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Research Article

STORAGE STABILITY OF HIGH FIBRE: LOW FAT KADAKNATH CHICKEN NUGGETS UNDER REFRIGERATION

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Abstract- The nuggets were developed to increase the functional value of products with increasing fibre and decreasing the fat content. Gram hulls and carrageenan were used in different combination and finally nuggets with 6% gram hulls and 0.5 % carrageenan was found superior and most acceptable by the sensory panelists, hence, selected for further storage stability under refrigeration. The pH, TBA and FFA values of developed high fibre-low fat kadaknath chicken nuggets were lower as compared to control throughout the storage period. A progressive and significant (P<0.05) increment in the pH, TBA and FFA values of control as well as developed kadaknath chicken nuggets were observed with the advancement of storage. The total plate count (TPC) followed a significantly (P<0.05) increasing pattern from 0 to 12 day in control as well as developed high fibre-low fat kadaknath chicken nuggets. Psychrotrophs were detected on 12 day of storage. The mean scores for all the sensory attributes for both control as well as developed high fibre-low fat kadaknath chicken nuggets decreased gradually with increasing storage period. From the study it was concluded that the developed high fibre- low fat kadaknath chicken nuggets may be considered as health full product which was very well accepted up to 12 day under refrigeration.

Keywords- *Kadaknath, storage study, functional nuggets, sensory attributes*

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Introduction

Kadaknath is only black meat chicken (B.M.C.) breed of India. It is a native bird of Madhya Pradesh, reared mainly by the tribal communities of Jhabua which is adjacent to Indore (Malwa region). The bird is very popular locally mainly due to its adaptability to the local environment, disease resistance, tasty meat quality, texture and flavor. Growing understanding of the relationship between diet and health is leading to new insights into the effect of food ingredients on physiological function and health, inducing increased consumer demand for healthy, nutritious foods with additional health promoting functions. Most research into meat-based functional foods has been confined to animal production or technological strategies for increasing the presence of healthy compounds [1-3]. A diet high in fibre usually advocates a healthier life-style and fibre intake can be viewed as a marker of healthy diet [4]. On the other hand, meat as such does not contain any dietary fibre. Moreover, meat and its products are considered harmful for health due to their high saturated fatty acid and cholesterol content. Image of meat as a healthy food has diminished in recent years which can be improved by incorporating plant based dietary fibre. Hence, there is a need for using suitable ingredient which is able to replace fat without affecting quality. Generally, low-fat meat and chicken products have generated a variety of strategies for reducing fat, but the final goal has been to reduce fat with retaining traditional full-fat flavor, taste and texture. So, by taking all these considerations, the present study was aimed to develop and to assess the storage stability under refrigeration offibre enriched low fat kadaknath chicken nuggets.

Material and methods

Meat and additives

Kadaknath chicken of 4-5 months age where be procured from Department of Poultry Science of the college, slaughtered according to traditional halal method. The meat was, packed in low-density polyethylene (LDPE) bags and brought to the laboratory within 20 min. The meat was deboned, trimmed-off separable fat and connective tissue. The samples were kept for conditioning in a refrigerator at 4 ± 1°C for 6–8 h and then frozen at -18°C till further use. The samples were used after partial thawing for 15 h at 4°C. Various Flours, condiments (onion, ginger, and garlic), oil, salt, gram hulls were purchased from standard shop of local market. The composition of spice mix is given in Table 01. The ingredients in desired ratio were procured from local market, dried at 45±2°C for 2 hours followed by grinding and sieving through 100 mesh. The spice mix was stored in low density polyethylene bags and used as per requirement. All the chemicals and media used in the study were of analytical grade and obtained from standard firm.

Table-1 Composition of spice mix

SN	Name of ingredients	Percentage of mix. (w/w)
1	Anise	10
2	Black pepper	5
3	Capsicum	10
4	Caraway	10
5	Cardamom	4
6	Cloves	2
7	Cinnamon	4
8	Cumin	20
9	Dry ginger	10
10	Turmeric	10
11	Coriander	15

Processing

The common salt, vegetable oil, refined wheat flour (maida), sodium tripolyphosphate, spice mixture and condiment mix were added to weighed meat according to formulation.

