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RESEARCH ARTICLE

EFFECT OF DIFFERENT NATURAL ANTIOXIDANT EXTRACTS ON THE SHELF LIFE OF FUNCTINAL CHICKEN MEAT NUGGETS

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Abstract

Chicken meat nuggets were incorporated with three different anti oxidant extracts (1% level) of curry leaf (T1), guava leaf (T2) and green tea (T3) separately along with control and stored at frozen temperature to study the antioxidant effect on the physico chemical, microbiological and sensory attributes. The results revealed that on advancement of storage period, the overall mean scores of physico chemical and microbiological parameters were increased ($P<0.05$) and sensory scores were decreased ($P<0.05$) irrespective of treatment. However, green tea incorporated nuggets (T3) showed ($P<0.05$) significantly lower scores for pH, TBARS, free fatty acid value and SPC than other treatments. Higher ($P<0.05$) sensory scores were observed for nuggets incorporated with green tea extract than control and other treated samples. Curry leaf and guava leaf extract incorporated nuggets also had minor anti oxidant affect on selected parameters than the control but not up to the level of green tea extract.

INTRODUCTION

Recently consumers are increasingly interested about health oriented functional meat products. According to them, food they consume should not only taste better, but also be attractive, safe and healthy, These products are generally produced by reformulation of meat by incorporating health producing ingredients like variety of fibers, protein, polyunsaturated fatty acids (PUFA), antioxidants etc. Besides health benefit effects, dietary fiber supplementations increase the bulk and prevent cooking loss in meat products with fewer changes in textural parameters by enhancing water binding capabilities and carries great economical advantages for both the consumers and processors (Grigelmo- Miguel *et al*., 1999). Lipid oxidation is the major quality deteriorative process in meat and meat products resulting in a variety of breakdown products which produce off-odours and flavours (Faustman & cassens, 1990; kanner, 1994). Oxidation of lipids has detrimental effect on colour, flavor, texture and nutritive value of meat (Anon 1991). The inhibition of oxidation process is very important in food stuffs. Antioxidants can delay or inhibit the oxidation propagation of oxidizing chain reactions in the oxidation process (Zheng and Wang, 2001). The meat industry is increasingly searching for natural solutions to minimize oxidative rancidity and extend the shelf-life of meat products rather than synthetic additives, because the synthetic anti oxidants used currently have been found to exhibit various negative health effects in consumers (Shahidi *et al*., 1992, Clayson *et al*., 1986; Saito, *et al*., 2003). Many natural plant extracts contain primarily phenolic compounds, which are potent antioxidants (Wong et al., 1995). There has been growing interest in natural ingredients because they have greater application for increasing consumer acceptability, stability and shelf-life of products. Compounds obtained from natural sources such as grain, oilseeds, honey, fruits and vegetables have been investigated for their natural antioxidant effects in

meat products. (Chen, *et al*., 1996. Naveena, *et al*., 2007). Thus, the research for alternative methods to retard oxidative processes in meat has led to research on alternative natural antioxidants. Green tea leaf extracts are becoming increasingly important as a functional food in the diet because of their high polyphenols contents (Manzocco, Anese, & Nicoli, 1998). The antioxidative property of green tea extract is due to the presence of catechins, apicatechins, epicatechin gallate, epigallocatechin, and epigallocatechin gallate (Higdon & Frei, 2003; Zandi & Gondon, 1999). Curry leaf (Murraya koenijii; Rutaceae) is a leafy spice characterizing authentic Asian-Indian cuisine and it is used in small quantities for its distinct aroma as well as for preservation purposes. Interest in greater use of curry leaf has been stimulated since its high antioxidant potency was reported due to mahanimbine, murrayanol and mahanine from M .koenigii (Tachibana *et al*., 2003; Ningappa et al., 2008). Chowdhury *et al*. (2001) reported that these alkaloids shown to have antimicrobial activity against gram positive and negative bacteria and fungi. Psidium guajava Linn, belonging to the family of Myrtaceae, has been used as health tea. Its leaf contains copious amounts of phenolic phytochemicals which inhibit peroxidation reaction in the living body, and therefore can be expected to prevent various chronic diseases such as diabetes, cancer, heart-disease (Kimura *et al*., 1985, Okuda *et al*., 1982, Watt and Branchwizk, 1969),

Materials and methods:

Source of meat samples: Spent hens of age group of over 30 weeks were purchased from local market and utilized in this study. The birds were dressed and deboned manually in the Department of Livestock Products Technology to obtain deboned chicken meat. The skin, subcutaneous fat and connective tissue were trimmed off and the deboned chicken meat was used for further studies. Spices were cleaned thoroughly without any extraneous materials and were ground individually and sieved to obtain a fine powder. Spice mix was formulated and stored for subsequent use.

