

Original Research Article

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Quality Characteristics of Chicken Meat Patties with Nutmeg Oil as Natural Preservative

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ABSTRACT

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The antioxidant and antibacterial properties of the nutmeg oil (NMO) were assessed in the present study, and its optimum inclusion level in chicken meat patties as a natural preservative was ascertained. NMO was added to the chicken patties at 0.01%, 0.05% and 0.10% levels. Chicken patties without any addition served as control. Emulsion pH, product pH, emulsion stability, product yield and water activity did not differ significantly among the treatments. DPPH scavenging activity of NMO was significantly highest in 0.10% and lowest in 0.01% treatments. There was no significant difference among the treatments, in the Minimum Inhibitory Zone formed by NMO against the general meat microflora. The sensory scores for flavour and overall acceptability of the chicken patties were significantly ($P < 0.05$) reduced in the 0.10% level whereas the scores of 0.01% and 0.05% treatments were comparable with that of control. In conclusion, it is recommended that NMO might be used as a natural antioxidant in the chicken patties up to 0.05% level.

Introduction

Spices are popular worldwide for their exclusive aroma and the medicinal qualities. Spices are part and parcel of the worldwide cuisine and used from the very ancient times. Apart from the use in food, the spices used in the traditional medicinal methods are well known for their curative properties. The scientific exploration of the spices had started many decades ago and their effects in the food

systems had been vividly studied across the globe. The antibacterial and the antioxidant effects of many spices and their essential oils had well been established and their use as preservatives is now gaining significance. At present, the consumer preference is shifting towards the use of natural foods devoid of chemical ingredients and preservatives. Essential oils from the spices would be the wiser choice to be used as the natural preservatives in most of the foods, especially

meat foods, since meat foods invariably contain the spices and hence would not be viewed by the consumers as an additional preservative ingredient.

The antimicrobial and antioxidant effects of various essential oils from different spices, and their application in different foods had been extensively reviewed (Burt, 2004; Jayasena and Jo, 2013; Kalaikannan *et al.*, 2015; Aminzare *et al.*, 2016 and Maisanaba *et al.*, 2017) and the application of essential oils as preservatives in meat and meat products had been studied (Menon and Garg, 2001; Fernandez-Lopez *et al.*, 2003; Barbosa *et al.*, 2009; Kong *et al.*, 2010; Karami *et al.*, 2011; Ghabraie *et al.*, 2016). The essential oils contain various volatile molecules such as terpenes and terpenoids, phenol-derived aromatic components and aliphatic components and act as prooxidants in eukaryotic cells affecting inner cell membranes and organelles (Bakkali *et al.*, 2008).

Nutmeg (*Myristica fragrans*) is one of the popular spices regularly used in the food preparations for its unique aroma and taste. Preparation and properties of various forms of the nutmeg such as the powder, extract and essential oil had been studied vividly and found to possess antioxidant, antibacterial and antifungal properties (Kahkonen *et al.*, 1999; Kazeem *et al.*, 2012; Assa *et al.*, 2014; Cui *et al.*, 2015; Morsy, 2016). The preservative role of nutmeg preparations in various meat products had been established by various researchers (Al-Jalay *et al.*, 1987; Lin *et al.*, 2016; Nishad *et al.*, 2018) and reviewed comprehensively (Oswell *et al.*, 2018).

Essential oil of nutmeg contains various phenolic compounds and possesses potent antioxidant and antibacterial properties (Shan *et al.*, 2005; Piaru *et al.*, 2012; Lin *et al.*, 2016). Cui *et al.*, (2015) investigated 54

compounds in NMO among which sabinene (39.12%), beta-pinene (10.10%) and alpha-pinene (11.94%) were found as major components which had significant antibacterial activity (Caillet *et al.*, 2009). Incorporation of NMO at 20 ppm in cooked sausages had been recommended for the shelf life extension (Sojic *et al.*, 2015). Galeano *et al.*, (2018) suggested that active films formulated with nutmeg oleoresins could be used in the meat industry to extend the shelf life of bovine loins.

