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Research Article

Development and evaluation of low fat Kadaknath chicken sausage by using sago flour

D. Patel[1], N. K. Nayak[1], P. Chauhan[1*], V. Pathak[2] and M. Goswami[2]

[1]Department of Livestock Products Technology, College of Veterinary Science and A. H. (NDVSU), Mhow, Indore-453 446, Madhya Pradesh, India; [2]Department of Livestock Products Technology, College of Veterinary Science and A.H. (DUVASU), Mathura-281 001, Uttar Pradesh, India

Abstract

The study was undertaken to develop low fat Kadaknath chicken sausage by incorporating sago flour (T1-2%, T2-4% and T3-6%) as a fat replacer in comparison to sausage without sago flour as control. Developed products were assessed for various physicochemical, textural and sensory attributes. The pH and cooking yield differed significantly (P<0.05) among the treatments. The fat content was reduced significantly (P<0.05) in developed functional chicken sausage compared to control. The moisture and fat retention were increased significantly (P<0.05) with increasing levels of sago flour. Textural attributes like hardness, gumminess, springiness and chewiness values of functional Kadaknath chicken sausage differed significantly (P<0.05) with control. Sensory attributes of sago flour incorporated with Kadaknath chicken sausage indicated comparable scores for T-2 compared to the control. Overall acceptability revealed that the product was very well accepted at 4% incorporation of sago flour and can be used as a fat replacer in the development of functional Kadaknath chicken sausage without affecting the quality and sensory attributes.

Keywords: Fat replacer, Kadaknath, Low fat, Sago flour, Sausage

Highlights

- Value addition of Kadaknath chicken meat
- Use of sago flour as fat replacer
- Development of low fat Kadaknath chicken sausage
- Incorporation of sago flour (4%) in the development of functional Kadaknath chicken sausage

INTRODUCTION

Kadaknath is the only indigenous black chicken breed of India, which is native to the Jhabua district of Madhya Pradesh. It is famous for its black meat, meat quality, texture and flavour. Meat is in high demand due to its health-promoting properties in the medicinal group (Sharma *et al.*, 2022). Kadaknath chicken contains 25-27% of the protein in comparison with other breeds of chicken. Its meat has lower cholesterol (0.73-1.05%) than white chicken. Because of the lower cholesterol content in Kadaknath meat, it is ideally suitable for people suffering from high blood pressure. It is also rich in several vitamins viz. B_1, B_2, B_6, B_{12}, niacin, C and E. Mineral content like calcium, phosphorus and iron are relatively high (Kumar *et al.*, 2021).

The quality attributes of meat and meat products, including juiciness, texture, meaty flavour, cooking yield and distinctive aroma, are all attributed to fat, which is considered as an essential component (Choi *et al.*, 2013). Consumption of food products with high fat and calories has various long-term risks of hypertension and heart diseases (Chauhan *et al.*, 2021). Fat replacement is an innovative development, and it is used as a fat substitute or fat-mimetics that plays a role in the physical and sensory characteristics of conventional fat (Tay *et al.*, 2018). Sago (*Metroxylon sagu*) is "tapioca root" internationally known as "cassava". It provides only carbohydrates and is low in protein, vitamins and minerals (Kumari *et al.*, 2019), and it is used as a fat replacer in meat products (Nayak and Pathak, 2018). The use of non-meat components such as starches can stimulate better-quality and healthier meat products. Starch is a versatile food ingredient with binding, adhesive, emulsion stabilizing, gelling and moisturizing properties. Starch can be used as an additive in emulsion products for sausage products (Giese, 1995).

MATERIALS AND METHODS

Raw material: Approximately 5 months age of Kadaknath chicken was procured from College of Veterinary Science & A.H. and Department of Poultry Science Mhow, Madhya Pradesh. The chicken was

*Corresponding Author, E-mail: dr.pranav.chauhan@gmail.com

slaughtered and meat was deboned and stored at -18°C till further use. Analytical grade of chemicals required for the study were procured from Hi Media Laboratories (P) Ltd, Mumbai. 250 gauge low density polyethylene (LDPE) bag and other ingredients used in the study were procured from standard firms and neighbouring markets as per availability and requirements of the project.