Preparation of Extracts of three different natural anti oxidants:

About 20 g of air dried and ground green tea leaves were mixed with 500 ml of boiling water and left for 5 min. The extract was obtained by filtration. The Fresh matured curry leaves (M. koenigii) and guava leaves (Psidium guajava L.) were collected from Institute campus and washed properly for removal of extraneous matter. Then they were air dried and grounded mechanically and sieved through a fine mesh separately. For preparation of extracts about 20 g each powder was mixed separately with 500 ml of boiling water and left for 5 min. The extract was obtained by filtration.

Preparation of control and treated chicken meat nuggets:

The composition of the nuggets incorporated with different antioxidants shown in Table 1. Meat batter was prepared in a bowl chopper (Seydelmann K20, Ras, Germany). Ground meat was divided into 4 groups. 1) Control without any anti oxidant, 2) T1 Curry leaf extract at 1%, 3) T2 guava leaf extract at 1% and 4) T3 Green tea extract at 1%. For each group of minced meat, condiment, corn flour and spice mix and respective extract of anti oxidant were added. Chopping ended after formation of uniform batter mix. For preparation of chicken meat nuggets of each group, Meat emulsion (~650 g) was placed into stainless steel moulds (18×12×4 cm), packed compactly and covered. The emulsion filled moulds from all the treatments were clipped and cooked in a steam oven without pressure for 35 min. The internal temperature of the cooked meat blocks (90±1°C) was measured using a probe type thermometer (Fisher Scientific, USA). The meat blocks were cooled to room temperature, chilled overnight at 4±1°C and manually cut into nuggets. About 200 g nuggets in each LDPE pouches were packed for further study. For the evaluation of antioxidant activity of curry leaf (T1), guava leaf (T2) and green tea (T3) during storage at frozen temperature for 60 days were studied and the treatments were evaluated for its quality at regular intervals of 0, 15, 30, 45 and 60 days with the following parameters like Physico-chemical characteristics, Microbiological evaluation and Organoleptic evaluation.

Evaluation of Quality characteristics:

Cooking loss:

Cooking loss was estimated by recording the difference between the pre and post cooking weights of meat patties and expressed as percentage.

pH: pH of the preparation was estimated by following the method of Trout *et.al*. (1992) using digital pH meter (Oakton Instruments, USA).

Thiobarbituric acid reactive substances (TBRAS) number : The TBARS number (mg malonaldehyde/kg) of the chicken meat nuggets was determined using the extraction method described by Witte et al. (1970) The values were expressed as mg malonaldehyde/kg of sample.

Free fatty acid value: The methods described by Koniecko (1979) were followed for the determination of free fatty acid value.

Microbiological examination: For microbiological examination, a representative of 10 g ground chicken meat sample was withdrawn and homogenized (Model PT-MR-2100, Kinematica AG, Switzerland) aseptically using 90 ml 0.1% peptone water (APHA, 1984) and serial dilutions were made using 0.1% sterile peptone water. The microbial quality of prepared were evaluated by estimating the Total plate count (TPC), Psychrophilic Count (PPC) and Yeast and Mould counts(Y&M) following pour plating technique as per standard procedure of ICMSF (1980).

Organoleptic evaluation: The chicken meat nuggets thus prepared as per the standardized formulations were shallow pan fried for 1 minutes and subjected to a 6 member taste panel including staff and students for sensory evaluation to evaluate color, flavor, juiciness, tenderness and overall acceptability on a 9 point hedonic scale.

Statistical analysis: The data thus obtained was subjected to statistical analysis using SPSS MAC, version 20.0, SPSS Chicago (US).

RESULTS AND DISCUSSION:

Physico-chemical characteristics

Cooking loss

The overall mean per cent cooking loss was significantly ($P<0.05$) low for chicken meat nuggets added with green tea extract at 1 per cent level (T_3) than the other treatments. This might be due to protective role of green tea extract against protein denaturation thus maintaining the protein integrity which retains more water in cooked meat matrix (Trout 1988). The per cent cooking loss of chicken meat nuggets kept in frozen storage for 60 days increased significantly ($P<0.05$) as the storage period increases irrespective of the treatments. This might be due to lowering of water binding capacity and loss of moisture during storage. Similar findings were observed by Kashyap *et. al*. (2012) in development of chicken meat patties incorporating natural antioxidants, Nagamallika *et al*., (2006) in refrigerated and frozen chicken patties, Bhaskar reddy *et al*., (2009) in pork sausages added with milk co-precipitates, Chandralekha *et al*., (2010) in refrigerated chicken meat balls added with natural and synthetic antioxidants and Obula reddy et al., (2014) in chicken meat patties with different anti-oxidants.

