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Research Paper

Effect of Mango Peel and Pulp Extract on the Quality Characteristics of Chicken Nuggets

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ABSTRACT

In the present study the effects of mango peel extract (MPeE), mango pulp extract (MPuE) and butylated hydroxyanisole (BHA) on the keeping quality of chicken nuggets was assessed. The results indicated significantly lower ($p<0.05$) pH, TBARS and peroxide value (PV) of the products containing 0.5% MPeE. Moisture and fat decreased ($p<0.05$) significantly during the storage (4 ± 1^0C) period of 25 days. Total plate count and pyschrophillic count for the products containing 0.5% MPeE and MPuE were significantly ($p<0.05$) low as compared to control and BHA. Significantly ($p<0.05$) higher scores for various attributes were observed for the products containing 0.5% MPeE. There was significant ($p<0.05$) decline in all the sensory attributes of all the products during storage period. It was concluded that MPeE added at 0.5% level found to be an efficient alternative over BHA in processed meats.

Keywords : *Mango peel extract, Mango pulp extract, BHA, Storage quality, Chicken nuggets*

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INTRODUCTION

Lipid oxidation is one of the major causes of meat products quality deterioration, because of their increased fat content, highly comminuted nature of the raw materials, as well as the possibility of long term storage (Georgantelis *et al.* 2007). Therefore, lipid oxidation in meat and meat products has to be effectively controlled by adding suitable substances such as antioxidants (Zhang and Wang 2001). In industrial meat processing, synthetic antioxidants, such as butylated hydroxytoluene (BHT) and butylated hydroxyanisole (BHA) are used to prevent lipid oxidation and food spoilage. These synthetic antioxidants show good stability during processing and storage of high lipid foods, however, many countries have suppressed the use of synthetic antioxidants in recent years because of detection of toxicity and carcinogenicity (Tang *et al.* 2001; Wanasundara and Shahidi 1998).

Alternatively, it has paved the way for antioxidant substances naturally found in fruits and vegetables. The use of these natural substances in meat products has also been considered due to their health benefits to consumers such as the reduction in the incidence of cardiovascular diseases and cancer. Moreover, natural antioxidants were more effective in retarding food oxidation (Zandi and Gondon 1999; Kang *et al.* 2001; Bub 2003; Naveena *et al*. 2008). Among the various fruits, mango (*Mangifera indica* L.) is high in carotenoid content which is responsible for antioxidative capacity. According to Bendich (1993) carotenoids possess function as quenchers of singlet oxygen, antioxidants and modulator of lipoxygenase in immune processes and provides protection against cancer, cardiovascular disease, cataracts, molecular disease as well as neurologic, inflammatory and immune disorders. Taking these facts into consideration, a study was conducted to evaluate the utilization of MPeE and MPuE as a source of natural antioxidant in chicken nuggets during refrigerated storage.

MATERIALS AND METHODS

Chicken: Broiler birds of 6 weeks old were procured from the local market and were slaughtered and dressed following traditional halal method. The body fat, tendons and separable connective tissues as well as skin were trimmed off. The deboned meat and skin were packed separately in low density polyethylene (LDPE) pouches and kept in refrigerator at 4 ± 1^oC over night which was then subsequently used for product preparation.

***Non-meat ingredients*:** Spice ingredients, viz. aniseed, black pepper, capsicum, cinnamon, coriander, cumin seeds, caraway seed, cardamom, small cardamom, nutmeg, turmeric and cloves etc. bought from the market were dried in hot air oven at 50 ± 1^OC for 2 h. and ground. All the powdered and ground spices were then sieved separately through a fine mesh. Spice mix was then prepared by mixing these ingredients in predetermined percentage and used in the formulation of

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chicken nuggets. The fine condiment paste was made by blending peeled onion, ginger and garlic in a ratio of 3:1:1 in a grinder.

