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Development and quality analysis of low fat Kadaknath chicken patties

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Abstract
Value addition and development of functional meat products from Kadaknath is very limited and meat-based functional foods are being seen as an opportunity to improve the ‘‘image” of meat and address consumer needs. Present study was undertaken with aim of quality and sensory analysis of guar gum incorporated low fat Kadaknath chicken patties. The product was prepared by using three different levels of guar gum (T-1 0.5%, T-2 1% and T-3 1.5%) by replacing added fat. All samples were processed for physicochemical and sensory analysis. There was significant (P<0.05) difference in the cooking yield and moisture content of Kadaknath chicken patties between control and treatments. The developed product had significantly (P<0.05) lower fat content and moisture compared to control. Fat retention was significantly (P<0.05) increased with the increasing level of guar gum from control to T-2 and thereafter a non-significant (P>0.05) increment was noticed. Textural and sensory attributes differed significantly (P<0.05). Overall acceptability revealed a significant (P<0.05) lower score for T-1 and T-3. However, score for T-2 was comparable to control. Hence, patties with 1% guar gum (T-2) was found superior and most acceptable by the sensory panelists and finally selected as low fat Kadaknath chicken patties.

Keywords: Kadaknath, low fat, functional, patties, guar gum

Introduction
Kadaknath is an Indian breed of chicken, also called Kali Masi ("fowl with black flesh"). The breed originated from Jhabua district of Madhya Pradesh. These birds are very much adaptable to local environment and also considered as resistant to various diseases. The meat of these birds is very much liked by local community because of its good taste, desirable flavor and medicinal value. Over the last several decades, meat products have come under increasing scrutiny by medical, nutritional and consumer groups because of the associations established between their consumption (low fat and high fibre) and the risk of some of the major degenerative and chronic diseases (heart disease, hypertension and obesity, colon cancer). Therefore, meat-based functional foods are being seen as an opportunity to improve the ‘‘image” of meat and address consumer needs and also to update the nutritional and dietary goals. The reduction of fat to develop healthier products is particularly challenging because it necessarily implies removing or partially replacing with substitute in the formulations of meat products (Weiss *et al*., 2010) [25]. Reduction of fat in comminuted meat products results in rubbery and dry textured products (Keeton, 1994) [13] and poses difficulties in terms of flavor and texture. Hence, there is a need for using suitable ingredient which is able to replace fat without affecting quality. Guar gum (galactomannan) extracted from the seeds of the leguminous plant *Cyamopsis tetragonoloba* is a widely used polysaccharide in food industry (Mudgil *et al.*, 2014) [15]. Due to plethora uses of guar gum such as gelling, thickening, firming and emulsifying agent, it is considered the most significant galactomannan employed industrially (Butt *et al.*, 2007, Pearson and Gillett, 1997) [5, 21]. Looking to the facts and overcome the problem associated with health of consumer the present study was carried out.

Materials and Methods
Source of Raw Material
Kadaknath chicken (4-5 months age) were be procured from Department of Poultry Science, College of Veterinary Science and Animal Husbandry, Mhow. The Halal method was used for slaughtering of chicken. Immediately within 20 minutes after the slaughter, the meat was packed in LDPE bags and brought to the laboratory. The meat was deboned and the excess fat and connective tissue were removed.

The samples were kept in refrigerator at 4±1 ºC for 6–8hrs for conditioning and then frozen at -18 ºC till further use. After partial thawing for 15 hrs at 4 ºC the meat samples were used for further product development. The present study was carried out during the period of November 2018 to March 2019, in the Department of Livestock Products Technology, College of Veterinary Science &A.H, Mhow

Spice mix

The ingredients in desired ratio: Anise (10%), Black pepper (5%), Capsicum (10%), Caraway (10%), Cardamom (4%), Cinnamon (4%), Cloves (2%), Coriander (15%), Cumin (20%), Dry ginger (10%) and Turmeric (10%) were procured from local market, dried at 45±2 ºC for 2 hours followed by grinding and sieving through 100 meshes. The spice mix was stored in low density polyethylene bags and used as per requirement.