Meat emulsion for patties was prepared in Bowl Chopper [MOD C 15 2.8G 4.0 HP, Marsango, Italy]. Minced meat was blended with salt and sodium tripolyphosphate for 1.5 minute. Adequate care was taken to keep the end point temperature below 18°C by preparing the emulsion in cool hours of morning, by addition of meat and other ingredients in chilled/partially thawed form and by addition of crushed ice or ice water. The emulsion were prepared in two different groups as per given formulation [Table-2]. Kadaknath Chicken meat was partially thawed overnight, cut into small cubes and double minced in an electrolux mincer. Pre-weighed quantity of minced chicken meat, salt\salt blends, sodium tripolyphosphate, and sodium nitrite were added and chopped for about 2-3 minutes. It was again chopped for 2 minutes after the addition of ice flakes. Refined vegetable oil was slowly incorporated while chopping till it was completely dispersed in the better. Condiments paste, dry spices mix and refined flour were added. Chopping was continued till uniform dispersion of all the ingredients and desired consistency of the emulsion was achieved. Weighed quantity of emulsion was taken and fills in stainless steel mould. Mould was covered with lid and tied with thread and steam cooked for 35 minutes. Kadaknath chicken meat blocks so obtained were sliced and cut into pieces to get nuggets. The nuggets were packed in low-density polyethylene pouches and stored at refrigerated temperature (4±1ºC).

Table-2 Formulation for control and functional (high fibre-low fat kadaknath) chicken nuggets

SN	Ingredients	Control	Functional
1	Meat (%)	75	69
2	Carrageenan (%)	0	0.5
3	Gram Hull (%)	0	6
4	Refined Flour (%)	4	4
5	Vegetable oil (%)	5	2.5
6	Condiments (%)	5	5
7	Ice – Flakes (%)	7	9
8	Spices (%)	2	2
9	Salt (%)	1.6	1.6
10	STPP (%)	0.4	0.4

Packaging materials

Low density Polyethylene (LDPE) bags of 250-gauge thickness were sourced from local market for packaging and were pre-sterilized by exposing to U.V. light for 30 minutes before use.

Physicochemical Analysis

Prior to measurement, pH meter was calibrated every time as per the manufacturer's instructions using known buffers of pH 7.0 and 4.01. Reading was taken twice for each sample and average of reading was taken as pH of sample.TBA value was estimated as per procedure given [5]. Free fatty acid value was determined by the prescribed method [6].

Microbiological analysis: (Total Plate Count, Psychrotropic count, Coliform count and Yeast & Mould Count): Samples was prepared and analyzed [7].

Sensory evaluation

An experienced sensory panel consisting of seven scientists and post-graduate students of the university evaluated the sensory characteristics of the warmed product viz., appearance, flavour, juiciness, texture, mouth coating and overall acceptability using 8-point objective scale where 8 denoted extremely desirable and 1 denoted extremely undesirable [8].

Statistical analysis

The data obtained in the study on various parameters were statistically analyzed on 'SPSS-16.0' software package as per standard method. Data were subjected to one way analysis of variance, homogeneity test and Duncan's Multiple Range Test (DMRT) for comparing the means to find the effects between samples [9].

Results

Physico- chemical parameters

The mean pH, TBA, and FFA values for control and high fibre low fat kadaknath nuggets during storage at 3 days regular interval are presented in [Table-3]. The recorded mean pH value for control kadaknath chicken nuggets on day 0 and 12 were6.18±0.01 and 6.38±0.01 whereas for high fibre low fat kadaknath nuggets were 6.12±0.08 and 6.28±0.01 respectively. The pH values differed significantly ($P<0.05$) during storage period. The observed mean TBA value for control kadaknath chicken nuggets on day 0 and 12 were0.486±0.015 and 0.952±0.009 whereas for high fibre low fat kadaknath nuggets were 0.448±0.008, and 0.842±0.006 respectively. The TBA values differed significantly ($P<0.05$) during storage period. The estimated mean FFA value for control kadaknath chicken nuggets on day 0 and 12 were0.200±0.005 and 0.630±0.009 whereas for high fibre low fat kadaknath nuggets were 0.160±0.005 and 0.533±0.011 respectively. The FFA values differed significantly ($P<0.05$) during storage period.