***Natural antioxidants*:** Mango peel (MPeE) powder was prepared from dried peels of fully ripened mango. The fruits were washed with distilled water, peeled and their edible portion (pulp) was carefully separated and cut into pieces. The peels and pulp were dried separately in a hot air oven at 50±1°C for 48 h and ground to a fine powder and passed through a 24 mesh sieve. Based on the results of preliminary studies, 0.5% levels of the extracts were chosen for this study and the extract was prepared by taking 5 g of both powders separately in 100 ml distilled water and boiled at 100°C. After 1h, the extract was obtained by filtering through Whatman filter paper No.1 and respective extracts were added to the emulsion.

***Cooking of chicken nuggets*:** The emulsion was moulded into stainless steel tiffin boxes and steam cooked for 20 min (121°C). Cooked loaf was cooled to room temperature and cut into nuggets of size 4 x 1.5 x 1.5 cm which were subsequently packaged in low density polyethylene bags and stored at C for 25 days.

***Shelf life studies*:** The refrigerated samples were drawn at an interval of 5 days and were analyzed for pH and peroxide value (AOAC 1995), TBARS value (Strange *et al*. 1977), microbiological quality (APHA 1984) and sensory attributes (Keeton 1983).

***Statistical analysis*:** The data obtained during the experiment were analyzed by Analysis of Variance following the standard procedure described by Snedecor and Cochran (1989). The experiment was replicated thrice and all parameters were measured in duplicate (n=6).

RESULTS AND DISCUSSION

***Physico-chemical characteristics*:** The data on various physico-chemical parameters of the chicken nuggets like pH, TBARS, PV during refrigerated storage period were presented in Table 1. The pH of control and treated samples increased significantly with increasing refrigerated storage period. The results were in agreement with the findings of Naveena *et al.* (2008) in the chicken patties treated with pomegranate juice, pomegranate rind powder extract and BHT. Increase in pH during the storage period might be due to growth of Gram-negative bacteria such as *Pseudomonas*, *Acinetobacter* (Das *et al.* 2011). Jay (1996) also reported increase in pH during storage due to accumulation of metabolites by bacterial action on proteins and amino acids.

There was a significant ($p<0.05$) increase in TBARS values of the control and treated samples during refrigerated (25 days) storage. The increase in TBARS value on storage might be attributed to oxygen permeability of packaging material that might have led to lipid oxidation (Singh *et al.* 2014). The results were in accordance with Devatkal *et al*. (2012) in chicken patties treated with BHT and aqueous extracts of curry leaves and fenugreek leaves. Biswas *et al.* (2011), Das *et al.* (2011), Verma *et al.* (2013) and Shukla *et al.* (2014) also recorded similar increase in TBARS values upon refrigerated storage of different meat products treated with mango, curry leaf, guava, carrot and papaya. Nayak and Tanwar (2005) attributed the increase in TBA values with the advancement of storage period to increased lipid oxidation and production of volatile metabolites in the presence of oxygen.

The peroxide value (PV) gradually increased in all treatments as well as in control samples during storage period. PV for all treatments were significantly lower than those of control ($p<0.05$) during the refrigerated storage period. These findings were in accordance with the findings of Juntachote *et al.* (2007) who reported that dried galangal powder and its ethanolic extracts exhibited antioxidative properties which in turn retarded lipid oxidation in cooked ground pork. The lowest PV was recorded for chicken nuggets added with MPeE. Similar trend were also reported by Singh *et al.* (2014).

***Microbiological quality*:** Although, all the treatments showed significantly ($p<0.05$) increased microbial counts with storage period, however, the counts in all the stored products were well within the limits of acceptability. A significant ($p<0.05$) decrease in TPC was recorded in MPeE and MPuE incorporated chicken nuggets as compared to the other treatments. Amongst all, the MPeE treated chicken nuggets had significantly ($p<0.05$) lowest TPC. Present findings were in accordance with those recorded earlier by Singh *et al.* (2015) and Biswas *et al.* (2011).