Poultry meat is considered to have low fat content compared to other meats and hence preferred by most consumers for health reasons. Also, due to remarkable growth in broiler enterprise, chicken meat is less priced and economically affordable for most consumers. At present, processed meat products are popular among the meat eating population, for the reasons such as convenience and taste. Considering the storage quality of the chilled meat products, it is imperative to use preservatives for the shelf life extension without affecting the product characteristics. However, nowadays consumers are aware of the ill effects of chemical preservatives and prefer natural alternatives. Hence using essential oils from spices as natural preservatives in meat products might be a better replacement.

Materials and Methods

Raw materials

Broiler chicken meat

Broiler boneless chicken was procured from the department of Livestock Products Technology (Meat Science), Veterinary College and Research Institute, Namakkal. The meat was trimmed of all visible adipose and connective tissues, minced through meat mincer and stored in low-density polyethylene

(LDPE) packaging at $-18\pm 2^{\circ}\text{C}$ for further use. The meat was used for preparation of patties after partial thawing at 4°C for 12 to 15 h.

Patty ingredients

Certified food grade nutmeg oil (NMO) was purchased from M/S Akayflavour and aromatics pvt limited, Kochi. The certificate of analysis for the physico-chemical and microbial qualities of the purchased essential oils were provided by the seller. Commercially available food grade ingredients available in the local market were purchased and used. Chicken meat patties were formulated with the addition of NMO at 0.01 %, 0.05 % and 0.1 % along with a control. The ingredients added other than chicken meat and NMO were maida (3%), oat flour (3%), vegetable oil (5%), salt (2%), spice mix (2.5%), condiment mix (7.5%) and added water (5%). Oat flour was added in the all the formulations in order to reduce the water activity.

Patty preparation

Preparation of meat emulsion

The emulsion was prepared by adding minced meat and other ingredients of the formulation in a sequential order at a specified time interval. During chopping, the temperature of the emulsion was maintained at $10-12^{\circ}\text{C}$ by the addition of slushed ice.

Processing of chicken meat patties

Chicken meat patties were formed by weighing 50 g of meat emulsion, shaped into patties using stainless mould and placed on the vegetable oil smeared stainless steel cooking trays. The patties were cooked in preheated hot air oven at 180°C for 25 minutes. After 15 minutes of heating, the patties were turned upside down and cooked for another 10

minutes so as to attain the internal temperature of $82\pm 1^{\circ}\text{C}$. After attaining the core temperature, the patties were maintained at 100°C for additional 10 minutes. Then the patties were cooled to room temperature, packed and stored for further physico-chemical and sensory evaluation.

Physico-chemical properties

pH

For measuring pH of the emulsion and product, 5 gm of sample was homogenized with 45 ml of distilled water by using tissue homogenizer (Polytron PT 3100, Switzerland) for about 1 minute. The pH of the homogenate was recorded by immersing combined glass electrode and temperature probe of the digital pH meter (Model 361, Systronics, India).

Emulsion stability (ES)

A method of Baliga and Madaiah (1971) as modified by Kondiah *et al.*, (1985) was followed for estimation of ES. 15 g of meat sample was weighed, packed in polyethylene bags and heated at 80°C for 20 minutes in temperature controlled induction stove. Then, the fluid released was drained and the meat sample was weighed. The ES was calculated by the formula

$$Es(\%) = \frac{\text{Weight after heating}}{\text{Raw emulsion weight}} \times 100$$

Product yield

Individual weights of patties before and after cooking were recorded. The product yield was calculated as below

$$\text{Product yield} = \frac{\text{weight of patties after cooking}}{\text{Raw emulsion weight}} \times 100$$

Water activity (a_w)

The water activity (a_w) of the patties was measured by Pawkit water activity meter (Decagon, Devices, USA). About 5 g of the sample was cut into small cubes of 5 mm thickness, then these cubes were half way filled in the sample cups of Pawkit water activity meter and the readings were directly read and reported.

