Studies On The Comparative Effect Of Rosemary Extract And Butylated Hydroxy Anisole On The Keeping Quality Of Value Added Chicken Meat Sausages

D.Maheswara Reddy[1], A.Jagadeesh Babu[2], B.Eswara Rao[3], P.R.S.Moorthy[4] and R.S.D.Gupta[5]

Department of Livestock Products Technology
College of Veterinary Science, TIrupati

ABSTRACT

The present investigation has been designed to know the effect of rosemary extract on the keeping quality of value added chicken meat sausages and to compare the effect of rosemary with synthetic antioxidant i.e. BHA. Significantly (P<0.01) lower values for cooking loss, pH, 2-TBARS and free fatty acid content due to the incorporation of rosemary extract at 0.2 % level during refrigeration storage was observed. Also there was a significant (P<0.01) increase in cooking loss, pH, TBARS values and free fatty acid content as the refrigeration storage period progressed from 0 to 8 days . Microbiological quality evaluation revealed that chicken meat sausages incorporated with rosemary extract at 0.2 % level had significantly (P<0.05) lower standard plate count and coliform count during refrigerated storage as compared to control and other treatment. Organoleptic evaluation indicated that addition of rosemary extract at 0.2% level to chicken meat sausages registered significantly (P<0.01) higher sensory scores for various eating quality attributes than the other treatments.

Received : 18 June 2013 Accepted: 10 january 2014

INTRODUCTION

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 (kanner , 1994). The inhibition of oxidation process is very important in foodstuffs. Antioxidants can delay or inhibit the oxidation propagation of oxidizing chain reactions in the oxidation process (Zheng and Wang, 2001) and considered as important nutraceuticals because of many health benefits . 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, such as butylated hydroxyl anisole (BHA), butylated hydroxyl toluene (BHT) and propyl gallate (PG). The synthetic antioxidants currently used have been found to exhibit various negative health effects in animals and primates (Saitoet et al.2003). Thus, the research for alternative methods to retard oxidative processes in meat has led to research on alternative natural antioxidants. The antioxidant activity of extracts from various plant species have been recognised since a long time such as extracts from grains, oil seeds, spices, honey, fruits and vegetables (Naveena et al. 2007). Due to concerns about toxicological safety of synthetic antioxidants such as butylated hydroxyl anisole (BHA) and butylated hydroxyl toluene (BHT), naturally derived antioxidants are perceived as better and safer than synthetics. The active anti oxidant compounds of rosemary extract promote health by preventing lipid oxidation and providing antibacterial, anti-carcinogenic and antiviral ability (Yang et al. 2000). Hence the present investigation has been designed to know the effect of rosemary extract on the keeping quality of value added chicken meat sausages and to compare the effect of rosemary with synthetic antioxidant i.e. BHA

MATERIALS AND METHODS

During this study six batches of chicken meat sausages were prepared with natural and synthetic antioxidants i.e. rosemary extract (Rosmarinus officinalis) at 0.2 per cent (T1) and Butylated hydroxyanisole (BHA) at 0.01per cent (T2) separately. These sausages were packed in low density polyethylene (LDPE) bags and stored at refrigeration temperature (4±1°C) up to 8 days. The refrigerated samples were drawn at an interval of two days (0, 2, 4, 6 and 8 days) and were analyzed for physico-chemical characteristics, proximate composition, microbial counts and organoleptic quality along with control. The procedure for the preparation of chicken meat sausages incorporated with various levels of antioxidants is illustrated in Figure 1.

Hygienically reared broiler birds were procured from the local farm 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.

The spices and their levels in the spice mix formulation used in this study are presented in Table 1. 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. Green condiments such as onion, ginger and garlic in the

*Corresponding author E-mail: afifi_magdy@gmail.com

ratio of 3:1:1 were used in this study. The external covers of onion, ginger and garlic were peeled off, washed thoroughly under running tap water and made into small pieces. The cut pieces were ground in a mixer-cum-grinder to the consistency of a fine paste.

The meat and skin were cut into small pieces to facilitate easy mincing and they were further subjected to thorough mincing by using a meat mincer (Sirman TC12E) through a 6 mm diameter plate to obtain a uniform mix and later through 4 mm diameter plate. The procedure for the preparation of meat sausages is depicted in the form of a flow chart in Figure 1.