Preparation of product: Once half thawed, the preparation is double to chop the chicken meat in an electric mincer (Sujata Plastic Dynamix, Mixer Grinder, 900 Watts, India). Pre-weight quantity of minced chicken meat and other required ingredients were added as per formulation for preparation of emulsion (Table 1).

Prepared sausage for each treatment as per the process mentioned in flow chart.

Flow chart of the preparation of functional low fat Kadaknath chicken sausage

Minced chicken meat
↓
Addition of ice flakes along with salt and polyphosphate
↓
Run in bowl chopper (2-3 minutes)
↓
Followed by refined vegetable oil is incorporated (Chopped in bowl chopper for 2-3 minutes)
↓
Addition of condiments, spices mix, sugar, sago flour and corn flour (Run in bowl chopper for 1-2 minutes)
↓
Mixed meat was stuffed into natural casing
↓
Cooked in hot air oven at 90°C (30 minutes)
↓
Cooling to ambient temperature
↓
Packaged and storage at 4±1°C
↓
Sensory evaluation and sample analysis

Analysis of product: The developed functional Kadaknath meat products were evaluated for various physicochemical analyses, viz. a digital pH meter (WTW, Germany, model pH 330i) to determine the pH of the samples. The average of two readings for each sample was considered as the final pH reading. Emulsion stability (Baliga and Madaiah, 1970) with minor modifications was estimated. Cooking yield (Murphy *et al*., 1975), proximate composition (AOAC, 1995), moisture retention and fat retention according to the equation given by El-Magoli *et al*. (1996) and Murphy *et al.* (1975), respectively were estimated. Instrumental texture profile was evaluated by using the Bourne (1978) method. The sensory was evacuation according to the scale described by Keeton (1983) (8-point description), where 1 represents extremely poor, and 8 represents extremely desirable. The seven semi-trained judges were selected from among college students and young staff of the College of Veterinary Science and A.H., Mhow, Indore M.P., India. A training/briefing session for the selected panel was organized, and then, the evaluation of the different treatments of Kadaknath chicken sausage for various sensory attributes was requested in the sensory room of the department.

Table 1. Formulation of low fat sausage developed from Kadaknath meat

Ingredients	Control	T-1	T-2	T-3
Meat (%)	71.0	71.0	71.0	71.0
Corn flour (%)	3.0	3.0	3.0	3.0
Vegetable oil (%)	8.0	4.0	4.0	4.0
Condiments (%)	3.0	3.0	3.0	3.0
Ice - Flakes (%)	10.0	12.0	10.0	8.0
Spices (%)	1.6	1.6	1.6	1.6
Salt (%)	2.0	2.0	2.0	2.0
Sugar (%)	1.0	1.0	1.0	1.0
Sago flour (%)	0.0	2.0	4.0	6.0
STPP (%)	0.4	0.4	0.4	0.4

C (Control): Kadaknath chicken sausage without sago flour; T-1: Kadaknath chicken sausage with 2% sago flour; T-2: Kadaknath chicken sausage with 4% sago flour; T-3: Kadaknath chicken sausage with 6% sago flour

Statistical analysis: The data generated from the present experiment on various parameters were statistically analyzed by using IBM SPSS Statistics (Version 16) software package as per standard methods of Snedecor and Cochran (1995). Three trials in duplicate for each experiment were conducted (n=6). A total of 3 attempts were made by a trained judges panel of seven members, so the total observations were 21 (n=21).

RESULTS

Physico-chemical properties: The average value of various physico-chemical properties of low fat Kadaknath chicken sausage incorporated with different

Table 2. Physico-chemical properties of sago flour incorporated low fat sausage developed from Kadaknath meat (Mean±SE)