Psycrophillic counts were not detected on day 0 in all the products. Psychrophillic counts were observed from day 5 and followed a significant ($p<0.05$) increasing trend in BHA, MPeE and MPuP as well as control nuggets. However, the counts were significantly (<0.05) lower in MPeE as compared to control. A detectable count on day 5 while no counts in preceding observations might be attributed to the fact that bacteria generally need some lag phase before active multiplications is initiated (Singh *et al.* 2014).

The coliforms were not detected in the products throughout the period of storage which may be due to the destruction of these bacteria during cooking. Further, hygienic practices followed during the preparation and packaging of products could also be one of the reasons for the absence of coliforms (Singh *et al*. 2011; Bhat *et al*. 2013).

***Sensory attributes*:** The scores of various sensory attributes were significantly ($p<0.05$) higher for natural antioxidants viz. MPeE and MPuE as compared to control and BHA (Table 2). The colour and appearance of the products was found to vary in the order as MPeE>MPuE>BHA>Control and decreased gradually as the days of storage progressed. The decrease in appearance and colour scores might be due to pigment and lipid oxidation resulting in non-enzymatic browning (Singh *et al*. 2014). A decrease in appearance scores of chicken nuggets with increase in storage period was also reported by Bhat *et al.* (2013). Similar findings were also reported by Das *et al.* (2011) in ground and cooked goat meat by adding curry leaf powder. The overall flavour and juiciness scores of control was significantly ($p<0.05$) lower than all other treatments. Nuggets incorporated with MPeE and MPuE at 0.5 percent level had significantly higher scores as compared to BHA and control in refrigerated storage. These findings were in agreement with Singh *et al.* (2014) in chevon cutlets. Irrespective of treatments, the flavour and juiciness decreased significantly ($p<0.05$) during refrigeration storage as the storage period progressed. Reduction in flavour scores might be due to the overall reduction in the quantum of volatile flavour components and due to the fat oxidation during storage (Singh *et al.* 2014). Evaporative losses leading to decline in moisture content might be responsible for such trends (Reddy *et al.* 2013).

Texture scores of all the samples decreased significantly ($p<0.05$) during storage period. Nuggets treated with MPeE and MPuE had significantly ($p<0.05$) higher scores than the BHA and control on almost all day of storage. The reduction in texture scores during refrigerated storage might be due to the relative reduction in moisture of the product which in turn may have led to hardening of the product (Reddy *et al.* 2013). Similar results were also presented by Bhat *et al.* (2013).

The overall acceptability of the products decreased significantly ($p<0.05$) with the storage. The scores were significantly ($p<0.05$) higher for MPeE and MPuE treated products as compared to BHA and control. Continuous decrease in overall acceptability scores might be resultant decline in scores of appearance, flavour, juiciness and texture. Similar trend in mean scores was also reported by Shukla *et al.* (2014) and Singh *et al.* (2015)

Table 1: Effect of mango peel and pulp extract on certain quality characteristics of chicken nuggets during refrigeration storage

Type of product	Storage period (Days)						Treatment (Mean ± S.E.)
	0	5	10	15	20	25	
				pH			
Control	6.16 ±0.015	6.25 ±0.016	6.34±0.012	6.38±0.011	6.47±0.015	6.54±0.018	6.36^{C} ±0.030
BHA	6.18 ±0.023	6.23 ±0.017	6.29±0.015	6.35±0.014	6.41±0.014	6.48±0.011	6.32^{BC} ±0.026
MPeE	6.12 ±0.018	6.18 ±0.026	6.30±0.019	6.38±0.013	6.42±0.002	6.44±0.002	6.29^{A} ±0.025
MPuE	6.13 ±0.016	6.20 ±0.027	6.25±0.023	6.32±0.021	6.39±0.014	6.45±0.002	6.31^{B} ±0.030
Storage (Mean ± S.E.)	6.15^{a} ±0.009	6.21^{a} ±0.011	6.30^{b} ±0.010	6.36^{b} ±0.008	6.42^{c} ±0.008	6.47^{c} ±0.003	
				TBARS (mg MDA/kg)			
Control	0.260±0.014	0.359±0.008	0.423±0.003	0.461±0.001	0.477±0.005	0.500±0.002	0.414^{C} ±0.117
BHA	0.219±0.011	0.269±0.001	0.311±0.002	0.378±0.010	0.424±0.008	0.445±0.006	0.341^{B} ±0.011
MPeE	0.207±0.015	0.244±0.007	0.267±0.006	0.311±0.009	0.342±0.004	0.369±0.005	0.290^{A} ±0.008
MPuE	0.228±0.002	0.249±0.002	0.276±0.002	0.322±0.009	0.352±0.007	0.385±0.004	0.302^{A} ±0.007
Storage (Mean ± S.E.)	0.226^{a} ±0.012	0.277^{b} ±0.015	0.315^{c} ±0.019	0.364^{d} ±0.019	0.395^{e} ±0.018	0.420^{f} ±0.016	