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

$$\text{Cooking loss (\%)} = \frac{\text{Weight of sample before cooking} - \text{Weight of sample after cooking}}{\text{Weight of sample before cooking}} \times 100$$

Per cent emulsion stability was determined as per the procedure of Townsend et al. (1968) and Parks and Carpenter (1987). About 20-30g of raw emulsion was weighed and taken into a LDPE bag and sealed tightly without any air pockets inside. The bag was placed in a thermostatically controlled water bath and cooked at 80°C for 20 minutes. It was then taken out, drained and weighed.

$$\text{Emulsion stability (\%)} = \frac{\text{Weight of cooked emulsion}}{\text{Weight of raw emulsion}} \times 100$$

The water-holding capacity of the emulsion was determined by following the procedure of Weirbicki et al. (1962). 25 grams of emulsion mix was blended with 75ml of distilled water for 90 seconds in a high speed blender. 35 ml of the meat slurry was centrifuged at room temperature at 1000 rpm for 15 minutes. After centrifugation the volume of supernatant liquid was collected in a graduated cylinder. The per cent of swelling was determined by the following formula.

$$\text{WHC (\%)} = \frac{300 - 11.43}{100} \text{ X } S/100$$

S = Amount of supernatant collected in ml.

The hardness of the product was measured in terms of penetration value with the help of cone penetrometer as described by Dixon and Parekh (1979). The product was placed on the platform of the cone penetrometer (ISI model, United scientific co. Madras) in such a way that the point of penetration was at least 2.5cm away from the edge of the dish and the platform was so adjusted that the tip of the cone just touched the sample. The cone assembly was allowed to descend in to the sample for exactly 10 sec. The distance through which the cone penetrated into the product was measured on the dial of the penetrometer.

The PH of the samples was determined by following the procedure of Jay (1964). Meat sample weighing 25 grams was blended with 100 ml of distilled water for one minute in a mechanical blender. From the total homogenate a 50 ml aliquot portion was immediately used for determination of PH using a digital PH (EI, Model 101E) meter after standardizing the instrument with two standard buffers.

TBARS value was determined based on procedure of Witte et al. (1970). Trichloroacetic acid (TCA) extract of the restructured mutton slices was prepared by homogenizing 4g of sample with 20ml of pre cooled 20per cent TCA solution for 2 min in ultra turrex homogenizer. The contents were allowed for extraction for 10 minutes and then centrifuged at 3000 rpm for 10 min. Three ml of supernant was mixed with equal volume of 0.1per cent TBA reagent. The mixture was boiled in water bath for 30 min, cooled and absorbance was measured at 532 nm using spectrophotometer and the TBARS values were calculated and expressed in mg malonaldehyde/kg. For blank, same procedure was followed as described above except that 3ml of 20per cent chilled TCA solution was added instead of TCA extract.

The methodology adopted by Pearson (1973) was followed to determine the free fatty acids present in the refrigerated and frozen samples. Samples of minced chicken meat balls weighing 25 grams was placed in a conical flask and mixed with 100 ml chloroform. The contents were shaken for 10 minutes and filtered twice through Whatman filter paper No.1 containing a small amount of anhydrous sodium sulphate. 25 ml of absolute alcohol was neutralized with few drops of 0.01N NaOH using phenolphthalein as indicator. 25 ml of the filtrate was added to this and was titrated with 0.01N NaOH until pink colour persisted for 15 seconds. The free fatty acid (gm per cent oleic acid) was calculated by using the formula.

1 ml of 0.01 N NaOH = 0.00282 g of Oleic acid.

The mesophilic, the psychrophilic and the yeast and mould counts per gram of chicken meat sausages at refrigerated (4±1°C) temperature were estimated as per the techniques recommended by Chestnut et al. (1977). 11grams of the sample was thoroughly blended with 99 ml of sterile phosphate buffer diluent for 2 minutes. 1 ml of the sample was aseptically pipetted out into tubes containing 9 ml of phosphate buffer

diluent. Serial dilutions of the sample were prepared and the samples in duplicates were inoculated by pour plate method using plate count agar (PCA) for enumeration of mesophiles. 1 ml of the inoculum was transferred into petri plates to which molten media i.e. plate count agar maintained at 45°C was poured and mixed with inoculum by gentle rotating movements and allowed to solidify. The plates meant for mesophilic count were incubated at 37ºC over a period of 24-48 hours.. Those plates revealing visible colonies in the range of 30-300 were selected, counted and the counts were expressed as log10 cfu/g of sample.