Free fatty acids

Free fatty acid content can be considered as an indicator of lipid oxidation and flavour of the product. The overall mean free fatty acid values (per cent oleic acid) of chicken meat nuggets incorporated with green tea extract (T_3) had significantly ($P<0.05$) lower values than control and other treatments. These results were in accordance with Kashyap *et. al*. (2012) in development of chicken meat patties incorporating natural antioxidants.

The overall mean free fatty acid values (per cent oleic acid) of chicken meat nuggets increased gradually with increased storage period. This increase might be due to progressive oxidation of lipids during storage. The results were in agreement with Modi et al., (2007) dehydrated chicken kebab mix and Chandralekha (2010) in refrigerated chicken meat balls added with natural and synthetic antioxidants.

pH

The overall mean pH values of chicken meat nuggets incorporated with green tea extract at 1 per cent level had significantly ($P<0.01$) lower values than control and T_1 treatment in frozen storage. The results were in agreement with Mirshekar *et al*., (2009) in frozen broiler meat by adding Rosemary, Echinacea, green tea extracts and ascorbic acid.

It was observed that the pH increased significantly ($P<0.01$) during frozen storage for 60 days which might be due to the accumulation of metabolites by bacterial action (Jay, 1996) in meat in addition to protein and amino acid degradation resulting in formation of ammonia and consequent increase in pH. The results were in agreement with Nagamallika *et al*., (2006) in chicken patties stored at frozen temperatures, Bhaskar reddy *et al*., (2009) in pork sausages added with milk co-precipitates, Chandralekha (2010) in refrigerated chicken meat balls added with natural and synthetic antioxidants.

Thio barbituric acid reactive substance (TBARS)

In the present study, the overall mean TBA values of chicken meat nuggets with green tea extract at 1 per cent level was significantly ($P<0.01$) lower than the control and other treatments during frozen storage. This might be due to green tea extract having large amount of poly-phenolic compounds like catechins, epicatechin, epigallocatechin, epicatechin gallate, epigallocatechin gallate, gallocatechin gallate, catechin gallate and gallocatechin (Zandi and Gondon 1999). The results were in accordance with Bozkurt (2006) Utilization of natural antioxidants: Green tea extract and Thymbra spicata oil in Turkish dry-fermented sausage, Banon *et al*., (2007) in refrigerated low sulphite beef patties added with ascorbate, green tea and grape seed extracts.

The results of this study revealed a significant ($P<0.05$) increase in the overall mean TBA values of control and all treatments during frozen (60 days) storage. This might be due to auto-oxidation of lipids over a period of low temperature storage and pro-oxidant nature of added salt. The results were in accordance with Chandralekha (2010) in refrigerated chicken meat balls added with natural and synthetic antioxidants.

Microbial evaluation:

Among the treatments chicken meat nuggets incorporated with green tea extract at 1 per cent level (T_3) showed significantly (P<0.05) lower counts than the other treatments which might be due to the presence of polyphenolic catechins like epicatechin, epigallocatechin, epicatechin gallate, epigallocatechin gallate which causes irreversible damage to bacterial cytoplasmic membrane and check the microbial growth (Yam et al., 1997; Hara 2001). These results were in accordance with Banon *et al.*, (2007) in refrigerated low sulphite beef patties added with ascorbate, green tea and grape seed extracts.

The overall mean bacterial count (log10 cfu/g) decreased up to day 15th but significantly (P<0.05) increased counts were observed with increase in storage period during refrigeration. This might be due to the permissive temperature and relative availability of moisture and nutrients for the growth of mesosphelic bacteria. These results were in accordance with Banon *et al.*, (2007) in refrigerated low sulphite beef patties added with ascorbate, green tea and grape seed extracts.

Psychrophiles could not be detected in any of the treatments and control during frozen storage. This might be due to the temperature variance for growth of psychrophilic bacteria. The results were in agreement with Cholan (2008) in low-fat chicken nuggets, Chandralekha (2010) in refrigerated chicken meat balls added with natural and synthetic antioxidants and Obula reddy *et al*., (2014) in chicken meat patties with different anti-oxidants"

Yeast and moulds could not be detected in any of the treatments in the present study. This might be due to hygienic processing of practices and also might be attributed to the antibacterial effect of spices. The results were in agreement with Cholan (2008) in low-fat chicken nuggets and Chandralekha (2010) in refrigerated chicken meat balls added with natural and synthetic antioxidants.

