained fresh onion, garlic and ginger in the ratio of 3:2:1. The spice mix formula was standardized in the laboratory. The dried walnuts were obtained from local market of Srinagar. The shells of these nuts were removed manually and the kernels were ground in powder form and packed in polythene bags and refrigerated at 4 ± 1 ^{0}C.

Table 1: Basic formulation of nuggets:

Ingredients	Percentage (w/w)
Lean mutton	78.00
Ice/Chilled water	8.70
Vegetable oil	5.00
Condiments	3.00
Salt	1.50
Whole egg	2.00
Dry spices	1.50
STPP	0.30

2.1 Preparation of mutton nuggets

Thawed mutton was cut into pieces and minced in a mincer after passing through 8mm plate (2 times) and 4mm plate (once). To this, salt was added along with half of chilled water and mixed for 2 minutes. Vegetable oil was then gradually added and thoroughly mixed for 2 minutes followed by addition of whole egg liquid, dry spice mix and condiment paste (onion: garlic: ginger = 3:2:1) and mixed for 1 minute. This formulation served as control. Throughout the preparation, walnut kernel paste (WKP) at 15 percent level was added by replacing lean meat from the basic formulation of the product. The emulsion prepared was then weighed and filled in stainless steel moulds. Mould was covered with lid and tied with thread and cooked in hot water (90^{o}C) for 35 minutes to an internal temperature of around 80^{o}C. Mutton loaves so obtained were cooled to room temperature and cut into nuggets of about 1cm^{3}size.

Table 2: Formulation of nuggets incorporated with WKP.

Ingredients (%)	Treatments			
	Control	T_1	T_2	T_3
Lean mutton	78.00	73	68	63
WKP	-	5	10	15
Ice/Chilled water	8.70	8.70	8.70	8.70
Vegetable oil	5.00	5.00	5.00	5.00
Condiments	3.00	3.00	3.00	3.00
Salt	1.50	1.50	1.50	1.50
Whole egg	2.00	2.00	2.00	2.00
Dry spices	1.50	1.50	1.50	1.50
STPP	0.30	0.30	0.30	0.30
Total	100	100	100	100

2.2 Physico-chemical Properties

2.2.1 pH

The pH of mutton nuggets was determined by the Trout method [22] by using digital pH meter (Model CP 901, Century Instrument Ltd. India).

2.2.2 Emulsion stability

The emulsion stability was determined as per the Anjaneyulu method [2]. About 25 g each of emulsion was placed in polyethylene bags and heated at 80 °C in a thermostatically controlled water bath for 20 minutes. After cooling and draining the exudate, the cooked emulsion mass was weighed and yield was expressed as emulsion stability in percentage.

2.2.3 Cooking yield

The weight of mutton nugget block was recorded before and after cooking. The cooking yield was calculated as follows and expressed in percentage;

$$\text{Cooking yield (\%)} = \frac{\text{Weight of cooked nugget block}}{\text{Weight of uncooked emulsion}} \times 100$$

2.3 Proximate composition

The percentage moisture, ash, protein, and ether extract of the meat product samples were evaluated as per standard procedure of Association of Official Analytical Chemists AOAC [4].

2.4 Sensory Evaluation

The sensory evaluation of all sample products was performed by a panel of seven trained members based on 8-point hedonic scale, wherein 8 denoted “extremely desirable” and 1 denoted “extremely undesirable” Keeton method [13]. The attributes of sensory evaluation included colour and appearance, flavour, juiciness, texture and overall acceptability.

2.5 Statistical Analysis

The statistically analyzed results has been tabulated and interpreted. The results were tabulated and analyzed statistically using one-way ANOVA. The results were expressed as Mean ± S. E at 5% level of significance.

3. Results

3.1 pH

The pH values of control were significantly (P<0.05) lower than all the walnut kernel paste extended mutton nuggets and among the treatment groups, pH values increased non-significantly (P>0.05) with increase in levels of walnut kernel paste.

3.2 Cooking yield

Cooking yield of control was significantly (P<0.05) lower than 15 percent walnut kernel paste extended mutton nuggets. Among 5 and 10 percent walnut kernel paste extended mutton nuggets, there was a non-significant (P>0.05) increase in the cooking yield with the increase in levels of walnut kernel paste.

3.3 Emulsion stability

The emulsion stability of 15 percent WKPEMN was significantly (P<0.05) higher than of control and 5 percent and non-significantly (P>0.05) higher than 10 percent WKPEMN.

3.3 Proximate composition

The mean values of various proximate composition namely moisture, ash, protein and fat of mutton nuggets incorporated with 0, 5, 10, and 15 percent levels of walnut kernel paste are presented in Table 3.

