J Krishi Vigyan 2022, 11 (1) : 137-145 DOI : 10.5958/2349-4433.2022.00121.0

Evaluation of Aerobically Packaged Fibre Enriched Low Fat Kadaknath Chicken Patties under Refrigeration Storage

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ABSTRACT

The fibre enriched low fat kadaknath chicken patties were packaged aerobically and evaluated for storage stability under refrigeration. The pH, TBA and FFA values of treated patties were lower as compared to control throughout the storage. A progressive and significant ($P<0.05$) increment in the pH, TBA and FFA values of control as well as fibre enriched low fat kadaknath chicken patties were observed with the advancement of storage in aerobically kadaknath chicken patties. The total plate count (TPC) followed a significantly ($P<0.05$) increasing pattern from 0 to 12 day in aerobic packaging in control as well as fibre enriched low fat kadaknath chicken patties. The psychotropic counts as well as Yeast and Mold count under aerobic packaging were not detected up to 9 day of storage either in control or in fibre enriched low fat kadaknath chicken patties and these were detected on 12 day of storage. The coliform were not detected during the entire period of storage in aerobic packaging. Sensory attributes under storage study did not have any significant ($P>0.05$) difference between control and fibre enriched low fat kadaknath chicken patties on all storage days of aerobic packaging. The mean scores for all the sensory attributes for both control as well as fibre enriched low fat kadaknath chicken patties decreased gradually with increasing storage period. From the study it was concluded that the fibre enriched low fat kadaknath chicken patties may be considered as health full product which was very well stable and accepted up to 12 day in aerobic packaging under refrigeration.

Key Words: Aerobic, Chicken patties, Fibre, Low fat, Packaging, Kadaknath meat.

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. The bird is very popular locally mainly due to its adaptability to the local environment, disease resistance, tasty meat quality, texture and flavour, also of medicinal value. Meat is an important source of protein and essential nutrients including iron, zinc, vitamin B12 and folic acid. However, a sector of the population perceives meat as a food that is detrimental to their health because it contains high levels of saturated fat and little or no fiber. Epidemiological studies have also associated meat consumption with cardiovascular diseases (CVD) and colon cancer (Chan and Giovannucci, 2010).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 need to address consumer needs and also to update the nutritional and dietary goals. A diet high in fibre usually advocates a healthier life-style and fibre intake can be viewed as a marker of healthy diet. On the other hand, meat as such does not contain any dietary fibre. For adults, the recommended acceptable intakes of dietary fiber are 28–36 g/d must be insoluble fibre. Apart from acting as an

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integral fraction of diet, dietary fibre performs many functions in meat products, *viz.,* improvement in yield, desirable processing attributes, fat reduction and texture modification etc. Thus, the inclusion of fibre in meat products helps in improving processing and technological functionality with proven health benefits for consumers. Black gram belongs to the Leguminosae family and widely used in different parts of the world. Protein content in black gram and its fractions ranged from 12 to 42%, while fat content ranged from 0.9 to 3.4%. Seed coat had the highest (78.5%) dietary fibre content (Girish *et al*, 2012).

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. Reduction of fat in comminuted meat products results in rubbery and dry textured products and poses difficulties in terms of flavor and texture. Hence, there is a need for using suitable ingredient 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).Guar gum imparts a slick creamy mouth feel to meat products, which mimics fat and is being used in low fat reformulated meat products (Pearson and Gillett, 1997).Several scientists throughout the globe have explored the possibility to increase fibre and reducing fat content to develop healthier and/or functional meat products. However, there is a wide gap in research and development of such products in Indian subcontinent.

MATERIALS AND METHODS

Source of Raw Material

Kadaknath chicken of 4-5 months age were be procured from Department of Poultry Science. The chicken was slaughtered as per scientific method. Meat was packed in low-density polyethylene 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^{o}C for 6–8 h and then frozen at -18^{o}C till further use. The samples were used after partial thawing for 15 h at 4^{o}C.

