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Shelf life of Low Sodium-Antioxidant Rich *Kadaknath* Chicken Patties

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ABSTRACT

The study was carried out with the objective of increasing antioxidant and reducing sodium content by incorporating different levels of salt replacer (Potassium chloride, cinnamon extract and mushroom extract) and pomegranate rind extract, respectively. Patties with 1.2% NaCl, 0.8% KCl and 3% pomegranate rind extract was found suitable and most acceptable by the sensory panelists, selected for further storage study under refrigeration. TBA, FFA value and microbial count of developed low sodium-antioxidant rich Kadaknath chicken patties were lower as compared to control throughout the storage. A progressive and significant ($P<0.05$) increment in the TBA and FFA values of control as well as developed low sodium-antioxidant rich Kadaknath chicken patties was observed with the advancement of storage period. The total plate count (TPC) followed a significantly ($P<0.05$) increasing pattern from 0 to 12 d in aerobic packaging in control as well as functional Kadaknath chicken patties. Psychotropic count was not detected up to 4th day of storage either in control or in low sodium-antioxidant rich Kadaknath chicken patties but detected from 8th day of storage. Yeast and Mold were not detected up to 8th day of storage either in control or in functional Kadaknath chicken patties and it was detected on 12th day of storage. Coliform were not detected during the entire period of storage. The observation indicated that microbial count as well as sensory attributes remained well below the permissible level and product was stable up to 12 days of storage under refrigeration (4±1ºC).

Key Words: Antioxidant, Low Sodium, Storage,Pomegranate Rind Extract, Salt.

INTRODUCTION

Kadaknath is the only grayish black meat breed of India. It is local breed of Jhabua and district Dhar of western Madhya Pradesh, reared by 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 flavor. Meat is an important source of protein and essential nutrients including Iron, Zinc, Vitamin B12 and Folic acid (Schonfeldt and Gibson, 2008). Epidemiological studies have also associated meat consumption with cardiovascular diseases and colon cancer (Chan and Giovannucci, 2010). Lipid oxidation is of great concern to the consumer because it causes physical and chemical deterioration of food quality and formation of potentially harmful components including free radicals and reactive aldehydes (Conde *et al*, 2011). The meat industry is actively seeking natural solutions to minimize oxidative rancidity and increase products shelf-life. Pomegranate (*Punica granatum*) is considered as a rich source of phenolic compounds (Khajehei *et al*, 2015). Interest in greater use of pomegranate rind extract has been stimulated since its high antioxidant potency was reported (Naveena *et al*, 2008).

Meat as such is relatively poor in sodium, containing only 50–90 mg of sodium per 100 g. But the addition of sodium chloride, which contains about 40% sodium, enhances the sodium content of meat and meat products significantly during processing. High intake of dietary sodium increases the risks of various diseases such as hypertension

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and cardiovascular diseases (Chrysant, 2016). Potassium chloride is the most common salt substitute used in low salt meat products, but at a higher concentration can confer a bitter taste to the product. (Gou *et al*, 1996; Colmenero *et al*, 2005; Desmond, 2006; Guardia *et al*, 2008; Horita *et al*, 2011; Canto *et al*, 2014). Using spice mixture is a promising alternative to improve the quality of meat products when replacement of sodium chloride with potassium chloride is done. Since, they can give a spicy flavour and different aroma, spice mixture can suppress or diminish the sensory effects caused by use of potassium chloride. Looking to the facts and current global demand of the consumer, the present study was undertaken.

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MATERIALS AND METHODS

Meat and additives

Kadaknath chicken of 5-6 months of age for the experiment was procured from the department of Poultry Science of the college. 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 ℃ for 6–8 hr and then frozen at -18^0 ℃ till further use. The samples were used after partial thawing for 15 hour at 4^0 ℃. 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 1. The ingredients in desired ratio were procured from local market, dried at 45±2°C for 2 hr 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.

Processing of product

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 2.8 G 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 180°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. 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 batter. 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 molded in to patties shape. Then patties

Table 1. Composition of spice mix.