Microbiological analysis

The mean Total plate count, Psychrotropic count, Coliform count and Yeast & Mold count for control and high fibre and low fat kadaknath chicken nuggets during storage at 3 days regular interval are presented in [Table-4]. The recorded mean total plate count value for control kadaknath chicken nuggets on day 0 and 12 were 2.62 ±0.16 and 4.78±0.16 whereas for high fibre low fat kadaknath nuggets were 2.52±0.13 and 4.64±0.06 respectively. The psychrotropic as well as yeast & mold counts for control and developed high fibre low fat kadaknath chicken nuggets were not observed till 9th day of storage. However, counts on 12 days were 1.30±0.02 and 1.29±0.01 for psychrotropic and 1.20±0.04 and 1.67±0.03 for yeast & mold for control and high fibre low fat kadaknath nuggets respectively.

Sensory Evaluation

The mean general appearance, flavor, texture, juiciness, mouth coating, saltiness and overall acceptability for control and high fibre-low fat kadaknath nuggets during storage at 3 days regular interval are presented in [Table-5]. The recorded mean general appearance value for control kadaknath chicken nuggets on day 0 and 12 were6.80±0.14 and 6.44±0.10 whereas for high fibre low fat kadaknath nuggets were 6.80±0.14 and 6.42±0.10 respectively. The general appearance values differed significantly ($P<0.05$) during storage period. The recorded mean flavor value for control kadaknath chicken nuggets on day 0 and 12 were7.04±0.12 and 5.03±0.16 whereas for high fibre low fat kadaknath nuggets were 7.04±0.12 and 5.09±0.22 respectively. The flavor values differed significantly ($P<0.05$) during storage period. The recorded mean juiciness value for control kadaknath chicken nuggets on day 0 and 12 were 6.90±0.14 and 5.89±0.10 whereas for high fibre low fat kadaknath nuggets were 7.00±0.13 and 6.04±0.17 respectively. The juiciness values differed significantly ($P<0.05$) during storage period. The recorded mean mouth coating value for control kadaknath chicken nuggets on day 0 and 12 were 6.71±0.12 and 5.78±0.16 whereas for high fibre low fat kadaknath nuggets were 6.85±0.14 and 6.00±0.15 respectively. The mouth coating values differed significantly ($P<0.05$) during storage period. The recorded mean texture value for control kadaknath chicken nuggets on day 0 and 12 were6.95±0.12 and 5.08±0.15 whereas for high fibre low fat kadaknath nuggets were 6.95±0.12 and 5.16±0.16 respectively. The texture values differed significantly ($P<0.05$) during storage period. The recorded mean saltiness value for control kadaknath chicken nuggets on day 0 and 12 were6.85±0.14 and 6.65±0.11 whereas for high fibre low fat kadaknath nuggets were 6.85±0.14 and 6.65±0.11 respectively. The saltiness values differed significantly ($P<0.05$) during storage period. The recorded mean overall acceptability value for control kadaknath chicken nuggets on day 0 and 12 were6.95±0.12 and 5.02±0.12 whereas for high fibre low fat kadaknath nuggets were 6.95±0.12 and 5.09±0.11 respectively. The overall acceptability values differed significantly ($P<0.05$) during storage period.

Discussion

Physico-chemical properties

The mean pH, TBA and FFA values with their standard error of control and developed high fibre-low fat kadaknath chicken nuggets during storage (Day 0,3,6,9 and 12) are presented in [Table-2]. The pH of developed high fibre-low fat kadaknath chicken nuggets was lower as compared to control throughout the storage period.