Coli forms could not be detected in any of the treatments and control during frozen storage. These bacteria are indicator of fecal contamination. Absence of these microorganisms indicated no contamination during post processing handling of chicken meat patties. Similar observations were also recorded by Banon *et al.*, (2007) in refrigerated low sulphite beef patties added with ascorbate, green tea and grape seed extracts.

Organoleptic evaluation

The overall mean scores of colour, juiciness, tenderness and overall acceptability between treatments differed significantly (P<0.05) However, chicken meat nuggets incorporated with green tea extract secured significantly (P<0.05) higher score than the all other treatments. Similar results were reported by Banon *et al.*, (2007) in refrigerated low sulphite beef patties added with ascorbate, green tea and grape seed extracts and Jo *et al.* (2003) found that GTE improved colour and did not affect the odour, flavour or tenderness of cooked pork patties. Chicken meat nuggets incorporated with curry leaf extract observed significantly (P<0.05) higher flavor scores than control and other treatments. The similar trend was observed by Biswas *et al*., 2003 in pork patties added with anti oxidants and Das *et.al*. (2006) in ground buffalo meat. Das *et. al.* (2011) in quality of ground and cooked goat meat, Obula reddy et al., (2014) in chicken meat patties with different anti-oxidants", The overall mean scores of colour, flavor, juiciness, tenderness and overall acceptability control and other treatments decreased significantly (P<0.05) in frozen storage. The reduction in sensory scores of stored product might be due to free radicals formed in lipid oxidation process can oxidize haem pigments to metmyoglobin which causes the discoloration of product during storage, oxidative fading and moisture loss. Similar results were reported by Nath *et. al*. (1995) in chicken meat patties, Lee *et. al.* (1997) in chicken breakfast sausages containing natural antioxidants, Biswas *et al*., 2003 in pork patties added with anti oxidants, Das *et.al.* (2006) in effect of carnosine pre-blending on the quality of ground buffalo meat, Chandralekha (2010) in refrigerated chicken meat balls added with natural and synthetic antioxidants, Kim *et. al*. (2011) in refrigerated low-fat pork sausages with tomato powder and Das *et. al.* (2011) in antioxidant effect of curry leaf (Murray koenigii) powder on quality of ground and cooked goat meat

Table I: The composition of the chicken meat nuggets incorporated with different natural antioxidants

Ingredient (%)	**control**	**T_1**	**T_2**	**T_3**
Lean meat	70.5	69.5	69.5	69.5
Vegetable oil	5	5	5	5
Spice mix	2	2	2	2
Condiment mix	5	5	5	5
Chilli powder	1	1	1	1
salt	1.5	1.5	1.5	1.5
Chilled water	5	5	5	5
Antioxidants	-	Curry leaves extract (1%)	Guava leaves extract (1%)	Green tea extract (1%)

Corn flour	10	10	10	10
total	**100**	**100**	**100**	**100**

Control – Chicken meat nuggets without any anti oxidants.
T1 - Chicken meat nuggets incorporated with 1% curry leaf extract
T2 - Chicken meat nuggets incorporated with 1% Guava leaf extract
T3 - Chicken meat nuggets incorporated with 1%green tea extract

Table II: Mean ± S.E values of Physico-chemical characteristics of chicken meat nuggets as influenced by different natural antioxidant aqueous extracts during frozen storage.

Means bearing at least one common superscript in the same row and in the same column do not differ significantly (P<0.05).