DPPH scavenging activity

Assessment of NMO

DPPH (2,2'-diphenylpicrylhydrazyl) was determined following the procedure of Wu *et.al.* (2003) with slight modifications. The concentration of NMO used were prepared using 95% ethanol as diluents.

From that solution, 0.1 ml was taken, mixed with 5 ml of 0.1 mM DPPH solution, dissolved in 95% ethanol, incubated in darkness for 30 minutes and the absorbance at 517 nm was measured. DPPH scavenging activity was calculated using the following formula

$$\text{DPPH scavenging activity (\%)} = \frac{A_c - A_s}{A_c} \times 100$$

where

A_c is the absorbance of the control (DPPH solution without essential oil/oloeresins)

A_s is the absorbance of the sample

Assessment of NMO in the product

The same procedure as for the assessment of the DPPH scavenging activity of the NMO was followed except for the modification that, 1 gm of cooked meat patties was homogenized with 10 ml of ethanol, and from that homogenate 1 ml was mixed with 5 ml of DPPH solution.

Minimum inhibitory zone

The Kirby Bauer method of zone of inhibition determination as described by Koneman (1997) was followed with slight modifications.

Preparation of inoculums

5 g of raw chicken meat was weighed and macerated with 45 ml of 0.1 % sterile peptone water. 0.1 ml volume was placed on the surface of the agar medium and streaked using sterile L spreader.

The plates were incubated at 30°C for 48 hours. Following incubation, the colony-forming units (CFU) of the total viable organisms which were the commensal organisms of meat were taken by means of sterile swabs and diluted with 10 ml of phosphate buffer. This was used as the inoculum.

Preparation of Petridishes

The plate count agar was prepared and sterilized according to the manufacturer's instructions. (± 25 ml was poured into 90 mm Petri dishes; Agar thickness approximately 4 mm.).

Inoculation of the culture

Using a sterile swab, a suspension of the inoculum was spread evenly over the surface of the sterile agar plates.

Preparation and application of NMO

0.01%, 0.05% and 0.1% dilutions of NMO were prepared using vegetable oil as diluent and the vegetable oil was used as the control. Four wells of 5 mm diameter each were cut in the agar and 0.01 ml (10 μ l) each of the three dilutions of NMO and the control were dispensed in the wells.

Incubation of agar plates

The agar plate was incubated for 24 hours at 37°C and the size of the zone of inhibition was measured.

Sensory evaluation

Semi trained sensory panel consisting of six members from the students and teaching faculty of the college evaluated the products. Samples were evaluated for appearance, flavor, texture, juiciness, spiciness and overall palatability using an 8- point hedonic scales (Keeton, 1983). The evaluation was done around 4.00 PM in the sensory laboratory with suitable illumination. Coded samples were served warm to the panellists. Water was provided for oral rinsing between the samples.

Statistical analysis

The data generated in the present study were subjected to statistical analysis (Snedecor and Cochran, 1995) for analysis of variance, critical difference and Duncan's multiple range test was done for comparing the means. Means and standard error were calculated following the standard statistical procedures. Each experiment was replicated thrice and the samples were analysed in duplicate except for the sensory scores. In significant effects, least significant differences were calculated at appropriate level of significance (0.05) for comparison of treatment means.

Results and Discussion

Physico-chemical characteristics

Emulsion pH and product pH were insignificantly higher in the 0.1% treatment compared to the control (Table 1). This was in accordance with the results of Sojice *et al.*, (2015) where NMO was added to cooked sausages at 10 ppm and 20 ppm levels. In the

assessment of nutmeg extract treated beef, Zakaria *et al.*, (2015) observed that the untreated samples showed the lowest pH values and stated that nutmeg extract could be used to maintain the chemical characteristics of raw beef during storage for three weeks. Application of active films with nutmeg oleoresin in bovine loins increased the meat pH (Galeano *et al.*, 2018). Emulsion stability and water activity did not differ significantly among the treatments. There was an insignificant numerical increase in the product yield with increase in the incorporation levels of NMO in chicken patties. With these results, it could be substantiated that the overall physico-chemical properties of the chicken patties were not affected significantly by the addition of NMO. Hence it is inferred from the findings of this study that at the NMO inclusion levels up to 0.1% in chicken meat patties will not affect the physico-chemical characteristics.