Table-3 Effect of refrigerated storage (4 ±1°C) on the pH, TBA and FFA values of high fibre-low fat kadaknath chicken nuggets

Treatment	Storage days				
	0	3	6	9	12
pH					
Control	6.183±0.011^{a}	6.240±0.016^{b}	6.320±0.010^{c}	6.400±0.014^{c}	6.383±0.015^{c}
Treatment	6.120±0.081^{a}	6.181±0.013^{a}	6.233±0.012^{b}	6.308±0.014^{b}	6.288±0.012^{b}
TBA (mg meloneledehyde/kg)					
Control	0.486±0.015^{a}	0.538±0.013^{b}	0.610±0.011^{c}	0.726±0.010^{d}	0.952±0.009^{e}
Treatment	0.448±0.008^{a}	0.490±0.005^{b}	0.566±0.017^{c}	0.630±0.005^{d}	0.842±0.006^{e}
FFA (% oleic acid)					
Control	0.200±0.005^{a}	0.310±0.005^{b}	0.390±0.005^{c}	0.493±0.007^{d}	0.630±0.009^{e}
Treatment	0.160±0.005^{a}	0.250±0.005^{b}	0.320±0.008^{c}	0.408±0.010^{d}	0.533±0.011^{e}

Means bearing different superscripts (a, b, c, d ...) in a row differ significantly (P<0.05)

Table-4 Effect of refrigerated storage (4±1°C) on the microbial count of high fibre-low fat kadaknath chicken nuggets

Treatment	Storage days				
	0	3	6	9	12
Total Plate Count (cfu/gm)					
Control	2.62±0.16^{a}	2.81±0.11^{b}	3.14±0.17^{c}	3.95±0.13^{d}	4.78±0.16^{e}
Treatment	2.52±0.13^{a}	2.68±0.08^{a}	2.96±0.21^{b}	3.74±0.14^{c}	4.64±0.06^{d}
Psychrotropic count (cfu/gm)					
Control	NotDetected	Not detected	Not detected	Not detected	1.30±0.02
Treatment	NotDetected	Not detected	Not detected	Not detected	1.29± 0.01
Coliform count (cfu/gm)					
Control	Not detected	Not detected	Not detected	Not detected	Not detected
Treatment	Not detected	Not detected	Not detected	Not detected	Not detected
Yeast & Mold count (cfu/gm)					
Control	NotDetected	Not detected	Not detected	Not detected	1.20±0.04
Treatment	Not detected	Not detected	Not detected	Not detected	1.67±0.03

Means bearing different superscripts (a, b, c, d ...) in a row differ significantly (P<0.05)

Table-5 Effect of refrigerated storage (4±1°C) on the sensory attributes of high fibre-low fat kadaknath chicken nuggets

Treatment	Storage days				
	0	3	6	9	12
General appearance					
Control	6.80±0.14^{b}	6.71±0.10^{b}	6.52±0.13^{ab}	6.42±0.11^{ab}	6.44 ±0.10^{a}
Treatment	6.80±0.14^{b}	6.71±0.10^{b}	6.85±0.10^{ab}	6.61±0.10^{ab}	6.42± 0.10^{a}
Flavor					
Control	7.04 ± 0.12^{c}	7.00 ±0.11^{c}	6.85±0.07^{bc}	6.52± 0.11^{b}	5.03±0.16^{a}
Treatment	7.04 ±0.12^{c}	7.00 ±0.11^{c}	6.80±0.14^{bc}	6.71± 0.10^{b}	5.09±0.22^{a}
Juiciness					
Control	6.90 ±0.14^{c}	6.61 ±0.10^{c}	6.71±0.13^{c}	6.34± 0.11^{b}	5.89±0.10^{a}
Treatment	7.00 ±0.13^{c}	6.90 ±0.13^{c}	6.71±0.17^{c}	6.33± 0.17^{b}	6.04±0.17^{a}
Mouth coating					
Control	6.71 ± 0.12^{c}	6.57±0.11^{bc}	6.38±0.12^{b}	6.08±0.14^{ab}	5.78±0.16^{a}
Treatment	6.85 ± 0.14^{c}	6.71±0.10^{bc}	6.57±0.13^{b}	6.08±0.14^{ab}	6.00±0.15^{a}
Texture					
Control	6.95 ± 0.12^{c}	6.61±0.20^{bc}	6.38±0.16^{b}	6.14± 0.14^{b}	6.08±0.15^{a}
Treatment	6.95 ± 0.12^{c}	6.66±0.18^{bc}	6.23±0.18^{b}	6.23± 0.15^{b}	5.86±0.16^{a}
Saltiness					
Control	6.85 ± 0.14	6.76 ± 0.16	6.61 ± 0.17	6.66 ± 0.10	6.65± 0.11
Treatment	6.85 ± 0.14	6.90 ± 0.11	6.76 ± 0.16	6.23 ± 0.14	6.65±0.11
Overall acceptability					
Control	6.95±0.12^{c}	6.85±0.14^{bc}	6.57± 0.11^{b}	6.33± 0.10^{b}	5.52±0.12^{a}
Treatment	6.95±0.12^{c}	7.00±0.11^{bc}	6.71±0.10^{b}	6.52± 0.11^{b}	5.69±0.11^{a}