Treatments	**Days of storage**					
	0	**15**	**30**	**45**	**60**	**Overall Mean**
Cooking Loss (per cent)						
C	6.27±0.15	8.90±0.21	11.62±0.12	14.77±0.11	19.25±0.01	12.16 ± 0.02^{A}
T_1	6.26±0.06	8.92±0.21	11.74±0.01	14.88±0.31	19.24±0.12	12.20 ± 0.01^{A}
T_2	6.43±0.21	8.94±0.11	11.66±0.01	14.90±0.01	19.91±0.11	12.36 ± 0.01^{A}
T_3	6.01±0.31	8.12±0.01	10.73±0.02	13.94±0.01	18.73±0.21	11.50 ± 0.01^{B}
Overall Mean	6.24 ± 0.22^{a}	8.72 ± 0.11^{b}	11.4 ± 0.21^{c}	14.62 ± 0.31^{d}	19.28 ± 0.51^{e}	
Free fatty acid value						
C	0.08±0.22	0.21±0.07	0.32±0.48	0.46±0.14	0.75±0.27	0.36 ± 0.71^{A}
T_1	0.07±0.23	0.15±0.48	0.17±0.47	0.23±0.20	0.57±0.20	0.23 ± 0.72^{B}
T_2	0.07±0.17	0.17±0.47	0.20±0.32	0.28±0.33	0.59±0.35	0.26 ± 0.69^{B}
T_3	0.07±0.25	0.09±0.31	0.12±0.66	0.20±0.59	0.42±0.23	0.18 ± 0.74^{C}
Overall Mean	0.07 ± 0.12^{e}	0.15 ± 0.18^{d}	0.20 ± 0.23^{c}	0.29 ± 0.17^{b}	0.59 ± 0.14^{a}	
pH						
C	5.96±0.004	6.14±0.002	6.20±0.004	6.26±0.01	6.33±0.003	6.18 ± 0.02^{B}
T_1	5.94±0.003	6.10±0.020	6.13±0.005	6.19±0.02	6.26±0.001	6.13 ± 0.02^{B}
T_2	5.92±0.002	6.00±0.020	6.10±0.002	6.16±0.01	6.21±0.004	6.07 ± 0.02^{A}
T_3	5.91±0.005	5.93±0.003	6.10±0.001	6.15±0.01	6.21±0.003	6.06 ± 0.02^{A}
Overall Mean	5.93 ± 0.005^{a}	6.04 ± 0.02^{b}	6.13 ± 0.01^{c}	6.21 ± 0.01^{d}	6.25 ± 0.01^{e}	
TBARS Value (mg malonaldehyde/kg of meat)						
C	0.18±0.003	0.43±0.010	0.97±0.010	1.41±0.040	3.13±0.040	1.23 ± 0.2^{D}
T_1	0.14±0.004	0.26±0.012	0.50±0.020	0.74±0.020	1.54±0.010	0.64 ± 0.09^{C}
T_2	0.12±0.006	0.19±0.002	0.35±0.010	0.58±0.010	0.94±0.010	0.44 ± 0.05^{B}
T_3	0.10±0.001	0.15±0.001	0.25±0.010	0.44±0.010	0.76±0.010	0.34 ± 0.04^{A}
Overall Mean	0.13 ± 0.01^{a}	0.26 ± 0.02^{b}	0.52 ± 0.06^{c}	0.79 ± 0.08^{d}	1.60 ± 0.20^{e}	

Table III: Total plate count (log_{10}cfu/g) values of chicken meat nuggets as influenced by different natural antioxidant aqueous extracts during frozen storage

Treatments	**Days of storage**	**overall mean**

	0	15	30	45	60	
C	4.63±0.010	5.22±0.010	5.49±0.010	5.82±0.010	6.93±0.009	5.62 ± 0.17^{C}
T_1	4.57±0.010	5.12±0.010	5.39±0.010	5.62±0.010	6.83±0.009	5.50 ± 0.17^{C}
T_2	4.20±0.010	3.64±0.009	3.82±0.009	4.25±0.009	4.75±0.009	4.13 ± 0.12^{B}
T_3	4.09±0.009	3.20±0.010	3.71±0.010	4.05±0.009	4.55±0.010	3.92 ± 0.12^{A}
overall mean	4.35 ± 0.13^{a}	4.04 ± 0.02^{b}	4.35 ± 0.05^{c}	4.71 ± 0.05^{d}	5.52 ± 0.15^{e}	

Means bearing at least one common superscript in the same row and in the same column do not differ significantly (P<0.05).

Table IV: Colour scores (Mean ± S.E) of chicken meat nuggets as influenced by different natural antioxidant aqueous extracts during frozen storage

	Days of storage					
Treatments	**0**	**15**	**30**	**45**	**60**	**overall mean**
C	8.52±0.01	8.39±0.01	8.11±0.03	7.78±0.03	7.64±0.01	8.09 ± 0.06^{A}
T_1	8.42±0.02	8.44±0.01	8.21±0.02	7.93±0.02	7.75±0.02	8.15 ± 0.05^{B}
T_2	8.43±0.01	8.40±0.06	8.14±0.02	7.86±0.05	7.71±0.02	8.11 ± 0.06^{B}
T_3	8.54±0.03	8.49±0.01	8.27±0.02	8.00±0.04	7.78±0.03	8.22 ± 0.06^{C}
overall mean	8.48 ± 0.01^{e}	8.43 ± 0.02^{d}	8.18 ± 0.02^{c}	7.89 ± 0.02^{b}	7.72 ± 0.01^{a}	

Means bearing at least one common superscript in the same row and in the same column do not differ significantly (P<0.05).