For estimation of coliforms Mac Conkey agar was prepared and 1ml of inoculum of each dilution was placed in duplicate petridishes. The sterile molten and cooled (45 ºC) medium was poured in 15-20 ml quantities into each petridish and mixed thoroughly. The petridishes, after solidification of the medium were incubated at 37 ºC for 18-24 hrs. Pink colored colonies were counted and expressed as log10 cfu/g of sample. The chicken meat sausages thus prepared as per the standardized formulations were oven cooked separately and subjected to sensory evaluation on a 9 point hedonic scale by a semi-trained five member taste panel.

RESULTS AND DISCUSSION

The overall mean per cent cooking loss was significantly ($P<0.01$) low for chicken meat sausages added with rosemary extract at 0.2 per cent level than the other treatments. This might be due to protective role of rosemary against protein denaturation thus maintaining the protein integrity which retains more water in cooked meat matrix (Trout 1988). These results are in agreement with Lara et al., (2011) in refrigerated cooked pork patties packed in modified atmosphere packing and stored at refrigeration.

The per cent cooking loss of chicken meat sausages kept in refrigerated storage (4±1ºC) for 8 days increased significantly ($P<0.01$) 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.

Among the treatments chicken meat sausages incorporated with 0.2 per cent rosemary extract had higher emulsion stability but no significant difference was observed among the treatments during refrigerated storage. The percent emulsion stability of chicken meat sausages kept in refrigerated storage (4±1ºC) for 8 days increased significantly ($P<0.01$) as the storage period increases irrespective of the treatments.

The mean values of per cent water-holding capacity of chicken meat sausages were significantly ($P<0.01$) influenced during storage period. No significant difference was observed among treatments and control. The results were in accordance with Mirshekar et al. (2009) in frozen broiler meat by adding rosemary, echinacea, green tea extracts and ascorbic acid. The overall mean per cent water-holding capacity of chicken meat sausages decreased significantly with increased storage period irrespective of the treatments. This might be due to decreased ability of tissues to save its water due to protein denaturation which lower the hydration capacity of proteins. This can also be attributed to the loosening up of the microstructure of muscles allowing more water to be entrained (Hamm 1960). The results were in accordance with Sahoo et al. (1998) in frozen ground buffalo meat samples. The hardness of chicken meat sausages was significantly ($P<0.01$) influenced during storage periods. No significant ($P=0.975$) difference was observed among treatments and control. The results were in agreement with Rababah et al. (2006) in refrigerated cooked chicken breast meat using plant extracts. Irrespective of the type of treatments used, the hardness values were significantly increased ($P<0.01$) as storage period progresses. This might be due to loss of moisture during storage and due to higher intensity of protein oxidation reactions leading to formation of cross linking and polymerization in lipids and proteins (Lund et al. 2007). The results were in agreement with Fernandez-Lopez et al. (2004) in refrigerated ostrich liver pate.

PH is one of the chemical parameters indicative of meat quality. The pH was determined to assess the storage stability of chicken meat sausages. The pH of meat and meat products is an important measure to estimate relative acidity or alkalinity which might indicate the potential storage life of the meat products. The overall mean pH values of chicken meat sausages incorporated with rosemary extract at 0.2 per cent level had significantly ($P<0.01$) lower values than control and other treatments in refrigerated 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 where green tea recorded significantly lower pH values. It was observed that the pH increased significantly ($P<0.01$) during refrigerated storage for 8 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. McCarthy et al. (2001) in fresh and previously frozen pork patties by adding natural food and plant extracts, Inderjith Singh et al. (2005) in chicken meat treated with alcoholic extract of cinnamon, Keokamnerd et al. (2008) in ground chicken thigh meat by adding commercial rosemary oleoresin preparations under refrigeration, Sasse et al. (2009) in frozen cooked ground pork patties by adding

natural and synthetic antioxidants, Lara et al. (2011) in cooked pork patties by adding rosemary extract and Karolina et al.(2011) in refrigerated meat products after adding green tea and rosemary extracts.