Table 3: Proximate composition of mutton nuggets containing various levels of walnut kernel paste (Mean ± S.E)

Parameters	Walnut kernel paste			
	Control	5%	10%	15%
Moisture (%)	60.17±0.27^{a}	60.85±0.26^{b}	61.84±0.14^{c}	62.36±0.14^{c}
Ash (%)	2.71±0.17^{a}	2.76±0.17^{a}	2.72±0.14^{a}	3.26±0.15^{b}
Protein (%)	22.63±0.36^{d}	20.66±0.18^{c}	19.23±0.24^{b}	17.06±0.37^{a}
Fat (%)	7.90±0.17^{a}	12.79±0.22^{b}	14.76±0.09^{c}	17.02±0.21^{d}

Row-wise group means with different superscripts differ significantly (P<0.05)
* N = 6

3.3.1 Moisture

Moisture content of control was significantly (P<0.05) lower than the treated groups. Moisture content of 10 and 15 percent WKPEMN was significantly (p<0.05) higher than 5 percent WKPEMN.

3.3.2 Ash

Ash content of 15 percent walnut kernel paste extended mutton nuggets was significantly (P<0.05) higher than control and 5 and 10 percent walnut kernel paste extended mutton nuggets. Ash content of control and 5 and 10 percent walnut kernel paste extended mutton nuggets did not differ significantly (P>0.05).

3.3.2 Protein

There was a significant (P<0.05) decrease in the protein content of mutton nuggets with the increase in levels of walnut kernel paste.

3.3.4 Fat

There was a significant (P<0.05) increase in the fat content of mutton nuggets with the increase in levels of walnut kernel paste.

3.4 Sensory attributes

Mean ± SE of various sensory attributes viz., appearance, flavour, texture, juiciness, saltiness, mouth coating and overall acceptability of control, 5, 10 and 15 percent WKPEMN are presented in Table-4.

Table 4: Sensory attributes of mutton nuggets containing various levels of walnut kernel paste (Mean ± S.E)

Sensory attributes	Walnut kernel paste			
	Control	5%	10%	15%
Appearance	7.62±0.13^{b}	7.38±0.15^{ab}	7.14±0.14^{a}	7.24±0.12^{ab}
Flavour	7.00±0.14^{a}	7.14±0.17^{a}	7.29±0.14^{a}	7.43±0.16^{a}
Texture	7.33±0.16^{a}	7.09±0.15^{a}	7.19±0.15^{a}	7.24±0.14^{a}
Juiciness	6.95±0.15^{a}	6.86±0.16^{a}	6.95±0.16^{a}	7.24±0.15^{a}
Mouth coating	8.00±0.00^{a}	8.00±0.00^{a}	8.00±0.00^{a}	8.00±0.00^{a}
Saltiness	7.14±0.14^{a}	7.00±0.15^{a}	7.09±0.15^{a}	7.24±0.17^{a}
Overall acceptability	6.95±0.15^{a}	7.00±0.17^{a}	7.05±0.16^{a}	7.29±0.12^{a}

Row-wise group means with different superscript differ significantly (P<0.05)
* 8-point descriptive scale (8 = extremely desirable, 1 = extremely undesirable)

3.4.1 Appearance

Appearance scores of 10 percent WKPEMN were significantly (P<0.05) lower than control. Among the treated groups, the appearance scores showed a non-significant (p>0.05) difference.

3.4.2 Flavour

There was a non-significant (P>0.05) increase in the flavour scores of mutton nuggets with increase in levels of walnut kernel paste.

3.4.3 Texture

There was a non-significant (P>0.05) increase in the texture scores of mutton nuggets with increase in levels of walnut kernel paste.

3.4.4 Juiciness

There was a non-significant (P>0.05) increase in the juiciness scores of mutton nuggets with increase in levels of walnut kernel paste.

3.4.5 Saltiness

There was a non-significant (P>0.05) increase in the saltiness scores of mutton nuggets with increase in levels of walnut kernel paste.

3.4.6 Overall acceptability
There was a non-significant (P>0.05) increase in the overall acceptability scores of mutton nuggets with increase in levels of walnut kernel paste.

4. Discussion
Mutton nuggets were prepared by incorporating walnut kernel paste at 0, 5, 10 and 15 percent levels. The quality of mutton nuggets was evaluated on the basis of physico-chemical properties, proximate composition and sensory evaluation of the product.