Sr. No.	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
Total		100

Table 2. Formulation for control and functional (low sodium-antioxidant rich) Kadaknath chicken patties.

Ingredient	Control	Functional
Meat (%)	70.0	70.0
Refined wheat flour (%)	3.0	3.0
Vegetable oil (%)	10.0	8.0
Condiments (%)	2.5	2.5
Ice – Flakes (%)	10.0	9.0
Spices (%)	2.0	2.0
Nacl (%)	2.0	1.2
Kcl (%)	0	0.8
Mushroom extract (%)	0	0
Cinnamon extract (%)	0	0
Pomegranate rind extract	0.0	3.0
STPP (%)	0.5	0.5
Total (%)	100	100

were cooked in hot air oven at 180°c for 12 minutes and 4 minutes after turning. Patties were cooled at room temperature and vacuum packed in low-density polyethylene pouches and stored under refrigerated (4±1ºC).

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 by Tarladgis *et al* (1960). Free fatty acid value was determined by the prescribed method (Koniecko, 1979). Microbiological analysis (Total Plate Count, Psychrotropic count, Coliform count and Yeast & Mould Count) samples were prepared and analyzed as per A.P.H.A (1992).

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, saltiness, mouth coating and overall acceptability using 8-point objective scale where 8 denoted extremely desirable and 1 denoted extremely undesirable (Keeton, 1983).

Statistical analysis

The data 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 (Snedecor and Cochran, 1994).

RESULTS AND DISCUSSION

Physico-chemical parameters

The mean pH, TBA, and FFA values for control and low sodium-antioxidant rich Kadaknath chicken patties during storage at 4 d regular interval are presented in Table 3. The pH value of control as well as low sodium-antioxidant rich 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 sodium antioxidant-rich Kadaknath chicken patties was comparable to control. The pH value increased gradually and became significant from 8th day in control and treatment. Further the rate of increment in the pH became 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 enhanced with the storage period. Radha Krishnan *et al* (2014) in raw chicken meat incorporated with spice extracts and Badole *et al* (2019) in functional Kadaknath chicken patties also noticed increase in pH during storage.

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Table 3. Effect of refrigerated storage (4 ± 10 C) on the pH, TBA and FFA values of aerobically packaged control and functional Kadaknath chicken patties

Treatment	Storage days			
	0	4	8	12
pH				
Control	6.25±0.02[a]	6.34±0.03[ab]	6.37±0.02[b]	6.33±0.03[b]
Treatment	5.99±0.01[a]	6.03±0.04[ab]	6.27±0.02[b]	6.23±0.02[b]
TBA (mg malonaldehyde/kg)				
Control	0.506±0.006[a]	0.646±0.018[b]	0.851±0.014[c]	0.979±0.013[d]
Treatment	0.381±0.004[a]	0.482±0.007[b]	0.608±0.009[c]	0.675±0.008[d]
FFA (% oleic acid)				
Control	0.367±0.004[a]	0.473±0.001[b]	0.672±0.016[c]	0.735±0.014[d]
Treatment	0.291±0.003[a]	0.354±0.003[b]	0.486±0.012[c]	0.519±0.005[d]

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

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TBA values measures secondary lipid oxidation products such as aldehydes, carbonyls and hydrocarbons, which causes off aromas in meat (Teets *et al,* 2008; Nayak and Chauhan, 2022). The TBA value for control product was significantly (P<0.05) higher as compared to low sodium-antioxidant rich Kadaknath chicken patties throughout the storage. A progressive and significant (P<0.05) increment in the TBA values of control as well as low sodium-antioxidant rich Kadaknath chicken patties 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. Nayak and Pathak (2018) also reported similar findings in noni incorporated low sodium chevon patties.

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; Chauhan and Nayak, 2022). FFA values of low sodium-antioxidant rich Kadaknath chicken patties were observed lower as 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. Manjhi *et al* (2018) also reported increasing FFA value with the advancement of storage period in chevon meat ball incorporated with tea polyphenol and grape seed extract.