The content of malonaldehyde in muscle foods can be determined by the TBA test. The 2-TBA assay is commonly used to measure oxidative rancidity of meats and other fat containing food products, more specifically this assay measures the quantity of malonaldehyde which is an oxidative breakdown product formed mainly from peroxidised polyunsaturated fatty acids. The results of this study revealed a significant ($P<0.01$) increase in the overall mean TBA values of control and all treatments during refrigerated (8 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 Newkirk et al. (1993) in whole hog sausages by adding synthetic antioxidants and rosemary extract, Yildiz-Turp and Serdaroglu (2004) in refrigerated chicken patties by adding ascorbic acid, rosemary extract and a-tocopherol, Nam et al. (2006) in irradiated and refrigerated pork loins added with rosemary and tocopherol, Georgantelis et al. (2007) in refrigerated pork sausages containing rosemary extract, chitosan and a-tocopherol, Abdel-Hamied et al.(2009) in minced meat by adding rosemary and sage extracts during refrigerated storage, and Cruzen et al. (2010) in pre-cooked ground beef patties added with rosemary extract and BHA/BHT.

In the present study, the overall mean TBA values of chicken meat sausages with rosemary extract at 0.2 per cent level was significantly ($P<0.01$) lower than the control and other treatments during refrigeration storage. The results were in accordance with Robbins and Moines (2010) in refrigerated cooked ground chicken patties added with rosemary, green tea and rosemary-green tea extracts; Martinez et al. (2006) in refrigerated pork sausages added with rosemary, borage, green tea, pu-erh tea and ascorbic acid; Mc Carthy et al. (2001) in fresh and previously frozen pork patties under refrigerated storage by adding tea catechins, sage and rosemary extract;; Jo et al. (2003) in raw and cooked pork patties containing green tea extract; and Mirshekar et al. (2009) in frozen broiler meat by adding rosemary, echinacea, green tea extracts and ascorbic acid. The increased TBARS value in the control sample was due to an extensive disruption or destruction of cellular structure during cooking of the product, which may allow mixing of various meat constituents, including unsaturated fatty acids and prooxidants (Rhee 1989). In addition, salt has been shown to have an accelerating effect on lipid oxidation. The pro-oxidative activity of NaCl is due to its ability to release iron from heme pigments and other heme binding molecules (Kanner et al. 1991).

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 sausages increased gradually with increased storage periods and there was no significant difference among the treatments. This increase might be due to progressive oxidation of lipids during storage. The results were in agreement with Kowale et al. (1996) in mutton stored at refrigerated temperature, , Kumudavally et al. (2008) in fresh mutton by adding green tea, and Ucak et al. (2011) in refrigerated atlantic mackerel fish burgers by adding rosemary extract.

Determination of microbial counts is obvious to determine the resistance of the product to spoilage. A significant difference ($P<0.05$) in total plate counts was observed between antioxidant treatments and between storage periods. Among the treatments chicken meat sausages incorporated with rosemary extract at 0.2 per cent level showed significantly ($P<0.05$) lower counts than the other treatments .The overall mean bacterial count (log6 cfu/g) decreased up to day 6th 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 mesophilic bacteria. These results were in accordance with Georgantelis et al. (2007) in refrigerated pork sausages containing rosemary extract, chitosan and a-tocopherol, Keokamnerd et al., (2008) in ground chicken thigh meat by adding commercial rosemary oleoresin preparations under refrigeration and Szymanczuk et al. (2011) in refrigerated pork batters containing rosemary preparations.

Coliforms are important source of faecal contamination. The analysis of variance revealed that chicken meat sausages incorporated with rosemary extract at 0.2 per cent level showed significantly ($P<0.05$) lower counts than the other treatments These results were in accordance with, Kazimierczuk and Kozlowska (2006) in sausages, pies and fish containing rosemary oil, and Georgantelis et al. (2007) in fresh pork sausages by adding rosemary extract.,The overall mean coliform count (log6 cfu/g) increased significantly ($P<0.05$) 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 coliforms bacteria. These results were in accordance with Szymanczuk et al. (2011) in refrigerated pork batters containing rosemary preparations.