4.1 Physicochemical characteristics
The mean values of various physicochemical parameters namely pH, cooking yield, emulsion stability of mutton nuggets incorporated with 0, 5, 10, and 15 percent levels of walnut kernel paste are presented in Table 5.

Table 5: Physico-chemical properties of mutton nuggets containing various levels of walnut kernel paste (Mean ± S.E).

Parameters	Walnut kernel paste			
	Control (0%)	5%	10%	15%
Product pH	6.15±0.03^{a}	6.21±0.01^{b}	6.24±0.02^{b}	6.25±0.02^{b}
Cooking yield (%)	86.23±0.40^{a}	86.77±0.33^{a}	87.13±0.52^{a}	92.03±0.99^{b}
Emulsion stability (%)	92.77±0.03^{a}	93.10±0.01^{a}	93.57±0.62^{ab}	94.53±0.53^{b}

Row-wise group means with different superscripts differ significantly (P<0.05)

The pH value of control was significantly (P<0.05) lower than all the walnut kernel paste extended mutton nuggets and among the treatment groups, pH values increased non-significantly (P>0.05) with increase in levels of walnut kernel paste. The slight increase in the pH values by the addition of walnut kernel paste can be attributed to higher pH [7] of the walnut kernels as compared to the raw lean meat [5-6]. Similar results have been reported for the influence of walnut upon the pH of restructured beef steaks with added walnut [12]. These results are also consistent with the findings in healthier frankfurters added with walnut [5]. Cooking yield of control was significantly (P<0.05) lower than 15 percent walnut kernel paste extended mutton nuggets. The walnut kernel being a rich source of proteins and fats improved the emulsion stability (hence cooking yield) of the product. Cooking loss of restructured beef decreased (p<0.05) as the proportion of walnut increased [19]. The emulsion stability of 15 percent WKPEMN was significantly (P<0.05) higher than of control and 5 percent WKPEMN. Rajkumar [17] reported that the addition of almond improved (p<0.05) the emulsion stability of goat meat nuggets. Walnuts have high capacity to hold water and fat which increases stability of meat emulsion. Similarly, the addition of almond improved (p<0.05) the emulsion stability of goat meat nuggets [17]. There was a significant (P<0.05) increase in the moisture content of mutton nuggets with the increase in levels of walnut kernel paste. The walnut kernel being a rich source of proteins might have contributed in better emulsion stability, hence moisture retention. Similarly, the walnut added frankfurters contained the lowest (p<0.05) moisture content than low fat frankfurters and traditional frankfurters [5]. Ash content of 15 percent walnut kernel paste extended mutton nuggets was significantly (P<0.05) higher than control and 5 and 10 percent walnut kernel paste extended mutton nuggets. Similar findings were reported that the addition of walnut significantly raised the ash level in frankfurters [5]. There was a significant (P<0.05) decrease in the protein content of mutton nuggets with the increase in levels of walnut kernel paste. The decreasing trend in the protein content of the product could be attributed to somewhat lower protein content of walnut kernels as compared to the lean meat (replaced in place for WKP in the formulation of the product). Similar findings upon the addition of walnut in restructured beef steaks reduced [8]. There was a significant (P<0.05) increase in the fat content of mutton nuggets with the increase in levels of walnut kernel paste. The higher fat content of the WKP could be the reason for significant increase in the fat content of WKPEMN. The results are being supported by Ayo [5] who also concluded that the addition of walnut raised the fat level in frankfurters. The panelists were not able to detect any major differences among the products. Organoleptic evaluation of the products revealed no significant differences in the various attributes between the control and WKPEMN. In contrast to our results, Similarly the detection of slight off-flavour (walnut-like) in the restructured beef steak with walnuts, which was more noticeable (P<0.05) in the product that had the higher percentage of added walnut [8]. Ayo [5] perceived some effects on sensory quality on the addition of walnut to frankfurters and restructured beef steaks. In the present case, the panel members were able to detect the addition of walnut as a slight off-flavour but this was not perceived as a negative element.

5. Conclusion
The present study showed successful utilization of WKP in the preparation of mutton nuggets sausages and the products had almost similar sensory attributes and acceptability as in control nuggets. WKP at levels (5%, 10%, 15%) can be incorporated in mutton nuggets while maintaining the various physico-chemical and sensory properties of the product. Incorporating natural rich source omega-3 fatty acids (walnut) into mutton nuggets may have resulted in remarkable increase in the omega 3 fatty acid content of formulas over control which has several health benefits. Thus, it is concluded that 15 percent WKP tried in this study can be successfully incorporated in mutton nuggets to improve the nutritive value. Further research should be focused on the use of WKP in other meat products.

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