Means bearing different superscripts (a, b, c, d ...) in a row differ significantly (P<0.05)

The pH value of control as well as developed high fibre-low fat kadaknath chicken nuggets increased significantly (P<0.05) with the advancement of storage period. However, developed kadaknath chicken nuggets showed no significant (P>0.05) difference between 0 and 3 days of storage. Thereafter, increased gradually and showed significantly (P<0.05) difference on 6th day. However, on 12th day of storage slight decrease in the pH value was observed. Such decline in pH might be due to the action of psychrotrophic bacteria which ferment carbohydrate present in the ingredients used in the formulation of the product. The subsequent increment in the pH value was due to the liberation of metabolites from the bacterial activities as the microbial load enhance with the storage period. Similar findings were also reported by other worker also noticed increasing in pH during storage of different meat products [10-11]. TBA values measures secondary lipid oxidation products such as aldehydes, carbonyls and hydrocarbons, which causes off aromas in meat [12]. The TBA value for control product was non-significantly (P>0.05) lower as compared to developed high fibre-low fat kadaknath chicken nuggets throughout the entire storage. A progressive and significant (P<0.05) increment in the TBA values of control as well as developed high fibre-low fat kadaknath chicken nuggets were observed with the advancement of storage. This could be due to increased lipid oxidation and production of volatile metabolites in the presence of oxygen during aerobic storage. Other worker also reported progressive increase in lipid oxidation during storage period. Our findings agree with the research findings of Nayak and coworker in chicken meat nuggets; and by other researcher in restructured sorghum incorporated chicken meat blocks and in chicken meat balls respectively [13-15]. FFA values are a measure of hydrolytic rancidity in food. FFA is the product of microbial or enzymatic degradation of lipids and determination of FFA gives information about stability of fat during storage.

FFA values of developed high fibre-low fat kadaknath chicken nuggets were observed lower compared to control on each day of storage. However, with the advancement of storage period the FFA value showed linear significantly ($P<0.05$) increasing trend from 0 to 12 day of refrigeration storage. These finding are in accordance with findings other scientist in chicken meat star [16-17].

Microbiological analysis

The mean Total plate count, Psychrotrophic count, Coliform count and Yeast and Mold count with their standard error of control and developed high fibre-low fat kadaknath chicken nuggets during storage (Day 0,3,6,9 and 12) are presented in [Table-4]. The total plate count (TPC) followed a significantly ($P<0.05$) increasing pattern from 0 to 12 day in control as well as developed high fibre-low fat kadaknath chicken nuggets. However, TPC did not differ significantly ($P>0.05$) between control and treatment with the progress of storage period. It could be due to incorporation of gram hulls in kadaknath chicken nuggets which could have provided easy carbohydrate substrate for microbial growth. Increasing trend with the advancement of storage period was also reported by other researcher in other meat products [18]. Psychrotrophic counts were not detected upto 9 day of storage either in control and/or developed high fibre-low fat kadaknath chicken nuggets. This could be due to destruction of psychrotrops during cooking. These counts were detected on 12 day of storage in both control and developed high fibre-low fat kadaknath chicken nuggets. This might be due to recovery of injured organism and then multiplication during subsequent period of storage. The count remained within the permissible limit of log 4.6 CFU/gm [19]. Coliform were not detected during the entire period of storage in both control as well as developed high fibre-low fat kadaknath chicken nuggets. The absence of coliform is due to their destruction during cooking above their death point of 57°C. Further hygienic practices followed during and after preparation of product. Similar results of zero count of coliform were also reported [20]. Yeast and Mold count was detected only on 12 day of storage. This might be due to absence of favorable condition (like humid climate for the growth of yeast and mold during the experiment). Results in chicken nuggets also reported similar findings [21].