Other ingredients

Ingredients like Spice mix, black gram, Guar gum used in the study were procured from standard firm and local market as per availability and requirement of the study. All the chemicals and microbiological mediaused in the study were of analytical grade and procured from Hi Media laboratories (P) Ltd, Mumbai.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.

Preparation of kadaknath chicken patties

Kadaknath Chicken meat was partially thawed overnight, cut into small cubes and double minced in an electrolux mincer. Meat emulsion was prepared in a bowl chopper (Seydelmann K20,Ras,Germany). Pre-weighed quantity of minced chicken meat, salt, sodium tripolyphosphate 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 given patties shape. Then patties were cooked in hot air oven at 180^{0}Cfor 12 minutes and 4 minutes after turning.

On the basis of physico-chemical, microbiological properties and sensory attributes, the selected variants of fibre-enriched low fat kadaknath chicken patties were used for the study. The product was aerobically and vacuum packaged separately in LDPE films & stored under refrigeration. The sample were evaluated for changes

in physicochemical, microbiological properties and sensory attributes from 0 day at 3 days of regular interval in aerobically packaged and from 0 day at 7 day of interval of vacuum packaged till spoilage for following parameters: pH, Thiobarbuturic acid value, free fatty acid value, microbiological quality (Total plate count, Psychrotropic count, Coliform count along with yeast and molds count) and sensory evaluation.

Table 1. Formulation for control and treatment (fiber enriched-low fat kadaknath)chicken patties.

Ingredients	C	T
Meat (%)	75.0	69.0
Guar gum (%)	00	1.0
Gram Hull (%)	0.0	6.0
Refined Flour (%)	4.0	4.0
Vegetable oil (%)	6.0	3.0
Ice – Flakes (%)	7.0	9.5
Condiments (%)	3.8	3.8
Spices (%)	2.0	2.0
Salt (%)	1.8	1.8
STPP (%)	0.4	0.4
Total	100	100

Whereas, C (Control)- Kadaknath chicken patties without treatment, T (Treatment) - Kadaknath chicken patties with 1.0% guar gum and 6.0% gram hull.

Analytical procedure

The physico-chemical pH, The TBA value was estimated as per procedure given by Tarladgis *et al* (1960). Free fatty acid value was determined by modified AOCS method (Koniecko, 1979).The sensory attributes, the selected variants of fibre-enriched low fat kadaknath chicken patties were used for the study.

Physico- chemical parameters

Microbiological analysis

The samples were prepared according to APHA (1992). The microbiological properties under aerobic packaging were evaluated with the Total Plate count, Psychotropic count, Coli form count, Yeast & mold was determined as per the procedure described in APHA (1992) using Nutrient agar with some modifications.

Sensory evaluation

The sensory quality of samples was evaluated by using 8 point descriptive scale (Keeton, 1983) 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.

The data obtained in the study on various parameters were statistically analyzed on 'SPSS-16.0' software package as per standard methods of Snedecor and Cochran (1995).

RESULTS AND DISCUSSION

Based on the observations from different physicochemical, textural profile and sensory attributes, finally patties containing 6 % black gram hull and 1% guar gum were selected for storage studies. The patties without any black gram hull and fat replacer served as control. The patties were stored in LDPE pouches under aerobic conditions at refrigeration temperature (4±1°C) and were assessed for different physicochemical, microbiological and sensory attributes regularly (Day 0, 3, 6, 9, and 12) till incipient spoilage was evident. The following abbreviations were used for the present study C (control) kadaknath chicken patties without any addition, T (treatment) kadaknath chicken patties with 6 % black gram hull and 1.0% guar gum.

Physico-chemical parameters

The mean pH, TBA, and FFA values for control and fibre enriched low fat kadaknath chicken patties during storage at 3 days regular interval are presented in Table 2. No significant difference (P>0.05) between control and fibre enriched

Table 2. Effect of refrigerated storage (4 ± 1^0 C) on the pH, TBA and FFA values (Mean±SE) of aerobically packaged fibre enriched low fat kadaknath chicken patties.