The overall mean colour scores between treatments differed significantly (P<0.01), and chicken meat sausages incorporated with rosemary extract secured significantly (P<0.01) higher score than the all other treatments. The overall mean colour scores of control and other treatments decreased significantly (P<0.01) in refrigerated storage. The reduction in colour scores of stored product might be due to free radicals formed in lipid oxidation process can oxidize haem pigments to methmyoglobin 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, O'Grady et al. (2001) in bovine muscles. In the present study, the overall mean flavour scores of control was significantly (P<0.01) lower than all other treatments and chicken meat sausages incorporated with rosemary extract at 0.2 per cent level secured significantly (P<0.01) higher flavour scores than the other treatments in refrigerated storage. Irrespective of treatment, the overall mean flavour scores decreased significantly (P<0.01) during refrigeration storage as the storage period progressed. Reduction in flavour score might be due to the overall reduction in the quantum of volatile flavour components and due to fat oxidation during storage. The results were in agreement with Lee et al. (1997) in chicken breakfast sausages containing natural antioxidants, Yildiz-Turp and Serdaroglu (2004) in refrigerated chicken patties by adding ascorbic acid, rosemary extract and a-tocopherol, Serdaroglu and Yildiz-Turp (2004) in frozen chicken patties by adding ascorbic acid, rosemary extract and a-tocopherol. The overall mean juiciness scores were significantly (P<0.05) higher in chicken meat sausages added 0.2 per cent rosemary extract than the other treatments during refrigerated storage.The overall mean juiciness scores significantly (P<0.05) decreased with increased storage period. Evaporative losses leading to decline in moisture content might be responsible for the above result.Similar findings were noticed by Bhoyar et al. (1998) in frozen restructured chicken patties, Ali et al. (2007) in frozen stored chicken patties. The tenderness scores of chicken meat sausages treated with 0.2 per cent rosemary extract was higher than the other treatments during refrigerated storage. In the present study, the overall mean tenderness scores decreased significantly (P<0.01) as the storage period increased. The reduction in mean tenderness scores during refrigerated storage might be due to the relative reduction in moisture and juiciness of the product that led to hardening of the product. The results were in agreement with Kala et al. (2007) in refrigerated chicken patties, Ali et al. (2007) in frozen stored chicken patties.The acceptability scores for control sample was significantly (P<0.01) lower than all other treatments during refrigerated storage and chicken meat sausages added with rosemary extract at 0.2 per cent level scored higher scores than all other treatments during refrigerated storage. The results were in agreement with Robbins and Moines (2010) in beef steaks added with rosemary-green tea extract during refrigerated storage. The overall mean acceptability scores decreased significantly (P<0.01) with increase in refrigerated storage periods. This decreasing trend might be due to the lowering scores of colour, flavour, juiciness and tenderness of the products during storage. Similar trend in mean overall acceptability scores during storage was reported by Bhoyar et al. (1998) in frozen restructured chicken steaks, Kala et al. (2007) in refrigerated chicken patties and Ali et al. (2007) in frozen chicken patties.

CONCLUSION

TPhysico-chemical parameters such as cooking loss, emulsion stability, WHC, hardness were not significantly affected only during refrigerated storage where as pH, 2-TBARS value and free fatty acid content in chicken meat sausages were significantly (P<0.01) affected due to the incorporation of natural and synthetic antioxidants and also due to refrigeration storage. Microbiological quality evaluation revealed that chicken meat sausages incorporated with rosemary extract at 0.2 % level had significantly (P<0.05) lower standard plate count and coliform count during refrigerated storage as compared to control and other treatment. However, there was a significant (P<0.01) decrease in all the organoleptic attributes of the product as the storage period increased under refrigerated conditions.

REFERENCES

Abdel-Hamied A A, Nassar A G and Badry N E (2009) Investigations on antioxidant and antibacterial activities of some natural extracts. World Journal of Dairy and Food Sciences 4(1):1-7.

Ahn Y J, Kawamura T, Kim M, Yamamoto T and Mitsuoka T (1991) Tea polyphenols: Selective growth inhibitors of Clostridium spp., Agric. Biol. Chem 55:1425–1426.

Ali S W and Rasool G (2007) Chemical and sensory characteristics of frozen stored chicken patties fried in different vegetable oils. Pakistan J Agric Sci 44 (2): 337-340.

An B J, Kwak J H, Son J H, Park J M, Lee J Y and Jo C (2004) Biological and antimicrobial activity of irradiated green tea polyphenols. Food Chem 88(4):549-555.

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 Sci77(4): 626-633.