Chemicals and other ingredients

Analytical grade chemicals were used in the study and procured from Hi Media laboratories (P) Ltd, Mumbai. As per the requirement of the study, other ingredients were procured from standard firm and local market. Low density Polyethylene (LDPE) bags of 250 gauge thickness were pre-sterilized by exposing to U.V. light for 30 minutes and the used for packaging of products.

Preparation of Kadaknath chicken patties

After overnight thawing the meat was cut into small cubes and further double minced in an electrolux mincer. Bowl chopper (Seydelmann K20, Ras, Germany) was used to prepare meat emulsion. Required quantity of minced chicken meat, salt, sodium tripolyphosphate were mixed and chopped in bowl chopper for 2-3 minutes. The ice flakes were added and again chopped for 2 minutes. During the entire process of chopping, refined vegetable oil was incorporated slowly till it was completely dispersed in the batter. Further, condiments paste of onion, garlic and ginger (3:1:1), dry spices mix and refined flour were added. Continuous chopping was done untill uniform dispersion of all the ingredients and desired consistency of the emulsion was achieved. 40 gram of emulsion was taken, molded in to patties shape and were cooked in hot air oven (180 ^{0}C) for 12 minutes. The patties was turned and aging cooked for 4 minutes.

Standardization of level of guar gum in Kadaknath chicken patties

Low fat patties were prepared by incorporation of three different levels of guar gum in Kadaknath chicken patties by replacing added fat (Table 01).

Table 1: Formulation for incorporation of guar gum for the development of low fat Kadaknath chicken patties

Ingredients	Control (C)	T1	T2	T3
Meat (%)	69.0	69.0	69.0	69.0
Guar gum (%)	00	0.5	1.0	1.5
Gram Hull (%)	6.0	6.0	6.0	6.0
Refined Flour (%)	4.0	4.0	4.0	4.0
Vegetable oil (%)	6.0	3.0	3.0	3.0
Condiments (%)	3.8	3.8	3.8	3.8
Ice – Flakes (%)	7.0	9.5	9.0	8.5
Spices (%)	2.0	2.0	2.0	2.0
Salt (%)	1.8	1.8	1.8	1.8
STPP (%)	0.4	0.4	0.4	0.4
Total	100	100	100	100

C: Kadaknath chicken patties without guar gum, T-1: Kadaknath chicken patties with 0.5% guar gum, T-2: Kadaknath chicken patties with 1.0% guar gum and T-3: Kadaknath chicken patties with 1.5% guar gum

Analytical procedure

Physico-Chemical properties

pH

pH was determined by using digital pH meter (WTW, Germany, model pH 330i) by immersing the spear type combination electrode (Sentix®, Germany) directly into minced meat sample.

Prior to measurement as per the manufacturer's instructions, pH meter was calibrated using known buffers. For each sample, reading was taken twice and average of reading was considered for the study.

Emulsion stability

The emulsion stability was determined by the method of Baliga and Madaiah (1970) [3] with minor modifications. Twenty five grams of meat emulsion was taken in polyethylene bag and heated in thermostatically controlled water bath at 80 ^{0}C for 20 min. after cooling and draining the exudates, the cooked mass was weighed. The percentage of cooked mass was expressed as emulsion stability.

Cooking yield

The weights of Kadaknath chicken patties were recorded before and after cooking. The cooking yield was calculated as under and expressed as percentage (Murphy *et al.*, 1975) [16].

$$\text{Cooking yield (\%)} = \frac{\text{Weight of cooked Kadaknath chicken patties}}{\text{Weight of raw Kadaknath chicken patties}} \text{X } 100$$

Proximate analysis

Moisture, protein fat, fiber and ash contents were determined as per AOAC (1995) [1] method.

Moisture Protein ratio

This was calculated by ratio of the moisture and protein content in the sample by using formula for 100 g of samples

Moisture Protein ratio = Moisture% / Protein%

Moisture-retention and Fat retention

Moisture retention and Fat retention were determined according to equation by El-Magoli *et al.* (1996) [10] and Murphy *et al.* (1975) [16], respectively.