Treatment	Storage days				
	0	3	6	9	12
PH					
Control	6.22±0.04^{a}	6.30±0.02^{ab}	6.35±0.04^{b}	6.41±0.05^{b}	6.40±0.03^{b}
Treatment	6.27±0.03^{a}	6.31±0.01^{a}	6.34±0.05^{ab}	6.40±0.03^{b}	6.41±0.02^{b}
TBA (mg malonaldehyde/kg)					
Control	0.460±0.06^{a}	0.537±0.07^{ab}	0.605±0.14^{b}	0.705±0.06^{b}	0.942±0.13^{c}
Treatment	0.434±0.13^{a}	0.483±0.05^{ab}	0.562±0.04^{b}	0.638±0.14^{b}	0.844±0.23^{c}
FFA (% oleic acid)					
Control	0.212±0.006^{a}	0.423±0.007^{b}	0.483±0.004^{c}	0.623±0.003^{d}	0.851±0.01^{e}
Treatment	0.200±0.008^{a}	0.390±0.005^{b}	0.434±0.004^{c}	0.586±0.002^{d}	0.807±0.012^{e}

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

low fat kadaknath chicken patties was recorded throughout storage period. The pH value of control as well as fibre enriched low fat kadaknath chicken patties increased significantly (P<0.05) with the advancement of storage period. However, the rate in the pH increment with storage in low fat fibre enriched kadaknath chicken patties compare to control. The pH value increased gradually and become significant from 6th day in control and from 9th day in treatment. Further the rate of increment in the pH becomes slightly decreased. 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. Uikey *et al* (2018) also noticed increasing in pH during storage in Kadaknath meat nuggets.

TBA values measures secondary lipid oxidation products such as aldehydes, carbonyls and hydrocarbons, which causes off aromas in meat (Chauhan *et al,* 2021). The TBA value for control product was non-significantly (P>0.05) lower as compared to fibre enriched low fat kadaknath chicken patties throughout the storage. A significant (P<0.05) increment in the TBA values of control as well as fibre enriched low fat kadaknath chicken patties was 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 were in agreement with the research findings of Nayak *et al* (2014) in chicken meat nuggets and Malav *et al* (2013) in restructured sorghum incorporated chicken meat blocks.

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 (Das *et al,* 2008, Badole *et al,* 2019). FFA values of fibre enriched low fat kadaknath chicken patties 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. Nayak *et al* (2014)

Table 3. Effect of refrigerated storage (4±1^{0}C) on the microbial count (Mean±SE) of aerobically packaged fibre enriched low fat kadaknath chicken patties.

Treatment	Storage days				
	0	3	6	9	12
Total plate count (cfu/gm)					
Control	2.68±0.16^a	2.81±0.11^a	3.57±0.17^b	4.24±0.13^c	4.82±0.16^d
Treatment	2.68±0.13^a	2.84±0.08^a	3.63±0.21^b	4.35±0.14^c	4.90±0.16^d
Psychotropic count (cfu/gm)					
Control	ND	ND	ND	ND	1.54±0.02
Treatment	ND	ND	ND	ND	1.46±0.01
Coli form count (cfu/gm)					
Control	ND	ND	ND	ND	ND
Treatment	ND	ND	ND	ND	ND
Yeast & mold (cfu/gm)					
Control	ND	ND	ND	ND	1.32±0.04
Treatment	ND	ND	ND	ND	1.46±0.03

* ND= Not Detected

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

and Chauhan *et al* (2018) also reported increasing FFA value with the advancement of storage period in different meat products.

Microbiological analysis

The mean Total plate count, Psychotropic count, Coliform count and Yeast & Mold count for control and fibre enriched low fat kadaknath chicken patties during storage at 3 days regular interval in aerobically packaged were presented in Table 3.The total plate count (TPC) followed a significantly (P<0.05) increasing pattern from 0 to 12 day in control as well as fibre enriched low fat kadaknath chicken patties. The TPC values for treatment were remains higher as compare to control on each storage day. However, the difference was non-significance. It could be due to incorporation of black gram hull in kadaknath chicken patties which could have provided easy carbohydrate substrate for microbial growth. Increasing trend with the advancement of storage period was also reported by other researcher Goswami *et al* (2015); Nayak *et al* (2014) and Uikey *et al* (2018) in various meat products. Psychrotrophic counts were not detected up to 9th day of storage either in control and/or in fibre enriched low fat kadaknath chicken patties. This could be due to destruction of psychrotrops during cooking. These counts were detected on 12 day of storage in both control and fibre enriched low fat kadaknath chicken patties. 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 in cooked meat products. These finding related are in accordance with observation taken by Uikey *et al* (2018) during aerobic storage.