Parameters	C	T-1	T-2	T-3
pH	6.15^{a}±0.01	6.20^{b}±0.07	6.24^{bc}±0.13	6.28^{c}±0.01
Emulsion stability (%)	92.69±0. 83	93.25±0.73	94.04±0.67	94.42±0.21
Cooking yield (%)	88.01^{a}±0.29	89.65^{b}±0.31	91.15^{c}±0.17	92.16^{c}±0.30
Moisture (%)	59.37±0.42	61.44±0.32	60.64±0.31	59.17±1.14
Protein (%)	21.51±0.21	21.76±0.34	21.88±0.29	21.91±0.31
Fat (%)	8.54^{b}±0.22	4.89^{a}±0.17	4.78^{a}±0.14	4.64^{a}±0.12
Ash (%)	3.36±0.14	3.44±0.13	3.51±0.16	3.63±0.21
Moisture retention (%)	52.25^{a}±0.25	55.08^{b}±0.59	55.27^{b}±0.61	55.53^{b}±0.19
Fat retention (%)	83.58^{a}±0.13	84.49^{a}±0.54	88.70^{b}±0.81	88.87^{b}±0.29

C (Control): Kadaknath chicken sausage without sago flour; T-1: Kadaknath chicken sausage with 2% sago flour; T-2: Kadaknath chicken sausage with 4% sago flour; T-3: Kadaknath chicken sausage with 6% sago flour. Different superscripts row wise differ significantly (P<0.05) (n= 6)

Table 3. Instrumental textural profile of sago flour incorporated low fat sausage developed from Kadaknath meat (Mean±SE)

Parameters	C	T-1	T-2	T-3
Hardness (N/cm^2)	161.91^{a}±0.88	196.20^{b}±1.59	247.28^{c}±2.23	306.73^{d}±1.35
Springiness (cm)	0.138^{b}±0.002	0.132^{b}±0.001	0.117^{ab}±0.004	0.105^{a}±0.003
Cohesiveness (ratio)	0.077±0.005	0.065±0.001	0.062±0.002	0.051±0.003
Gumminess (N/cm^2)	9.33^{a}±0.06	9.84^{b}±0.27	12.94^{bc}±0.10	13.38^{c}±0.22
Chewiness (N/cm)	12.88^{a}±0.46	16.45^{b}±0.30	19.03^{c}±0.26	20.52^{c}±0.29

C (Control): Kadaknath chicken sausage without sago flour; T-1: Kadaknath chicken sausage with 2% sago flour; T-2: Kadaknath chicken sausage with 4% sago flour; T-3: Kadaknath chicken sausage with 6% sago flour. Different superscripts row wise differ significantly (P<0.05) (n= 6)

levels of sago flour content is shown in Table 02. The analysis of variance indicated significant (P<0.05) differences in pH value, cooking yield (%), fat (%), and fat retention (%) between treatments. However, all these parameters showed significant (P<0.05) differences when compared with control. The moisture retention (%) mean values did not differ significantly in treatments T-1 to T-3, but it was significantly (P<0.05) increased as compared with the control. Whereas for the emulsion stability, moisture content, protein (%) content and ash content indicate there was no significant (P>0.05) differences between treatments T-1, T-2, T-3 and control.

Instrumental texture profile: The mean values for textural properties of low fat Kadaknath chicken sausage incorporated with different levels of sago flour are presented in Table 3. The values indicated significant (P<0.05) differences in the mean value of springiness, hardness, gumminess and chewiness values between treatments; however, there was no significant (P>0.05) difference in the mean value of cohesiveness between treatments. There were significant (P<0.05) increases in gumminess, hardness and chewiness values from control to T-2, but changes in these parameters were non-significant (P>0.05) between treatment T-2 and T3.

Sensory evaluation: The mean value for general appearance, texture, flavour, juiciness, mouth coating, saltiness and overall acceptability of low fat Kadaknath chicken sausage incorporated with different levels of sago flour is listed in Table 4. The mean sensory score of parameters indicated significant (P<0.05) differences in general appearance, texture, flavour and overall acceptability scores between treatments. The sensory parameters, like mouth coating and juiciness, indicated no significant (P>0.05) difference between treatment groups. Sensory attributes like flavour, general appearance, texture and overall acceptability of sago flour-enriched Kadaknath nuggets showed decreased trends as the level of incorporation increased from control to T-3, but all these attributes were above the acceptable limits of sensory scores.