Texture profile analysis

Texture profile analysis (TPA) was performed (Bourne,

1978)[4] using homogeneous sample (1.5mm x 1.5mm x 1.5mm) for each treatment which was compressed to 10 mm (1cm) of original height through miniature Ottowa and Kramer shear cell platen probe. Cross head speed of 2.00 mm per second, posttest speed 10.00 mm per sec. target mode distance 10.00 mm was used. The following parameters were determined *viz.* Hardness (N/cm^2) = maximum force required to compress the sample(H); Adhesiveness (Ns/g sec) = work necessary to pull the compressing plunger away from the sample; Cohesiveness (Ratio) = Extent to which samples could be deformed prior to rupture (A2/A1, A1 being the total energy required for first compression and A2 total energy required for second compression); and Gumminess (N/cm2 or g/mm^2) = force necessary to disintegrate a semi solid sample for swallowing (H x Cohesiveness)

Sensory evaluation

The sensory quality of samples was evaluated by using 8 point descriptive scale (Keeton, 1983)[12] where 8 denoted extremely desirable and 1 denoted extremely poor. A sensory panel (semi trained) of seven judges drawn from post-graduate students and staff of Veterinary College, Mhow after training/briefing were requested to evaluate the product for different quality attributes *viz*., general appearance, texture, juiciness, saltiness, flavor and overall acceptability.

Statistical analysis

The data obtained in the study were statistically analyzed on 'SPSS-16.0' software package as per the standard methods described by Snedecor and Cochran (1995) [24]. Duplicate samples were drawn for each parameter and the experiment was replicated thrice (n=6). Sensory evaluation was performed by a panel of seven member judges three times, so total observations being 21 (n=21) Data were subjected to one way analysis of variance (ANOVA), homogeneity test and Duncan's Multiple Range Test (DMRT) for comparing among treatments.

Results and Discussion

Physico-chemical properties

The data presented in Table - 2 indicated that the emulsion stability was found to be increased initially from control to T-2 and then decreases with the further increasing level of guar gum. However, the difference was non-significant ($P>0.05$). The compactness of the protein gel network allowed more binding of water therefore, with an increase in gun concentration, the water holding capacity increased (Ayadi *et al.,* 2009) [2]. These findings are in accordance with the findings of Nayak *et al.* (2015) [20] in carrageenan incorporated chevon patties.

Table 2: Physico-chemical properties (Mean±SE) of low fat Kadaknath chicken patties incorporated with different levels of guar gum

Parameters	Control (C)	T1	T2	T3
Emulsion stability (%)	94.57±1.48	94.67±1.56	95.66±1.87	95.37±1.88
Cooking yield (%)	$87.60±0.24^{a}$	$88.10±0.36^{ab}$	$89.31±0.19^{b}$	$90.63±0.26^{b}$
Moisture (%)	$58.74±o.14^{a}$	$61.24±0.47^{b}$	$61.54±0.56^{b}$	$61.18±0.61^{b}$
Protein (%)	20.65±1.21	20.18±1.32	20.32±1.22	20.35±1.12
Fat (%)	$7.46±0.13^{b}$	$4.79±0.24^{a}$	$4.81±0.18^{a}$	$4.92±0.12^{a}$
Fibre (%)	2.41±0.04	2.45±0.07	2.51±0.08	2.43±0.05
Ash (%)	3.59±0.14	3.60±0.19	3.62±0.13	3.64±0.14
Moisture–Protein ratio	$2.84±0.06^{a}$	$3.03±0.03^{b}$	$3.02±0.050^{b}$	$3.00±0.07^{b}$
Moisture retention (%)	$51.45±0.52^{a}$	$53.95±1.26^{ab}$	$54.94±o.71^{ab}$	$55.44±0.0.42^{b}$
Fat retention (%)	$87.33±0.38^{a}$	$90.22±0.43^{b}$	$93.32±0.36^{c}$	$93.39±0.62^{c}$

Means bearing different superscripts within a row differ significantly ($P<0.05$).

There was a significant ($P<0.05$) difference in the cooking yield of Kadaknath chicken patties between control and treatments. Cooking yield increased non–significantly ($P>0.05$) in guar gum added Kadaknath chicken patties. However, the cooking yield was significantly ($P<0.05$) higher at T-2 and T-3 as compared to control. It might be due to ability of guar gum to form complex with water and protein (Egbert *et al.,* 1991) [9], which improves the water retention and cooking yield. Rather *et al.* (2017) [22] also reported higher cooking yield in guar gum added low fat meat emulsion.