Bhoyar A M, Pandey N K, Anand S K and Verma S S (1998) Quality characteristics of restructured chicken steaks as influenced by packaging during frozen storage. Indian J. Poult Sci 33 (1): 56-60.

Bozkurt H (2006) Utilization of natural antioxidants: Green tea extract and Thymbra spicata oil in Turkish dry fermented sausage. Meat Science 73:442-450.

Chestnut C M, Emswiler B S, Kotula A W and Young E P (1977) Bacteriological quality of ingredients used in ground beef manufacture. J Anim Sci 44: 213- 217.

Choi S H, Kwon H C An, D J, Park J R and Oh D H (2003) Nitrite contents and storage properties of sausage added with green tea powder.Korean Journal for Food science of Animal Resources 23: 299-308.

Cowan M M (1999) Plant products as antimicrobial agents. Clin. Microbiol. Rev12: 564 –582.

Cruzen S M, Pinchak W E, Min B R and Miller R K (2010) plant based tannins as antioxidants in pre-cooked ground beef patties. 63rd Reciprocal Meat Conference Abstracts/ Meat Sci 86:533-576.

Dixon, B.D. and Parekh, J.V. (1979) Use of the cone penetrometer for testing the firmness of butter. J. Texture Studies 10:421-434.

Ferial M Abu-Salem, Esmat A Abou-Arab, Hayam M Ibrahim and Azza A Abou Arab (2011) Effect of Adding Green Tea Extract, Thyme Oil and/or their Combination to Luncheon Roll Meat during Refrigerate Storage. Journal of American Science 7(7): 538-548.

Georgantelis D, Ambrosiadis I, Katikou P, Blekas G and Georgakis S A (2007) Effect of rosemary extract, chitosan and a-tocopherol on microbiological parameters and lipid oxidation of fresh pork sausages stored at 4°C. Meat sci 76 (1): 172-181.

Hamm R (1960) Eating quality of meat in "Lawrie's Meat Science" Vol.6 (Ed)R.A Lawrie pp.223 woodhead publishing Ltd., Cambridge.

Hara Y (2001) Green tea: health benefits and applications. New York, USA: Marcel Dekker.

Hara Y, Watanabe M and Sakaguchi G (1989) The fate of Clostridium botulinum spores inoculated into tea drinks, Shokuhin Kogyo Gakkaishi 36, 375–379.

Higdon J V and Frei B (2003)Tea catechins and polyphenols: health effects, metabolism and antioxiant functions. Critical Reviews in Food Science and Nutrition 43:89-143

Inderjith Singh, Yadav A S, Pandey N K and Singh R P(2005) Antimicrobial effect of spices extracts against Salmonella typhimurium in chicken patties during frozen storage and its detection by PCR method. International Poultry Science Association ference(IPSACON) 2005.

Jay J M (1964) Release of aqueous extracts by beef homogenates and factors affecting extract release volume. J Food Tech 18: 129-131.

Jay J M 1996 Modern Food Microbiology, 4th edition CBS publication and distributors,New Delhi.

Jin-ling QIAO, Yong-jin HU, Zhen-hui CAO, Chang-rong GE (2009) Effects of green tea extract on preservation of chilled mutton. Food Sci 2009-12

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 Sci 64:13-17.

Juneja V K, Bari M L, Inatsu Y, Kawamoto S and Friedman M (2009) Thermal destructionof Escherichia coli 0157:H7 in sous-vide cooked ground beef as affected by tea leaf and apple skin powders. J Food Prot 72:860-865.

Kanner J, Harel S and Jaffe R (1991) Lipid peroxidation of muscle food as affected by NaCl. J Agric Food Chem 39: 1017-1021.

Karolina M Wojciak, Zbigniew J Dolatowski, Anna Okon (2011) The effect of water plant extracts addtion on the oxidative stability of meat products. ACTA Scientiarum Polonorum Technologia Alimentaria 10(2):175188.

Kazimierczuk K and Kozlowska M (2006) Prospects of applying essentials oils in meat processing. Gosp. Miesna 60 (4): 18-20.

Keokamnerd T, Acton J C, Han I Y and Dawson P L (2008) Effect of commercial rosemary oleoresin preparations on ground chicken thigh meat quality packaged in a high- oxygen atmosphere. Poult Sci 87 (1): 170-179.