Table V: Flavour scores (Mean ± S.E) of chicken meat nuggets as influenced by different natural antioxidant aqueous extracts during frozen storage

	Days of storage					
Treatments	**0**	**15**	**30**	**45**	**60**	**overall mean**
C	8.51±0.01	8.38±0.01	8.12±0.03	7.79±0.03	7.63±0.01	8.09 ± 0.06^{A}
T_1	8.54±0.03	8.49±0.01	8.27±0.02	8.00±0.04	7.78±0.03	8.22 ± 0.06^{C}
T_2	8.44±0.01	8.47±0.06	8.18±0.02	7.89±0.05	7.77±0.02	8.14 ± 0.06^{B}
T_3	8.50±0.02	8.44±0.01	8.21±0.02	7.93±0.02	7.75±0.02	8.15 ± 0.05^{B}
overall mean	8.47 ± 0.01^{e}	8.44 ± 0.02^{d}	8.17 ± 0.02^{c}	7.88 ± 0.02^{b}	7.73 ± 0.01^{a}	

Means bearing at least one common superscript in the same row and in the same column do not differ significantly (P<0.05).

Table VI: Tenderness scores (Mean ± S.E) of chicken meat nuggets as influenced by different natural antioxidant aqueous extracts during frozen storage

	Days of storage					
Treatments	**0**	**15**	**30**	**45**	**60**	**overall mean**
C	8.53±0.01	8.38±0.01	8.12±0.03	7.79±0.03	7.62±0.01	8.09 ± 0.06^{A}
T_1	8.42±0.02	8.44±0.01	8.21±0.02	7.93±0.02	7.75±0.02	8.15 ± 0.05^{B}
T_2	8.43±0.01	8.40±0.06	8.14±0.02	7.86±0.05	7.71±0.02	8.11 ± 0.06^{B}
T_3	8.54±0.03	8.49±0.01	8.27±0.02	8.00±0.04	7.78±0.03	8.22 ± 0.06^{C}

overall mean	8.48±0.01^{e}	8.42±0.02^{d}	8.17±0.02^{c}	7.87±0.02^{b}	7.71±0.01^{a}	

Means bearing at least one common superscript in the same row and in the same column do not differ significantly (P<0.05).

Table VII: Juiciness scores (Mean ± S.E) of chicken meat nuggets as influenced by different natural antioxidant aqueous extracts during frozen storage

	Days of storage					
Treatments	**0**	**15**	**30**	**45**	**60**	**overall mean**
C	8.52±0.01	8.39±0.01	8.13±0.03	7.78±0.03	7.61±0.01	8.09±0.06^{A}
T_1	8.54±0.02	8.44±0.01	8.21±0.02	7.93±0.02	7.75±0.02	8.17±0.05^{B}
T_2	8.53±0.01	8.45±0.06	8.19±0.02	7.86±0.05	7.77±0.02	8.16±0.06^{B}
T_3	8.57±0.03	8.50±0.01	8.28±0.02	8.05±0.04	7.85±0.03	8.25±0.06^{C}
overall mean	8.54±0.01^{e}	8.43±0.02^{d}	8.20±0.02^{c}	7.90±0.02^{b}	7.74±0.01^{a}	

Means bearing at least one common superscript in the same row and in the same column do not differ significantly (P<0.05).

Table VIII: Overall acceptability scores (Mean ± S.E) of chicken meat nuggets as influenced by different natural antioxidant aqueous extracts during frozen storage

	Days of storage					
Treatments	**0**	**15**	**30**	**45**	**60**	**overall mean**
C	8.50±0.01	8.40±0.01	8.11±0.03	7.79±0.03	7.60±0.01	8.08±0.06^{A}
T_1	8.56±0.02	8.45±0.01	8.22±0.02	7.94±0.02	7.73±0.02	8.18±0.05^{B}
T_2	8.54±0.01	8.44±0.06	8.18±0.02	7.87±0.05	7.74±0.02	8.15±0.06^{B}
T_3	8.59±0.03	8.50±0.01	8.28±0.02	8.04±0.04	7.85±0.03	8.25±0.06^{C}
overall mean	8.54±0.01^{e}	8.44±0.02^{d}	8.19±0.02^{c}	7.91±0.02^{b}	7.73±0.01^{a}	

Means bearing at least one common superscript in the same row and in the same column do not differ significantly (P<0.05).

Conclusion:

The results of this study exhibited that green tea extract incorporated chicken meat nuggets observed significantly higher scores with respective of sensory evaluation and lower scores in physico-chemical and microbial evaluation. However, curry leaf and guava leaf extracts also had minor anti oxidant affect on selected parameters than the control but not up to the level of green tea extract. The anti oxidant property of green tea showed better inhibitory effect on lipid oxidation and microbial growth than any other. Incorporation of green tea extract could protect chicken meat nuggets against lipid oxidation during frozen storage. Incorporation of green tea extract up to one percent level did not affect nuggets oganoleptic attributes. Thus green tea extract can be used as a source of anti oxidant in chicken meat nuggets without affecting their acceptability.