There was significant ($P<0.05$) difference in the moisture content of Kadaknath chicken patties between control and treatments. However, a non–significant ($P>0.05$) difference was recorded in between treatment. This might be due to addition of compensatory water in the formulation of low fat Kadaknath chicken patties as well as the ability of gum particles to retain more water (Huffman *et al.,* 1992) [11]. The results are in agreement with the findings of Rather *et al.* (2016) [23] in guar gum incorporated mutton goshtaba and Nayak and Pathak (2016) [18] in low fat carrageenan added chevon patties.

Results clearly indicated that no significant ($P>0.05$) difference in the protein content of guar gum added Kadaknath chicken patties was noticed. This might be due to approximately similar amount of meat used in the formulation. Condogan and Kolsarici (2003) [6] reported that no significant ($P>0.05$) difference in the protein content of carrageenan incorporated low fat frankfurters.

Guar gum added low fat Kadaknath chicken patties had significantly ($P<0.05$) lower fat content compared to control. This was because of obvious difference in the formulation of low fat Kadaknath chicken patties since they contained only 3 % added fat as compared to 6% as in control. Naruka (2005) [17] in low fat guar gum added pork nuggets. Demirci *et al.* (2014) [8] in guar gum added meat ball also reported significant ($P<0.05$) decrease in fat percentage. There was no significant ($P>0.05$) increase in the fat content with the increasing level of guar gum from T-1 to T-3 because of fat binding ability of guar gum. Nayak and Pathak (2016) [19] also reported similar observation in carrageenan incorporated chevon patties.

Fibre and ash content of guar gum added Kadaknath chicken patties did not differ significantly ($P>0.05$). However, lower value of fibre and ash content was observed in control compare to that of treatments. Demirci *et al*. (2014) [8] also reported non-significant difference ($P>0.05$) of ash content in guar gum added meat ball.

Moisture-Protein ratio was found to be non-significant ($P>0.05$) among the different treatments. This might be due

to obvious water and protein content of the low fat Kadaknath chicken patties.

Moisture retention was significantly ($P<0.05$) lower in control as compared to low fat guar gum incorporated Kadaknath chicken patties. The marginal improvement between treatment was also noticed which may be due to water binding nature of guar gum. Nayak and Pathak (2016)[18] also reported higher moisture retention in carrageenan incorporated chevon patties.

Fat retention was significantly ($P<0.05$) increased with the increasing level of guar gum from control to T-2 and thereafter a non-significant ($P>0.05$) increment was noticed. Nayak and Pathak (2016)[18] also reported similar findings in carrageenan added chevon patties.

Texture profile analysis

A progressive significant ($P<0.05$) increment in the hardness value of guar gum incorporated low fat Kadaknath chicken patties from control to T-3 was recorded (Table 3). Improvement in hardness value of carrageenan incorporated low fat frankfurters was also recorded by Mittal and Barbut (1994) [14]. Significant ($P<0.05$) effect on hardness value in poppy seed incorporated low fat chevon patties was also reported by Nayak and Pathak (2017) [19].

Table 3: Texture profile analysis (Mean±SE) of low fat Kadaknath chicken patties incorporated with different levels of guar gum

Parameters	Control (C)	T1	T2	T3
Hardness (N/cm^2)	53.26±0.40^a	56.02±0.44^b	60.25±0.47^c	63.63±0.51^d
Adhesive force (Ns/g sec)	-2.52±0.28	-2.43±0.31	-2.76±0.0.32	-2.80±0.31
Cohesiveness (ratio)	0.746±0.003^b	0.661±0.003^a	0.669±0.002^a	0.65±0.003^a
Gumminess (N/cm^2)	41.38±0.68^a	39.38±0.74^a	50.52±0.69^b	45.38±0.68^b

Means bearing different superscripts within a row differ significantly ($P<0.05$)

A non-significant ($P>0.05$) lower adhesive force in the guar gum incorporated low fat Kadaknath chicken patties was recorded. The cohesiveness value of guar gum incorporated low fat Kadaknath chicken patties were significantly ($P<0.05$) lower as compared to control. Nayak and Pathak (2017) [19] reported non-significant ($P>0.05$) difference in adhesiveness and significant ($P<0.05$) difference in cohesiveness value in poppy seed incorporated low fat chevon patties.