Coliform were not detected during the entire period of storage in both control as well as fibre enriched low fat kadaknath chicken patties. The absence of coliform was due to their destruction during cooking above their death point of 57^0 C. Further hygienic practices followed during and after preparation of product. Similar results of zero count of coliform were also reported by Uikey *et al* (2018) in chicken nuggets. 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.

Sensory evaluation

The mean general appearance, flavor, texture, juiciness, mouth coating, saltiness and overall acceptability for control and fibre enriched low fat kadaknath patties during storage at 3 days regular interval in aerobically packaged were presented in Table 5 and depicted in figure.The score for general appearance did not have any significant (P>0.05) difference between control and fibre enriched low fat kadaknath chicken patties on all storage days. The higher score for fibre enriched low fat kadaknath chicken patties as compare to control was noticed in the last phase of storage. The mean score for general appearance of both control and fibre enriched low fat kadaknath chicken patties decreased gradually with increasing in storage period. Mean flavor score between control and fibre enriched low fat kadaknath chicken patties did not differ significantly (P>0.05) throughout the storage. However, on subsequent storage significant (P<0.05) difference was noticed from 9^{th} day onwards. The pattern was similar for control as well as for fibre enriched low fat kadaknath chicken patties. The progressive decrease in flavor could be correlated to some increase in TBA value of meat product (Tarladgis, 1960). No significant (P>0.05) difference in the score of texture between control and fibre enriched low fat kadaknath chicken patties was recorded during the storage. Further, with the advancement of storage period from 9^{th} 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 by Nayak *et al* (2014) in chicken patties and Uikey *et al* (2018) in kadaknath chicken nuggets.The score for saltiness did not have significant (P>0.05) difference between control and kadaknath chicken patties 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.No significant (P>0.05) difference in the score of juiciness between control and fibre enriched low fat kadaknath chicken patties was recorded during the storage. The score presented in table showed linear decreasing trend from 0 to 12 day under refrigeration storage in fibre enriched low fat kadaknath chicken patties as well as in control. A significant (P<0.05) difference was noticed from 9^{th} day in either of the product. Malav *et al* (2013) also reported the decreasing value of juiciness with the advancement of storage in chicken meat blocks extended with sorghum flour and carrageenan incorporated low fat chicken nuggets, respectively. No significant (P>0.05) difference in the score of mouth coating between control and fibre enriched low fat kadaknath chicken patties was recorded during the storage. However, the scores for fibre enriched low fat kadaknath chicken patties were recorded higher as compared to control on each day of storage. Further, with the advancement of the storage from 6^{th} day a significant (P<0.05) difference was observed in both control as well as fibre enriched low fat kadaknath chicken patties. The mean overall acceptability score differ non-significantly (P>0.05) between control and fibre enriched low fat kadaknath chicken patties throughout the storage. With the subsequent storage the scores were gradually decreased and showed significant (P<0.05) difference from 9^{th} day of storage. It might be due to synergistic effect of increasing pH and microbial load in respective treatment during the storage. Similar observation of decreasing overall acceptability scores with increasing storage were

Table 5. Effect of refrigerated storage (4±1^{0}C) on the sensory attributes (Mean±SE) of aerobically packaged fibre enriched low fat kadaknath chicken patties