Peroxide Value (meq/kg fat)							
Control	0.682±0.037	1.41±0.021	2.21±0.022	2.72±0.003	3.34±0.006	3.94±0.018	2.38^{D}±0.018
BHA	0.611±0.007	1.12±0.034	1.83±0.03	2.32±0.003	2.97±0.060	3.43±0.023	2.04^{C}±0.167
MPeE	0.480±0.024	0.85±0.015	1.22±0.012	1.70±0.015	1.86±0.132	2.24±0.032	1.39^{A}±0.14
MPuE	0.481±0.014	0.926±0.008	1.29±0.013	1.83±0.01	2.464±0.043	2.86±0.034	1.64^{B}±0.141
Storage (Mean ± S.E.)	0.563^{a}±0.221	1.080^{b}±0.04	1.64^{c}±0.08	2.14^{d}±0.121	2.66^{e}±0.121	3.122^{f}±0.132	
Total Plate Count (log_{10}cfu/g)							
Control	1.19±0.044	2.77±0.046	2.95±0.054	3.18±0.046	3.44±0.033	3.81±0.063	2.89^{D}±0.141
BHA	1.35±0.068	2.62±0.041	2.748±0.064	2.99±0.065	3.29±0.100	3.60±0.050	2.76^{C}±0.122
MPeE	0.94±0.032	2.38±0.008	2.475±0.078	2.73±0.08	2.95±0.031	3.43±0.071	2.48^{A}±0.132
MPuE	0.97±0.034	2.51±0.008	2.72±0.113	2.95±0.82	3.16±0.053	3.4±0.083	2.62^{B}±0.137
Storage (Mean ± S.E.)	1.11^{a}±0.04	2.57^{b}±0.03	2.72^{c}±0.051	2.96^{d}±0.04	3.21^{e}±0.046	3.56^{f}±0.045	
Psychrophilic Count (log_{10}cfu/g)							
Control	ND	2.04±0.027	2.16±0.01	2.62±0.04	3.12±0.033	3.47±0.049	2.23^{D}±0.189
BHA	ND	1.71±0.01	1.88±0.016	2.41±0.021	2.86±0.036	3.36±0.049	2.04^{C}±0.181
MPeE	ND	1.58±0.025	1.78±0.016	2.19±0.02	2.7±0.01	2.84±0.03	1.85^{A}±0.159
MPuE	ND	1.63±0.029	1.86±0.03	2.25±0.034	2.80±0.06	2.92±0.031	1.91^{B}±0.165
Storage (Mean ± S.E.)	ND	1.74^{a}±0.039	1.92^{b}±0.031	2.37^{c}±0.037	2.87^{d}±0.037	3.15^{e}±0.058	

Mean ± SE with different superscripts in a row differ significantly ($p<0.05$)

Table 2: Effect of various antioxidants on sensory attributes of chicken nuggets during refrigeration storage