Gumminess value differed non-significantly ($P>0.05$) at T-1. However, then increased and showed a significant difference at T-2 AND T-3. Cierach and Szacilo (2003) [7] also reported that sausages containing carrageenan were characterized by higher value of gumminess than the control.

Sensory evaluation

A non-significant ($P>0.05$) difference in the general appearance of the low fat Kadaknath chicken patties was observed. The comparable scores of T-2 and T-3 compared to control were observed and lowest score for general appearance was recorded at T-1 (Table 4).

Table 4: Sensory attributes (Mean±SE) of low fat Kadaknath chicken patties incorporated with different levels of guar gum

Parameters	Control (C)	T1	T2	T3
General appearance	6.95±0.23	6.80±0.21	6.90±0.22	6.90±0.24
Flavor	7.14±0.19^b	7.04±0.19^b	7.09±0.20^b	6.76±0.20^a
Texture	7.04±0.22^b	6.95±0.20^b	7.04±0.21^{ab}	6.66±0.21^a
Mouth coating	6.76±0.21	6.80±0.21	6.95±0.19	6.52±0.20
Saltiness	6.95±0.22	7.04±0.21	7.19±0.22	6.90±0.24
Juiciness	6.90±0.19	7.14±0.21	7.04±0.20	7.19±0.20
Overall acceptability	7.09±0.12^b	6.90±0.09^a	7.14±0.12^b	6.80±0.11^a

Means bearing different superscripts within a row differ significantly ($P<0.05$).

Flavor score at T-1 and T-2 were comparable to control although score was significantly ($P<0.05$) lower for T-3. It might be due to pronounced off flavor at higher level of guar gum. These findings are in accordance with the research observations of Naruka (2005) [17] in guar gum incorporated meat sausage and Nayak *et al.* (2015) [20] in carrageenan added nuggets.

Texture score decreased non-significantly ($P>0.05$) from control to T-2, and the difference was significant ($P<0.05$) at T-3. Sensory panelists rated T-2, similar to control for texture attributes. It could be due to good fat mimicking property of guar gum at particular level. Rather *et al.* (2017) [22] reported comparable texture score in guar gum incorporated low fat meat emulsion.

A non-significant ($P>0.05$) difference in the scores of mouth coating and saltiness were recorded in the guar gum incorporated low fat Kadaknath chicken patties. Score for saltiness of guar gum incorporated low fat Kadaknath chicken patties were higher as compare to control and lowest score for T3 was recorded. This might be due to decreasing acceptability with increasing level of guar gum.

A gradual non-significant ($P>0.05$) increment in the score of juiciness was recorded with the increasing level of guar gum. This might be due to higher moisture content in the low fat Kadaknath chicken patties as well as higher moisture and fat retention capacity of guar gum. Sensory attributes of low fat formulation supplemented with 0.5 % gum had quality characteristics that were similar to those of control (Rather *et al.*, 2017) [22].

Overall acceptability revealed that there was significant ($P<0.05$) variation among different guar gum incorporated low fat Kadaknath chicken patties. A significant ($P<0.05$) lower score were observed for T-1 and T-3. However, score for T-2 was comparable to control. This might be due to additive effect of other sensory attributes. These findings are in agreements with the observation recorded by Demirci *et al.* (2014) [8] in guar gum added meat balls, Nayak and Pathak (2016) [18] in carrageenan added chevon patties and Rather *et al.* (2017) [22] in meat emulsion.

Conclusion

On the basis of physico-chemical properties, texture profile

analysis and finally sensory evaluation, patties incorporated with 1% guar gum was found superior and most acceptable by the sensory panelists and finally selected as low fat Kadaknath chicken patties. Hence, 1% guar gum may suitability be used as a source of fat replacer for the development of low fat Kadaknath chicken meat patties without affecting the physicochemical and sensory attributes of the products

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