Microbiological analysis

The total plate count (TPC) followed a significantly (P<0.05) increasing pattern from 0 to 12 day in control as well as low sodium-antioxidant rich Kadaknath chicken patties. The TPC values for treatment were lower as compared to control on each storage day. It might be due to the inhibitory effect of bioactive and phenolic compounds present in pomegranate peel and its extract that may have resulted in significantly (P<0.05) lower TPC in treated patties in comparison to control at the end of storage. Increasing trend with the advancement of storage period was also reported by Dashti *et al* (2015) in thyme essential oil incorporated chicken nuggets. Psychrotrophic counts were not detected up to 4th day of storage either in control and/or in low sodium-antioxidant rich Kadaknath chicken patties. This could be due to destruction of psychrotrophs during cooking. These counts were detected on

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8th day of storage in both control and low sodium-antioxidant rich 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/g as reported by Creamer and Chipley (1977) in cooked meat products. Coliform were not detected during the entire period of storage in both control as well as low sodium-antioxidant rich Kadaknath chicken patties. The absence of coliform is 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 Shukla *et al* (2019) in chicken patties with edible coating of chitosan. Yeast and Mold count was detected only on 12th 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). Goswami *et al* (2015) and Langroodi *et al* (2018) also reported similar results in various meat products.

Sensory evaluation

The mean scores for general appearance, flavor, texture, mouth coating, saltiness, juiciness and overall acceptability of low sodium-antioxidant rich Kadaknath chicken patties during storage at 4 days regular interval are presented in Table 5. The score for general appearance did not have any significant (P>0.05) difference between control and low sodium-antioxidant rich *Kadaknath* chicken patties on all storage days. The higher score for low sodium-antioxidant rich *Kadaknath* chicken patties as compared to control was noticed in the last phase of storage. The mean score for general appearance of both control and low sodium-antioxidant rich Kadaknath chicken patties decreased gradually with advancement of storage. Similar result was also reported by Lorenzo *et al.* (2014) in foal steaks incorporated with green tea extract. Mean flavor score between control and low sodium-antioxidant rich Kadaknath chicken patties did not differ significantly (P>0.05) throughout the storage. However, following storage slight difference was noticed from 8th day onwards. The pattern was

Table 04. Effect of refrigerated storage (4 ± 10 C) on the microbial count of aerobically packaged control and functional Kadaknath chicken patties

Treatment	Storage days			
	0	4	8	12
Total plate count (cfu/gm)				
Control	2.56±0.01[a]	3.45±0.01[b]	4.24±0.03[c]	4.76±0.02[d]
Treatment	2.18±0.04[a]	2.52±0.03[b]	3.21±0.01[c]	3.83±0.01[d]
Psychrotrophic count (cfu/gm)				
Control	ND	ND	1.32±0.02	2.10±0.04
Treatment	ND	ND	1.25±0.03	2.01±0.03
Coliform count (cfu/gm)				
Control	ND	ND	ND	ND
Treatment	ND	ND	ND	ND
Yeast & mold count (cfu/gm)				
Control	ND	ND	ND	1.77±0.04
Treatment	ND	ND	ND	1.31±0.04

Means bearing different superscripts (a, b, c, d…) in a row differ significantly (P<0.05). * ND= Not Detected

similar for control as well as for low sodium-antioxidant rich *Kadaknath* chicken patties. The progressive decrease in flavor could be correlated to some increase in TBA value of meat product (Tarladgis *et al,* 1960). Jayawardana *et al* (2019) also reported decrease in flavor score in pork sausages incorporated with black and green tea extract.

No significant (P>0.05) difference in the score of texture between control and low sodium-antioxidant rich *Kadaknath* chicken patties was recorded during the storage. Further, with the advancement of storage period from 8th day, the scores was 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 Radha Krishnan *et al* (2014) in raw chicken meat incorporated with spice extracts and Uikey *et al.* (2018) in kadaknath chicken nuggets incorporated with carrageenan and black gram hull. Mean mouth coating score between control and low sodium-antioxidant rich *Kadaknath* chicken patties did not differ significantly (P>0.05) throughout the storage. However, with the advancement of storage the mean score for control and treatment were decreased significantly (P<0.05). Similar trend was also reported by Rodrigues *et al* (2020) in

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Table 5. Effect of refrigerated storage (4 ± 10 C) on the sensory attributes of aerobically Packaged control and functional Kadaknath chicken patties.