References:

Anon (1991): Natural antioxidants capitalize on “clean label” trend. Prepared Foods, 160, 83.
APHA (1984): Compendium of methods for the microbiological examination of foods.2nd.edn. (ed.M.L.Speck).Am Pub Health Assoc, Washington, DC.
Banon, S., Diaz, P., Rodriguez, M., Garrido, M. D., Price, A., (2007): Ascorbate, green tea and grape seed extracts increase the shelf life of low sulphite beef patties. Meat Science 77(4): 626-633.
Bhaskar Reddy, G .V. Moorthy, P. R. S., and Reddy, K. P., (2009): Effect of milk co-precipitates on

quality characteristics of pork sausages. Tamilnadu J. Veterinary and Animal Sciences 5 (6):257-263.
Biswas, A .K., Keshri, R. .,C and Sunil Kumar. (2003) : Effect of enrobing and antioxidants on quality characteristics of pork patties Asian-Australian journal of animal science 16 (9): 1374-1383.
Bozkurt, H. (2006): Utilization of natural antioxidants: Green tea extract and Thymbra spicata oil in Turkish dry fermented sausage. Meat Science 73:442-450.
Chandralekha, S. (2010): Effect of natural and synthetic antioxidants in chicken meat balls M.V.Sc thesis, submitted to C.V.Sc., Sri Venkateswara Veterinary University, Tirupathi.
Chen, Z .Y., Chan, P .T., Ma, H. M, Fung, K. P., and Wang, J. (1996): Antioxidative effect of ethanol green tea extracts on oxidation of canola oil. Journal of the American Oil Chemists Society 73: 375-380.
Cholan, P.(2008) : Effect of fat replacers on the quality and storage stability of low-fat chicken nuggets. M.V.Sc thesis submitted to Rajiv Gandhi College of Veterinary and Animal Sciences, Pondicherry University, Puducherry.
Chowdhury, B.K., Jha, S., Bhattacharyya, P. and Mukherjee, J. (2001): Two new carbazole alkaloids from Murraya koenigii. Indian Journal of Chemistry 40: 490-494.
Clayson, D .B., Iverson, F., Nera ,E., Lok, E., Rogers, C., and Rodrigues, C ., (1986): Histopathological and radioautographical studies on the forestomach of F344 rats treated with butylatedhydroxyanisole and related chemicals. Food Chemistry and Toxicology 24:1171-1182.
Das, A. K., Anjaneyulu, A .S. R., and Biswas, S. (2006): Effect of carnosine preblending on the quality of ground buffalo meat. Food Chemistry 97: 531-538.
Das, S .K., Pazhaniandi, P .P., Tanwar, V. K., Biswas, S., and Khan, A., (2011): Effect of sorghum flour and finger millet flour as fat replacers for preparing low cost chicken. FLEISCHWIRTSCHAFT International 26(3):64-68.
Faustman, C., and Cassens, R. G., (1990) The biochemical basis for discoloration in fresh meat: A review. Journal of Muscle Foods. 1:217-243.
Grigelmo-Miguel, N., Abadias-Seros, M., and Martin-Belloso, O., (1999): Characterization of low fat high-dietary fiber frankfurters. Meat Sci., 52: 247-256.
Hara, Y., (2001): Green tea: health benefits and applications. New York, USA: Marcel Dekker.
Higdon, J. V., and Frei, B. (2003): Tea catechins and polyphenols: health effects, metabolism, and antioxidant functions. Critical Reviews in Food Science and Nutrition, 43, 89–143.
Jo, C., Ho Son, J., Bae Son, C., and Woo Byun, M., (2003): Functional properties of raw and cooked pork patties with added irradiated, freez- dried green tea leaf extract powder during storage at 4°C. Meat Science 64:13-17.
Kashyap , A., Thind ,S .S., and Kaur, A., (2012): Development of chicken meat patties incorporating natural Antioxidants. International Journal of Food Science & Technology Vol.2 (2): 27- 40.
Kim, S .S., Jin, K., Yang, M . R., Chu, G .M., Park, J . H., Rashid, R .H. I., Kim, J. Y., and Kang, S .N.,(2013) Efficacy of Tomato Powder as Antioxidant in Cooked Pork Patties. Asian Australas. J. Anim. Sci. 26(9): 1339-1346.
Kimura, S., Tamaki, T., Aoki, N., (1985): Acceleration of fibrinolysis by the N-terminal peptide of alpha 2-plasmin inhibitor. American Society of Hematology, 66(1):157-160.
Koniecko, E. K., (1979) In: Handbook for Meat Chemists. pp 68-69, Chapter 6, Avery Publishing Group Inc.,Wayne, New Jersey, USA
Lee, T .G, Williams, S . K, Sloan, D., and Littell, R., (1997): Development and evaluation of a chicken breakfast sausage manufactured with mechanically deboned chicken meat. Poultry Science 76(2):415–421.
Manzocco, L., Anese, M., & Nicoli, M. C. (1998): Antioxidant properties of green tea extracts as affected by processing. Lebensmittel-Wissenschaft und Technologie, 31, 694–698.
Mirshekar, R., Dastar, B., and Shabanpour, B., (2009): Effect of Rosemary, Echinacea, Green Tea extracts and Ascorbic acid on broiler meat quality. Pakistan Journal of Biological Sciences, 12: 1069-1074.
Modi, V. K., Sachindra, N. M., Nagegowda, P., Mahendrakar. N. S., & Rao, D. N. (2007): Quality changes during the storage of dehydrated chicken kebab mix. International Journal of Food Science and Technology 42, 827–835.
Nagamallika, E., Reddy, K .P., and Reddy, P .M.,(2006): Effect of storage on physico-chemical, microbiological and sensory quality of chicken patties. Indian Journal of Poultry Science 41 (3): 271-274.
Nath, R. L., Mahapathra, C .M., Kondaiah, N., Anand, S . K., and Singh, J . N., (1995): Effect of levels of chicken fat on the quality and storage life of chicken patties. Indian Journal of Poultry science 30:52-57.
Naveena, B. M., Sen , A. R., Kingsly, R.P., Singh, D. B., and Kondaiah, N., (2007): Antioxidant activity of pomegranate rind powder extract in cooked chicken patties. International Journal of Food Science and Technology 43(10):1807-1812.
Ningappa, M.B., Dinesha, R., and Srinivas, L., (2008): Antioxidant and free radical scavenging