Sensory Evaluation

The mean scores for general appearance, flavor, texture, mouth coating, saltiness, juiciness and overall acceptability with their standard error for control and developed high fibre-low fat kadaknath chicken nuggets during storage (Day 0,3,6,9 and 12) are presented in [Table-5]. The score for general appearance did not have any significant ($P>0.05$) difference between control and developed high fibre-low fat kadaknath chicken nuggets on all storage days. The higher score for high fibre-low fat kadaknath chicken nuggets as compare to control was noticed in the last phase of storage. The mean score for general appearance of both control and developed high fibre-low fat kadaknath chicken nuggets decreased gradually with increasing in storage period. Similar results were reported in chicken patties [22]. Mean flavor score between control and developed high fibre-low fat kadaknath chicken nuggets did not differ significantly ($P>0.05$) throughout the storage. However, on subsequent storage significant ($P<0.05$) difference was noticed from 9th day onwards. The pattern was similar for control as well as developed kadaknath chicken nuggets. The progressive decrease in flavor could be correlated to some increase in TBA value of meat product. Other worker also reported decrease in flavor score [23]. No significant ($P>0.05$) difference in the score of juiciness between control and developed high fibre-low fat kadaknath chicken nuggets was recorded during the storage. The score presented in table showed linear increasing trend from 0 to 12 day under refrigeration storage in developed high fibre-low fat kadaknath chicken nuggets as well as in control. A significant ($P<0.05$) difference was noticed from 9th day in either of the product. No significant ($P>0.05$) difference in the score of mouth coating between control and developed high fibre-low fat kadaknath chicken nuggets was recorded during the storage. However, the scores for high fibre-low fat kadaknath chicken nuggets were recorded higher as compared to control on each day of storage. Further, with the advancement of the storage from 6th day a significant ($P<0.05$) difference was observed in both control as well as developed high fibre-low fat kadaknath chicken nuggets. The decrease in mouth coating scores might be due to lipid and protein oxidation during storage. No significant ($P>0.05$) difference in the score of texture between control and developed kadaknath chicken nuggets was recorded during the storage. Further, with the advancement of storage period from 6th day, the scores were decreased significantly ($P<0.05$). The gradual decrease in texture might be due to breakdown of meat protein. The decreasing trend in texture score during storage under refrigeration in meat products were also reported in tofu incorporated chicken meat patties [24]. The score for saltiness did not have significant ($P>0.05$) difference between control and developed kadaknath chicken nuggets on all storage days. Subsequently with the advancement in storage period no significant ($P>0.05$) difference was recorded in either of the product throughout the storage period. The mean overall acceptability score differs non-significantly ($P>0.05$) between control and developed high fibre-low fat kadaknath chicken nuggets throughout the storage. With the subsequent storage the scores were gradually decreased and showed significant ($P<0.05$) difference from 6th day of storage. It might be due to synergistic effect of increasing pH and microbial load in respective treatment during the storage. The developed product was very well adopted up to 12 day under refrigeration (4±1°C). However, thereafter sensory panelists rejected the acceptability of product. Moreover, lipid oxidation product and production of ammonia from protein breakdown by microbes may lead to production of off flavor might be probable cause of poor acceptability of the product by the sensory panelists beyond 12 days. This observation indicated that microbial count and rancidity level as well as sensory attributes remained well below the permissible level and product was stable up to 12 days of storage under refrigeration (4±1°C).

Conclusion

Based on the research findings and corresponding discussion, 6% gram hulls with 0.5% carrageenan incorporated kadaknath chicken nuggets was selected for storage study. Further, observation indicated that microbial count and rancidity level as well as sensory attributes remained well below the permissible level during the study. Hence, it is concluded that developed functional fibre enrich low fat kadaknath chicken nuggets was stable up to 12 days of storage under refrigeration(4±1°C).

Application of research: It may be applicable in food industry for the development of functional meat products

Research Category: Meat quality, meat microbiology

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Sample Collection: Kadaknath chicken of 4-5 months age procured from Department of Poultry Science, slaughtered according to traditional halal method

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