Antioxidant properties

The percent DPPH scavenging activity of NMO observed for 0.01%, 0.05% and 0.1% were 55.26, 59.69 and 61.93 respectively, and in the chicken patties higher activity was observed with the corresponding values of 12.23, 20.58 and 27.71, where the control showed least activity with a value of 11.56% (Table 2). The DPPH scavenging activity values of NMO increased insignificantly with higher concentrations, whereas in the product a significant ($P < 0.05$) increase was noticed with increase in the level of NMO.

It had been shown that the free radical inhibition by the spices occur in the concentration dependent manner (Kazeem *et al.*, 2012). In a similar manner, there was decrease in the peroxide values of bovine loins treated with nutmeg oleoresin active films indicating its antioxidant potential which was dose dependent (Galeano *et al.*, 2018) Sojic *et*

al., (2015) demonstrated that incorporation of NMO at 20 ppm in cooked sausages delayed the lipid oxidation.

Jukic *et al.*, (2006) exploited the high potential of glycosidically bound antioxidant substances in the commercial preparations of nutmeg. The DPPH scavenging activity of the nutmeg oil concurred with the findings of Chatterjee *et al.*, (2007), Houet *et al.*, (2012), Piaru *et al.*, (2012) and Kapoor *et al.*, (2013). Similar to the present findings, Kong *et al.*, (2010) noticed the antioxidant efficacy of nutmeg extract in cooked meat. The antioxidant index of nutmeg was assessed to be 3 when added dry in oil emulsion system which was considered to be higher compared to most other spices (Al-Jalay *et al.*, 1987).

Antibacterial properties

The minimum inhibitory zone was found to be 7.00 mm, 7.00 mm and 8.33 mm for 0.01%, 0.05% and 0.1% of NMO respectively (Table 2). There was an insignificant numerical increase in the minimum inhibitory zone of chicken patties with 0.1% NMO compared to the other two treatments with lower concentrations of NMO. Arief *et al.*, (2017) observed that the minimum inhibitory zone formed by 5% nutmeg essential oil (3.19 cm²) was higher than that formed by 5% nutmeg powder (2.26 cm²). Lin *et al.*, (2016) assessed

that the minimum inhibitory concentration (MIC) value of NMO was 1.0 mg/mL, and minimum bactericidal concentration (MBC) was 2.0 mg/mL for *L.monocytogenes*, while the MIC was 0.5 mg/mL, and MBC was 1.0 mg/mL for *E. coli* and established that NMO had obvious antibacterial activities for both Gram-positive and Gram-negative bacteria. It had been shown that NMO exhibited good antimicrobial activity against *E. coli* and *S. aureus* in pork and therefore, could be regarded as a natural and efficient antiseptic against foodborne pathogens (Cui *et al.*, 2015).

It had been ascertained that the incorporation of NMO at 20 ppm level in cooked sausages delayed the growth of total aerobic mesophilic bacteria (Sojic *et al.*, 2015). Zhang *et al.*, (2009) observed that the inhibition zone formed by NMO against total viable organism was not affected by the concentrations. Bovine loins coated with nutmeg oleoresin active films showed lower microbial counts (Galeano *et al.*, 2018).

Sensory properties

In the sensory evaluation, the scores for appearance, texture, juiciness, mouth coating and overall acceptability did not vary with the addition of NMO in the chicken meat patties (Table 3).