Table 4. Sensory attributes of sago flour incorporated low fat sausage developed from Kadaknath chicken (Mean±SE)

Parameters	C	T-1	T-2	T-3
General appearance	6.42^{a}±0.08	6.49^{ab}±0.11	6.53^{ab}±0.06	6.72^{b}±0.07
Flavour	6.90^{b}±0.05	6.85^{b}±0.05	6.82^{b}±0.06	6.61^{a}±0.07
Texture	6.42^{ab}±0.09	6.35^{ab}±0.03	6.63^{b}±0.05	6.18^{a}±0.13
Mouth coating	6.69±0.10	6.64±0.11	6.61±0.19	6.49±0.09
Juiciness	6.73±0.11	6.85±0.08	6.88±0.08	6.73±0.07
Overall acceptability	7.09^{ab}±0.09	6.99^{ab}±0.16	7.10^{b}±0.10	6.76^{a}±0.12

C (Control): Kadaknath chicken sausage without sago flour; T-1: Kadaknath chicken sausage with 2% sago flour; T-2: Kadaknath chicken sausage with 4% sago flour; T-3: Kadaknath chicken sausage with 6% sago flour. Different superscripts row wise differ significantly (P<0.05) (n= 21)

DISCUSSION

Physico-chemical properties: The physico-chemical properties indicated (Table 2) that pH was higher in cooked chicken sausage, and the mean score increased significantly (P<0.05) from control to T-3. It may be attributed to the concentration of components coagulation and deamination of proteins in the cooked product during cooking (Badole *et al.*, 2021). Our findings are in accordance with the results of Gorachiya *et al.* (2021) in finger millet flour incorporation in chicken sausage. The emulsion stability mean score showed an increasing value from control to T-3 with increasing levels of sago flour. However, the difference was non-significant (P>0.05). The denser nature of the protein gel network allows more water to increase the sago flour and increase the water holding capacity (Ayadi *et al.*, 2009). Similar findings were reported by Nayak and Pathak (2016) in carrageenan incorporated chevon patties and Badole *et al.* (2021) in low fat chicken patties incorporated with gaur gum.

The cooking yield was significantly (P<0.05) increased from control to T-2, and then a non-significant difference was noticed between treatment T-2 and T-3. This may be due to the increased moisture content of added sago flour (Mason, 2018). A similar pattern was observed by Chappalwar *et al.* (2021) in lemon albedo incorporated in added chicken patties. The moisture increased non-significantly (P>0.05) from control to T-1, and then a non-significant increasing trend was noticed from treatment T-1 to T-3. This may be due to the greater moisture retention ability of products made with sago flour (Mason, 2018). Protein content differed non-significantly (P>0.05) between all treatments of sago flour added low fat Kadaknath chicken sausage. This may be because it contains a similar amount of meat, which is the only major contributor of protein in the product. Ikhlas *et al.* (2011) also found similar results with different flour incorporated in different meat products. A significantly (P<0.05) higher value of fat content in control as compared to sago flour incorporated Kadaknath chicken sausage was observed. However, in between treatment groups of sago flour incorporated Kadaknath chicken sausage, the difference was non-significant (P>0.05). This is because there is a significant difference in the formulation of low fat Kadaknath chicken sausage, since they contained only 4% added fat as compared to 8% as in control. Similar results were also reported by Nayak and Pathak (2018), who attempted to develop low-fat chevon patties. Yadav *et al.* (2018) also reported low fat content in chicken sausage as well as wheat bran and dried carrot pomace. Ash content of sago flour added Kadaknath chicken sausage did not differ significantly (P>0.05). However, significantly lower mean values were observed in the control compared to the treatment. Badole *et al.* (2021) observed similar results of ash content in guar gum added Kadaknath chicken patties. Moisture retention was significantly (P<0.05) lower in control as compared to low fat sago flour incorporated Kadaknath chicken sausage. The marginal improvement with increasing levels of sago flour was also noticed among the treatments, which may be due to the water retention nature of sago flour. Our findings are consistent with those of Nayak and Pathak (2016) in carrageenan incorporated chevon patties and fat retention significantly (P<0.05) increased with the increasing level of sago flour from control to T-2 and thereafter a non-significant (P>0.05) increment was noticed. Its properties make it easier to remove fat from fatty sausage as starch has a good fat-binding nature (Mason, 2018) because of a greater probability of encounter and expansion of fat droplets (Gorachiya *et al.*, 2021). Muthia *et al.* (2012) reported similar findings in duck sausage incorporated with tapioca and sago flour with and without egg white powder.

