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ORIGINAL ARTICLE

Effects of incorporation of ground mustard on quality attributes of chicken nuggets

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Abstract Chicken nuggets were prepared from spent hen meat using ground mustard as phyto-preservative without impairing the sensory attributes of the product and also the antioxidant and antimicrobial efficacy of mustard on keeping quality of the product was assessed. The emulsion stability (%), cooking yield (%) and moisture content (%) of the product containing ground mustard differed significantly ($p \leq 0.05$) from the control. Nuggets containing ground mustard maintained significantly ($p \leq 0.05$) higher sensory scores throughout the storage period (at 4±1 °C for 15 days). The pH as well as thiobarbituric acid value increased significantly ($p \leq 0.05$) with advancement of storage period. Ground mustard maintained significantly lower thiobarbituric acid values throughout the observation period than the control. Microbiological studies revealed significant increase in total plate count and lipolytic count with the length of storage period. Microbial counts were found to be significantly ($p \leq 0.05$) higher in control than in nuggets containing ground mustard.

Keywords Mustard · Phyto-preservative · Chicken nuggets · Storage stability

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Introduction

Today's consumers demand foods with high nutritional value that are free from chemical preservatives and are microbiologically safe. Therefore, more emphasis is being laid on bio- and phyto-preservatives i.e., use of natural preservatives either alone or in combination with other methods. Spices in the form of powder, extract or essential oils to check growth of many spoilage bacteria and fungi in food have been well documented (Meena and Sethi 1997; Subbulakshmi and Naik 2002; Rajkumar and Berwal 2003). Mustard (*Brassica campestris* L.) has been consumed by humans as a condiment. The original use of mustard was to mask the taste of degraded perishables. When mustard seeds are crushed and exposed to liquids, an enzyme called myrosinase hydrolyses glucosinolates to release isothiocyanates. The isothiocyanates are responsible for its antibacterial, antifungal and antiprotozoal activities of mustard oil (Cui 1997). The mode of action of isothiocyanates is not well known but inhibition of oxygen uptake in yeast, alteration of proteins and inactivation of intracellular enzymes have been reported (Delaquis and Mazza 1995). Kanemaru and Miyamoto (1990) found that mustard extract and allyl isothiocyanate increased the lag phase of several bacteria.

Chicken nugget is a comminuted meat product, which offers an alternative avenue for better utilization of spent hen meat. The present investigation was undertaken to

evaluate the effect of incorporating ground mustard on physico-chemical, sensory and storage stability of chicken nuggets prepared from spent hen meat.

Materials and methods

The spent hens were procured from Instructional Poultry Farm of the University. The birds were slaughtered, dressed, manually de-boned, packed in low density polyethylene (LDPE) bags and stored overnight at 4±1 °C in refrigerator. The ingredients of spice mix were procured from local market, cleaned and dried in oven at 50 °C for 2 h; ground and sieved through 100 mesh and fine powder obtained was used. The condiment mix contained onion, garlic and ginger prepared afresh in 4:2:1 ratio as fine paste. Yellow mustard (*Brassica campestris* L.) seeds were procured from the Department of Genetics and Plant Breeding of the university. The seeds were cleaned and ground to fine powder and stored in air-tight containers at room temperature (24±2 °C). Refined soybean oil, refined wheat flour, table salt, sugar, skim milk powder and eggs were procured from local market.

Preparation of chicken nuggets Meat was cut into small pieces and ground twice in a meat mincer (Hobart®, USA) with 5 mm plate followed by 3 mm plate. Emulsion of each formulation was prepared using Bowl chopper (Hobart®, USA). All the nuggets formulations consisted of spent hen meat 60%, vegetable oil 10%, ice flakes 10%, refined wheat flour 2.5%, skim milk powder 2%, whole egg liquid 5%, table salt 2%, sugar 1%, sodium tri-polyphosphate (STPP) 0.25%, condiments 5%, spices mix 1.5% and sodium nitrite 150 ppm. The prepared emulsion was tightly packed in oil coated metallic mold fitted with lids and steam cooked for 45 min at 5 lb pressure. Subsequently the cooked product was cooled, weighed and removed carefully from the mould. The meat block thus obtained was sliced and cut into pieces (4×1.5×1.5 cm). The nuggets were packed aerobically in sterilized LDPE bags and stored at refrigerated temperature (4±1 °C) for analysis.