Treatment	Storage days				
	0	3	6	9	12
General appearance					
Control	6.95±0.14^{b}	6.90±0.10^{b}	6.71±0.13^{ab}	6.42±0.11^{ab}	6.09±0.10^{a}
Treatment	6.95±0.14^{b}	6.90±0.10^{b}	6.80±0.10^{ab}	6.52±0.10^{ab}	6.28±0.10^{a}
Flavor					
Control	7.14±0.12^{c}	7.09±0.11^{c}	6.85±0.07^{bc}	6.52±0.11^{b}	5.66±0.16^{a}
Treatment	7.14±0.12^{c}	7.09±0.11^{c}	6.95±0.14^{bc}	6.76±0.10^{b}	5.95±0.22^{a}
Texture					
Control	6.90±0.12^{c}	6.85±0.20^{bc}	6.61±0.16^{b}	6.33±0.14^{b}	5.71±0.15^{a}
Treatment	6.90±0.12^{c}	6.90±0.18^{bc}	6.57±0.18^{b}	6.38±0.15^{b}	5.71±0.16^{a}
Saltiness					
Control	7.04±0.14	6.95±0.16	6.95±0.17	6.85±0.10	6.80±0.11
Treatment	7.09±0.14	6.90±0.11	6.95±0.16	6.90±0.14	6.76±0.11
juiciness					
Control	7.09±0.14^{c}	6.95±0.10^{c}	6.71±0.13^{c}	6.09±0.11^{b}	5.52±0.10^{a}
Treatment	7.04±0.13^{c}	6.95±0.13^{c}	6.71±0.17^{c}	6.28±0.17^{b}	5.66±0.17^{a}
Mouth coating					
Control	6.73±0.12^{c}	6.66±0.11^{bc}	6.38±0.12^{b}	6.14±0.14^{ab}	5.76±0.16^{a}
Treatment	7.04±0.14^{c}	6.71±0.10^{bc}	6.42±0.13^{b}	6.19±0.14^{ab}	5.80±0.15^{a}
Overall acceptability					
Control	7.09±0.12^{c}	7.02±0.14^{bc}	6.73±0.11^{b}	6.38±0.10^{b}	5.76±0.12^{a}
Treatment	7.14±0.12^{c}	7.04±0.11^{bc}	6.80±0.10^{b}	6.42±0.11^{b}	5.80±0.11^{a}

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

reported by Chander lekha *et al* (2012); Nayak *et al* (2014); Uikey *et al* (2018) in different meat products. The fibre enriched low fat kadaknath chicken patties was very well accepted up to 12 day under refrigeration (4±1^{o}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

The patties were packaged aerobically and evaluated for storage stability under refrigeration. Based on the observations from different physicochemical, textural profile and sensory attributes, finally patties containing 6 % black gram hulls and 1% guar gum were selected for refrigeration temperature (4±1°C) storage in LDPE pouches under aerobic conditions studies at regular interval Day 0, 3, 6, 9, and 12 till incipient spoilage was evident. The pH value of control as well as fibre enriched low fat kadaknath chicken patties increased significantly ($P<0.05$) with the advancement of storage period. The TBA and FFA values for control product were non-significantly ($P>0.05$) lower as compared to fibre enriched low fat kadaknath chicken patties throughout the storage. The total plate count (TPC) followed a significantly ($P<0.05$) increasing pattern from 0 to 12 day in control as well as fibre enriched low fat kadaknath chicken patties. However, TPC did not differ significantly ($P>0.05$) between control and treatment with the progress of storage period. Psychrotropic counts as well as Yeast and Mold count were not detected upto 9 day of storage either in control and/or fibre enriched low fat kadaknath chicken patties, were detected on 12 day of storage. Coliform were not detected during the entire period of storage in both. Sensory analysis under storage study indicated that scores for general appearance, flavor, texture, juiciness, mouth coating and overall acceptability did not have any significant ($P>0.05$) difference between control and fibre enriched low fat kadaknath chicken patties on all storage days. The higher score for fibre enriched low fat kadaknath chicken patties as compare to control was noticed in the last phase of storage with decreased gradually with increasing in storage period. 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).

ACKNOWLEDGEMENT

Authors are thankful to honorable Vice-Chancellor (NDVSU) and MPCOST Bhopal for providing financial assistance for the research.

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Received on 30/6/2022 *Accepted on 22/8/2022*