Uikey *et al.* (2018) also reported similar findings in carrageenan incorporated Kadaknath chicken nuggets.

Instrumental texture profile: The instrumental textural profile of sago flour incorporated functional Kadaknath chicken sausage, as seen in Table 3. A progressive significant (P<0.05) increasing hardness value of sago flour incorporated low fat Kadaknath chicken sausage from control to T-3 was recorded. This may be due to the greater solubility and swelling power of sago flour (Ikhlas *et al.*, 2011). Significant difference in the hardness value was also recorded in low fat chevon patties using poppy seed (Nayak and Pathak, 2017). Springiness was significantly (P<0.05) higher in the control than the sago flour added Kadaknath chicken sausage treatment T-3, however it was comparable up to T-2 with control. Nayak and Pathak (2018) reported a similar trend in chevon patties. Yadav *et al.* (2018) reported that adding wheat bran and dried carrot pomace to chicken sausage. Mean values of cohesiveness indicated non-significant (P>0.05) decreases from control to T-3. Zaini *et al.* (2020) also reported a decrease in the association of chicken sausage with added banana peel powder incorporated was also reported by gumminess, and the chewiness value increased significantly (P<0.05) from control to incorporated sago flour in Kadaknath chicken sausage. Chatterjee *et al.* (2019) reported a similar trend with incorporated tapioca flour in chicken breast meat patties.

Sensory evaluation: Sensory attributes of sago flour incorporated low fat sausage developed from Kadaknath is listed in Table 4. General appearance differed significantly (P<0.05) between control and treatment T-3, whereas it was comparable to treatment T-2 with control. These results agreed with the findings of Nurlela *et al.* (2018) on chicken nuggets mixed with sago flour. The flavor scores of T-1 and T-2 were compared with the control, but the score of T-3 was significantly (P<0.05) lower. This may be due to its higher sago flour content and distinct taste. These findings are in accordance with Swastike *et al.* (2020), which incorporated tapioca and beetroot in chicken sausage. A significant (P<0.05) difference in the texture value of sago flour incorporated Kadaknath chicken sausage was recorded as higher for T-2 was noticed that was significantly (P<0.05) higher as compare to T-3. This may be due to good fat mimicking properties of sago flour at particular level. Abdolghafour and Saghir (2014) reported that the addition of sago flour in chicken sausage resulted in higher scores for texture. There was no significant difference (P>0.05) between mouth coating and juiciness control score and the sago flour incorporated low fat Kadaknath chicken sausage. Nayak *et al.* (2022) also reported similar findings in carrageenan incorporated Kadaknath chicken nuggets. Overall acceptability showed a significant (P<0.05) variation among different sago flour incorporated low fat Kadaknath chicken sausage. However, T-2 received the highest score and was compared with the control. This may be due to the additive effect of other sensory properties (Chauhan *et al.*, 2018). These findings are consistent with observations recorded by addition of sago flour in chevon patties (Nayak and Pathak, 2018).

The most acceptable low-fat Kadaknath chicken sausage is prepared by mixing 4% sago flour by reducing 50% of added fat and cooking at 90°C for 30 minutes. There was no adverse effect on the physicochemical and texture properties as well as sensory properties of low fat Kadaknath sausage developed with 4% of sago flour. The sensory panel rated either higher or comparable scores for this functional product. Hence, it is concluded that sago flour may be considered as excellent fat replacer and can suitably be used to replace added fat development of low fat Kadaknath chicken sausage.

Conflict of interest: Authors have no conflict of interest regarding the present research work.

Author's contribution: DP: Conceptualization, resource, methodology, analysis; NK: Conceptualization, validation, resource; PC: Conceptualization, methodology, drafting, editing; MG: Analysis, drafting and editing.

Data availability statement: The data which has been generated during research will be available from the corresponding author on reasonable request.

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