Table.1 Effect of nutmeg oil (NMO) on the physico-chemical characteristics of chicken meat patties

Quality attributes	Control	NMO 0.01%	NMO 0.05%	NO 0.1%	Significance
Emulsion pH	6.09±0.05	6.12±0.05	6.12±0.04	6.13±0.04	NS
Product pH	6.25±0.04	6.27±0.04	6.27±.05	6.28±0.04	NS
Emulsion Stability (%)	96.07±0.28	95.74±0.46	96.65±0.08	96.11±0.29	NS
Product yield (%)	87.17±0.17	89.5±1.04	90.50±2.00	90.00±2.29	NS
Water activity (a _w)	0.936±0.009	0.923±0.009	0.926±0.003	0.920±0.000	NS

NS - Not significant

Table.2 Effect of nutmeg oil (NMO) on antioxidant and antibacterial activity of chicken meat patties

Quality attributes	Control	NMO 0.01%	NMO 0.05%	NO 0.1%	Significance
DPPH scavenging activity of NMO (%)	-	55.26±18.55	59.69±14.40	61.93±12.79	NS
DPPH scavenging activity of NMO in product (%)	11.56±0.43 ^c	12.23±2.33 ^{bc}	20.58±2.81 ^{ab}	27.71±0.81 ^a	**
Minimum Inhibitory Zone (mm)	-	7.00±0.00	7.00±0.58	8.33±0.33	NS

Means bearing different superscripts between columns differ significantly.

** - (P≤0.01)

NS - Not significant

Table.3 Effect of nutmeg oil (NMO) on the organoleptic properties of chicken meat patties

Quality attributes	Control	NMO 0.01%	NMO 0.05%	NO 0.1%	Significance
Appearance score	7.00±0.17	6.75±0.13	6.67±0.19	6.50±0.19	NS
Flavour score	7.00±0.21 ^a	6.33±0.14 ^{ab}	6.67±0.31 ^{ab}	5.92±0.19 ^b	**
Spiciness score	6.25±0.13 ^b	7.00±0.21 ^a	6.00±0.25 ^b	5.92±0.15 ^b	**
Texture score	6.92±0.19	6.92±0.31	6.33±0.28	6.33±0.19	NS
Juiciness score	5.83±0.27	6.42±0.19	6.58±0.19	5.83±0.34	NS
Mouth coating score	6.92±0.15	6.67±0.26	6.50±0.29	6.08±0.23	NS
Overall acceptability score	6.58±0.19 ^{ab}	7.00±0.21 ^a	6.92±0.29 ^{ab}	6.08±0.23 ^b	*

Means bearing different superscripts between columns differ significantly

** - (P≤0.01)

* - (P≤0.05)

NS - Not significant

Flavour and overall acceptability scores of the 0.01% and 0.05% treatments were comparable with that of the control whereas the scores were significantly (P<0.05) lower for the 0.1% treatment. Similar to this, Sojic *et al.*, (2015) found that the aroma of the cooked sausages with NMO at 10 ppm and 20 ppm levels were not affected. Niyas *et al.*,

(2003) reported that the free fatty acid (FFA) content of nutmeg powder increased with radiation dose and subsequently the sensory scores also decreased. This indicates that the high lipid content of nutmeg may cause off odours due the release of FFA during heat processing. The spiciness score was significantly (P<0.05) higher for the 0.01% compared to the control and other treatments.

Inclusion of spices in cooked ground beef significantly ($P < 0.05$) increased the spice flavor intensity (Dwivedi *et al.*, 2006).

In conclusion food research always focuses on consumer preference, with priority for their health and safety. Presently, there is increased availability and consumption of processed meat foods which often contain chemicals used for improved sensory values and extending the shelf life and it is imperative to curtail these ingredients. Hence, at this juncture use of essential oils of various spices as natural preservatives in meat products would be a better choice. In addition, various hurdle technologies can be combined with the use of the essential oils. From the results of this study, it is recommended that NMO might be used as a natural antioxidant in the chicken patties up to 0.05% level without affecting the sensory qualities.

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