Type of product	Storage period (Days)						Treatment (Mean ± S.E.)
	0	5	10	15	20	25	
				Appearance			
Control	7.19	6.48	6.21	5.74	5.56	4.51	5.95^{A} ±0.20
BHA	6.82	6.63	6.32	6.19	5.93	5.6	6.25^{B} ±0.071
MPeE	7.28	6.97	6.8	6.66	6.6	6.42	6.79^{D} ±0.071
MPuE	7.14	6.90	6.73	6.61	6.4	6.32	6.68^{C} ±0.073
Storage period (Mean ± S.E.)	7.10^{f}±0.060	6.75^{e}±0.065	6.51^{d}±0.080	6.30^{c}±0.11	6.12^{b}±0.123	5.71^{a}±0.233	
				Flavour			
Control	6.97	6.81	6.50	6.13	5.65	4.96	6.17^{A} ±0.174
BHA	6.86	6.64	6.42	6.08	5.98	5.77	6.29^{B} ±0.09
MPeE	7.10	6.98	6.80	6.66	6.42	6.17	6.69^{C} ±0.08
MPuE	7.15	6.96	6.73	6.55	6.38	6.10	6.64^{C} ±0.087
Storage period(Mean±S.E.)	7.02^{f}±0.044	6.85^{e}±0.052	6.61^{d}±0.054	6.36^{c}±0.084	6.11^{b}±0.102	5.75^{a}±0.146	

Juiciness							
Control	6.92	6.59	6.08	5.85	5.72	4.46	$5.93^{A} \pm 0.195$
BHA	6.88	6.66	6.35	6.22	5.85	5.42	$6.23^{B} \pm 0.260$
MPeE	7.17	6.96	6.81	6.60	6.44	6.35	$6.72^{C} \pm 0.072$
MPuE	7.11	6.93	6.75	6.55	6.35	6.18	$6.64^{C} \pm 0.079$
Storage period(Mean±S.E.)	$7.02^{f} \pm 0.042$	$6.78^{e} \pm 0.055$	$6.49^{d} \pm 0.095$	$6.31^{c} \pm 0.095$	$6.09^{b} \pm 0.094$	$5.60^{a} \pm 0.237$	
Texture							
Control	6.92	6.46	6.11	5.97	5.72	3.67	$5.81^{A} \pm 0.253$
BHA	6.96	6.66	6.37	5.93	5.67	5.35	$6.15^{B} \pm 0.138$
MPeE	7.12	6.95	6.60	6.45	6.32	6.18	$6.60^{C} \pm 0.08$
MPuE	7.02	6.89	6.74	6.47	6.29	6.15	$6.59^{C} \pm 0.078$
Storage period(Mean ± S.E.)	$7.00^{f} \pm 0.032$	$6.74^{e} \pm 0.064$	$6.45^{d} \pm 0.07$	$6.20^{c} \pm 0.085$	$6.0^{b} \pm 0.097$	$5.33^{a} \pm 0.310$	
Overall palatability							
Control	6.49	6.19	6.04	5.71	5.01	3.58	$5.50^{A} \pm 0.239$
BHA	6.84	6.28	6.29	6.06	5.9	5.53	$6.15^{B} \pm 0.098$
MPeE	7.18	6.95	6.77	6.6	6.31	6.21	$6.67^{D} \pm 0.085$
MPuE	7.11	6.92	6.77	6.39	6.19	6.07	$6.57^{C} \pm 0.093$
Storage period(Mean ± S.E.)	$6.90^{f} \pm 0.084$	$6.59^{e} \pm 0.109$	$6.47^{d} \pm 0.099$	$6.19^{c} \pm 0.105$	$5.85^{b} \pm 0.157$	$5.35^{a} \pm 0.320$	

Mean ± SE with different superscripts in a column differ significantly ($p<0.05$).

Mean values are scores on 8 point descriptive scale where 1 denotes poor and 8 extremely desirable

CONCLUSION

During refrigerated ($4\pm1^{O}C$) storage, chicken nuggets incorporated with MPeE and MPuE at 0.5% level were superior in overall quality as compared to control and BHA. Thus it can be concluded that MPeE added at 0.5% level found to be an efficient alternative over synthetic antioxidants such as BHA in processed meats.

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