Optimization of ground mustard The meat emulsion for control product consisted of basic formulation given above without test ingredient. Ground mustard was added to the above formulation at 1, 1.5 and 2% (w/w) levels of meat emulsion. The preliminary trials were conducted to access the best level of incorporation of ground mustard into chicken nuggets on the basis of sensory evaluation by semi-trained sensory panel of 11 panelists. On the basis of sensory evaluation, chicken nuggets with 1.5% ground mustard were selected for further study.

Physico-chemical characteristics The emulsion stability was determined by the method of Baliga and Madaiah (1970) with minor modifications. The pH value was recorded by using a digital pH meter (ECI Ltd, India) and water activity (a_w) by using water activity meter (Rotronic Hygrolab 3, USA). Thiobarbituric acid (TBA) value (mg malonaldehyde/kg of sample) was estimated as per procedure given by Tarladgis et al. (1960). Moisture, protein, fat and total ash content of chicken nuggets were determined following AOAC (1984) procedures. Total plate count (TPC), lipolytic count, coliform count and yeast and mold counts were enumerated by following APHA (1992) methods. The sensory quality of samples was evaluated using 8-point Hedonic scale (Keeton et al. 1984) using semi-trained 11 panelists.

Storage study Storage study of the product was conducted by keeping the products at 4±1 °C for 15 days. Sensory evaluation, pH, TBA values and microbiological counts were assessed for both control and mustard added product after 5 days interval. Data were recorded and statistically analysed to evaluate the stability of optimized product in comparison to control preparation.

Statistical analysis Statistical analysis of the data was done using ANOVA technique according to the method described by Snedecor and Cochran (1994) on completely randomized design. Average of three replicates was used in calculations.

Results and discussion

Physico-chemical characteristics Table 1 indicates that incorporation of ground mustard in chicken nugget formulation caused significant ($p \leq 0.05$) increase in

Table 1 Effect of addition of mustard on physico-chemical properties of chicken nuggets

	Control	Treatment
Emulsion stability,%	94.4±0.31[b]	96.34±0.22[a]
Cooking yield,%	95.8±0.23[b]	97.4±0.24[a]
a_w	0.972±0.003	0.976±0.002
Moisture,%	62.0±0.19[b]	62.9±0.25[a]
Protein,%	15.3±0.42	15.6±0.37
Fat,%	12.9±0.43	13.1±0.31
Total ash,%	2.8±0.04	2.8±0.04

*Means bearing same or no superscripts row-wise do not differ significantly ($p<0.05$) ($n=3$).

Ground mustard was added in the formulation at 1.5% level (w/w) of meat emulsion.

emulsion stability, cooking yield and moisture content, whereas a_w, protein, fat and total ash contents were marginally increased. Slightly higher values of moisture content of mustard product may be attributed to water absorbing property of ground mustard. Bawa et al. (1988) also reported that mustard flour gave higher ($p \leq 0.05$) emulsion stability in meat emulsion system. The high emulsion stability of mustard product might be due to better emulsifying and water holding capacity of mustard. Similar findings of 10% increase in cooking yield of ground pork was also reported by Saleemi et al. (1993) when they incorporated low pungency ground mustard seed at 2% level in the formulation. The higher cooking yield might be due to presence of mucilage in ground mustard, which can absorb and retain water in the product.

Changes in quality during storage Results presented in Table 2 show that chicken nuggets containing ground mustard scored higher ($p \leq 0.05$) for all sensory parameters than the control throughout the storage period. Mustard nuggets had a yellowish tint. Similar result was observed by Saleemi et al. (1993) in comminuted pork incorporated with low pungency ground mustard. Higher texture scores of mustard nuggets might be due to higher emulsifying and water holding capacity of ground mustard (Bawa et al.