activities of polyphenol-enriched curry leaf (Murraya koenigii L.) extracts. Food Chemistry 106: 720-728.

Obula reddy , B. (2014): Studies on the development of oat flour supplemented chicken meat patties with different anti oxidants. M.V.Sc thesis, submitted to N.T.R C.V.Sc., Sri Venkateswara Veterinary University, Tirupathi.

Okuda, T., Yoshida, T., Hatano, T., Yakazi, K., Ashida, M., (1982). Ellagitannins of the casuarinaceae, stachyuraceae and myrtaceae. Phytochemistry, 21(12):2871-2874.

Saito ,M., Sakagami, H., and Fujisawa, S., (2003): Cytotoxicity and apoptosis induction by butylated hydroxyanisole and butylated hydroxytoluelene. Anticancer Research 23:4693-4701

Shahidi, F., Janita, P. K., & Wanasundara, P. D. (1992): Phenolic antioxidants.Critical Reviews of Food Science and Nutrition 32, 67–103.

Tachibana, Y., Kikuzaki, H., Lajis, N.H. and Nakatani, N. (2003): Comparison of antioxidative properties of carbazole alkaloids from Murraya koenigii leaves. Journal of Agriculture and Food Chemistry 51: 6461-6467.

Trout, E. S., Hunt, N .C., Jhonson, D. E., Claus, J .R., Kastner, C. L .,and Kropf, D .H., (1992) Chemical, physical and sensory characterization of ground beef containing 5 to 30% fat .journal of food science57:25-29.

Watt, J.M., Branchwizk, M.G., (1969): The Medicinal and Poisonous Plants of Southern and Eastern Africa. E &S Livingstone, London, p.789-799.

Witte, V.C., Krause, G.F. and Bailey, M. F. (1970): A new extraction method for determining 2-thiobarbituric acid values of pork and beef during storage. Journal of Food Science 35: 582-585.

Wong, J .W., Hashimoto, K., and Shibamoto, T., (1995): Antioxidant activities of rosemary and sage extracts and vitamin E in a model meat system. Journal of Agricultural Food Chemistry 43:2797-2712.

Yam, T. S., Shah, S., Hamilton-Miller, J .M. T.,(1997): Microbiological activity of whole and fractionated crude extracts of tea (Camellia sinensis), and of tea components. FEMS Microbiology Letters 152:169–174.

Zandi, P., & Gondon, M. H. (1999): Antioxidant activity of extracts from old tea leaves. Food Chemistry, 64, 285–288.

Zheng, W., and Wang, S .Y., (2001): Antioxidant activity and phenolic compounds in selected herbs. J Agric Food Chem., 49: 5165-5170.