Treatment	Storage days			
	0	4	8	12
General appearance				
Control	6.88±0.03^{b}	6.79±0.02^{b}	6.71±0.03^{b}	5.94±0.09^{a}
Treatment	6.91±0.05^{b}	6.87±0.04^{b}	6.75±0.04^{b}	6.05±0.08^{a}
Flavour				
Control	6.86±0.03^{c}	6.67±0.04^{b}	6.61±0.04^{b}	5.99±0.07^{a}
Treatment	6.91±0.04^{c}	6.78±0.03^{b}	6.72±0.03^{b}	6.11±0.07^{a}
Texture				
Control	6.97±0.05^{c}	6.60±0.07^{b}	6.51±0.07^{b}	5.79±0.04^{a}
Treatment	7.04±0.03^{c}	6.65±0.05^{b}	6.57±0.05^{b}	5.95±0.03^{a}
Mouth coating				
Control	6.93±0.05^{c}	6.62±0.04^{b}	6.52±0.08^{b}	5.91±0.06^{a}
Treatment	7.19±0.03^{c}	6.66±0.05^{b}	6.55±0.06^{b}	5.96±0.06^{a}
Saltiness				
Control	6.85±0.07^{c}	6.58±0.04^{b}	6.55±0.05^{b}	5.98±0.05^{a}
Treatment	7.21±0.08^{c}	6.75±0.04^{b}	6.60±0.03^{b}	5.93±0.06^{a}
Juiciness				
Control	6.94±0.09^{c}	6.76±0.07^{b}	6.64±0.03^{b}	5.98±0.05^{a}
Treatment	7.08±0.02^{c}	6.72±0.05^{b}	6.62±0.05^{b}	5.91±0.07^{a}
Overall acceptability				
Control	6.87±0.08^{c}	6.69±0.02^{b}	6.63±0.03^{b}	5.88±0.05^{a}
Treatment	7.09±0.04^{c}	6.82±0.05^{b}	6.76±0.06^{b}	6.06±0.05^{a}

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

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sausages incorporated with banana inflorescences extract. The score for saltiness did not show significant (P>0.05) difference between control and low sodium-antioxidant rich *Kadaknath* chicken patties on all storage days. However, with the advancement in storage period the scores for saltiness were decreased significantly (P<0.05) from 0 to 12th day of storage. The trend was observed in both control as well as treatment. No significant (P>0.05) difference in the score of juiciness between control and low sodium-antioxidant rich *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 low sodium-antioxidant rich *Kadaknath* chicken patties as well as in control. Fernandes *et al* (2018) in sheep sausages incorporated with oregano extract also reported the decreasing value of juiciness with the advancement of storage. The mean overall acceptability score differed non-significantly (P>0.05) between control and low sodium-antioxidant rich *Kadaknath* chicken patties throughout the storage. With the subsequent storage the scores were gradually decreased and showed significant (P<0.05) difference from 8th 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 was reported by Nayak and Pathak (2021) in low sodium functional chevon patties.

The low sodium-antioxidant rich *Kadaknath* chicken patties were acceptable 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

The study was carried out with the objective of increasing antioxidant and reducing sodium content by incorporating different levels of salt replacer (Potassium chloride, cinnamon extract and mushroom extract) and pomegranate rind extract. Patties with 1.2% NaCl, 0.8% KCl and 3% pomegranate rind extract was found suitable and most acceptable by the sensory panelists. The physico-chemical quality of treated samples were better, whereas TBA, FFA value and microbial count of developed low sodium-antioxidant rich *Kadaknath* chicken patties were lower as compared to control throughout the storage. A progressive and significant (P<0.05) increment in the TBA and FFA values of control as well as developed low sodium-antioxidant rich *Kadaknath* chicken patties was observed with the advancement of storage. The observation indicated that microbial count 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).

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