Table 2 Effect of addition of mustard and storage period on quality attributes of chicken nuggets

Treatments	Storage period, days				Treatment mean
	0	5	10	15	
Appearance/Color					
C	6.8±0.15	6.7±0.15	6.0±0.09	4.9±0.25	6.1±0.42[a]
T	7.3±0.14	7.2±0.12	6.9±0.11	5.9±0.21	6.8±0.31[b]
Flavor					
C	6.9±0.12	5.6±0.17	3.7±0.20	3.5±0.09	4.9±0.81[a]
T	7.7±0.06	6.0±0.08	4.4±0.19	4.3±0.22	5.6±0.81[b]
Texture					
C	6.6±0.12	6.5±0.11	6.21±0.08	5.4±0.10	6.2±0.26[a]
T	7.6±0.11	7.5±0.10	7.3±0.10	6.6±0.07	7.3±0.23[b]
Juiciness					
C	6.4±0.08	6.2±0.08	6.0±0.12	5.8±0.12	6.1±0.12[a]
T	7.7±0.10	7.5±0.09	7.2±0.09	7.0±0.08	7.4±0.15[b]
Overall acceptability					
C	7.1±0.13	6.5±0.15	5.3±0.14	4.2±0.08	5.8±0.64[a]
T	7.6±0.10	7.3±0.10	6.2±0.08	6.1±0.05	6.8±0.38[b]
pH					
C	6.1±0.01	6.2±0.01	6.2±0.01	6.3±0.01	6.2±0.03
T	6.1±0.01	6.2±0.01	6.2±0.01	6.2±0.01	6.2±0.03
Thiobarbituric acid number, mg malonaldehyde/kg					
C	0.34±0.00	0.72±0.03	1.1±0.05	1.4±0.04	0.89±0.23[b]
T	0.34±0.00	0.49±0.01	0.69±0.02	0.86±0.03	0.56±0.11[a]
Total plate count, log cfu/g					
C	2.5±0.13	3.4±0.19	4.3±0.15	6.4±0.10	3.9±0.94[b]
T	2.5±0.12	3.0±0.07	3.3±0.10	3.6±0.17	3.1±0.23[a]
Lipolytic count, log cfu/g					
C	2.1±0.14	2.7±0.13	3.2±0.12	3.6±0.10	2.9±0.31[b]
T	2.2±0.25	2.2±0.11	2.3±0.13	2.3±0.14	2.2±0.04[a]
Coliform count, log cfu/g					
C	ND	ND	1.8±0.16	2.5±0.07	1.1±0.65[b]
T	ND	ND	ND	1.5±0.10	0.37±0.37[a]
Yeast and mold count, log cfu/g					
C	ND	ND	1.2±0.06	2.0±0.10	0.81±0.50[b]
T	ND	ND	0.63±0.26	1.2±0.13	0.47±0.23[a]

C Control; *T* Treated

Mean values bearing same or no superscripts column-wise for same parameter (alphabets) do not differ significantly ($p<0.05$) ($n=3$).

Ground mustard was added to the formulation at 1.5% level (w/w) of meat emulsion.

ND Not detectable

1988). Decrease in flavour scores might be due to development of oxidative rancidity and microbial deterioration in products. Significant decrease ($p \leq 0.05$) in juiciness was observed in both the preparations. Biswas et al. (2006) also reported that all the sensory quality values of patties prepared from broiler meat decreased during storage.

A marginal effect of incorporating ground mustard on pH value of the nuggets was observed while a significantly increasing ($p \leq 0.05$) trend was observed in pH on storage (Table 2). The increase in pH value during storage suggests the breakdown of meat protein on storage. The increase in pH during storage of meat was also reported earlier (Yadav and Sanyal 1999). Chicken nuggets containing ground mustard maintained lower ($p \leq 0.05$) TBA values throughout the storage period. Lower TBA values in mustard product were due to the anti-oxidant properties of ground mustard (Saleemi et al. 1993).

An increasing ($p \leq 0.05$) trend in microbial counts was observed in both the preparations during storage (Table 2). Lower ($p \leq 0.05$) microbial counts (TPC, coliforms, lipolytic and yeast and molds) were observed throughout the storage period in chicken nuggets containing ground mustard than in control. This was due to the antimicrobial properties of mustard. The antimicrobial effect of mustard was also reported earlier (Nadarajah et al. 2005; Sekiyama et al. 1996; Cui 1997), which may be due to isothiocyanates of mustard believed to inhibit oxygen uptake in yeast, alter proteins and inactivate intracellular enzymes of microbes (Delaquis and Mazza 1995).

Conclusion

Ground mustard can be used at 1.5% level (w/w) of meat emulsion with beneficial effect on physico-chemical and sensory qualities of chicken nuggets. This product can be stored at refrigeration temperature (4±1 °C) for 15 days in LDPE bags with good acceptability.

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