Kowale B N, Rao V K, Babu N P, Sharma N and Bisht G S (1996) Lipid oxidation and cholesterol oxidation in mutton during cooking and storage. Meat Sci 43 (2): 195-202.

Kumudavally K V, Phanindrakumar H S, Tabassum A,Radhakrishna K andBawa A S (2008) Green tea – A potential preservative for extending the shelf life of fresh mutton at ambient temperature (25 ± 2 °C). Food Chem107: 426–433.

Lara M S, Gutierrez J I, Timon M and Andres A I (2011) Evaluation of two natural extracts (rosemarinus

officinalis L. and Melissa officinalis L.) as antioxidants in cooked pork patties packed in MAP. Meat Sci 88:481-488.

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. Poult Sci 76(2):415–421.

Lund M N, Hviid M S and Skibsted L H (2007) The combined effect of antioxidants and modified atmosphere packanging on protein and lipid oxidation in beef patties during chill storage. Meat Sci76:26-233.

Martinez L, Cilla I, Beltran J A and Roncales P (2006) Antioxidant effect of rosemary, borage ,green tea, pu-erh tea and ascorbic acid on fresh pork sausages packaged in a modified atmosphere: influence of the presence of sodium chloride. J Sci Food Agri 86(9) 1298–1307.

Mc Carthy T L, Kerry J P, Kerry J F, Lynch P B and Buckley D J(2001) Assessment of antioxidant potential of natural food and plant extracts in fresh and previously frozen pork patties. Meat Sci 57(2):177-184.

Mirshekar R, Dastar B and Shabanpour B (2009) Effect of Rosemary, Echinacea, Green Tea extracts and Ascorbic acid on broiler meat quality. Pakistan J Bio Sci 12: 1069-1074.

Mitsumoto M, O' Grady M N, Kerry J P, Buckley D J (2005) Addition of tea catechins and vitamin C on sensory evaluation, colour and lipid stability during chilled storage in cooked or raw beef and chicken patties. Meat sci 69(4): 773-779.

Nam K C, Min B R, Ismail H, Lee E J, Cordray J and Ahn D U (2006) Influence of rosemary-tocopherol/packaging combination on meat quality and the survival of pathogens in irradiated porkloins.MeatSci 74:380-387.

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 J Poult Sci 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. Int J Food Sci and Technol 43(10):1807-1812.

Newkirk K A, Gilchrist C L, Hand L W and Sutton D S (1993) Effects of synthetic antioxidants and rosemary extracts on oxidative rancidity and color stability in whole hog sausages. Animal Science Research Report 78-83.

O'Grady M N, Monahan F J, Brunton N P(2001) Oxymyoglobin and lipid oxidation in bovine muscles. Mechanistic studies. J Food Sci 66, 386.

Parks L L and Carpenter J A(1987) Functionality of six non-meat proteins in meat emulsion systems. J Food Sci 52: 271-274, 278.

Pearson D (1973) Flesh foods, meat and fish in laboratory techniques in food analysis First edition 166-212. Butter worths and Co (P) Ltd, London.

Pinar Yerlikaya, Nalan Gokoglu (2010)Effect of previous plant extract treatment on sensory and physical properties of frozen bonito (sarda sarda) fillets. Turkish Journal of Fisheries and Aquatic Sciences 10: 341-349.

Rababah T M, Ereifej K I, Mahasneh M A Al and Rababah M A Al(2006) Effect of plant extracts on physicochemical properties of chicken breast meat cooked using conventional electric oven or microwave. Poult Sci 85:148–154.

Robbins K and Moines D (2010)Impact of rosemary and green tea extract on the colour stability, flavour and oxidative properties of enhanced beef steaks. 63rd Reciprocal Meat Conference Abstracts/Meat Sci 86:533-576.

Rounds L, Havens C M, Feinstein Y, Friedman M and Ravishankar S (2012) Plant extracts, spices, and essential oils inactivate Escherichia coli O157:H7 and reduce formation of potentially carcinogenic heterocyclic amines in cooked beef patties. J Agri. Food Chemi A-G

Sahoo J, Anjaneyulu A S R and Srivasta A K(1998) Improvement in quality of frozen ground buffalo meat by preblending with natural antioxidants and vaccum packaging. J Food Sci and Tech 35(3):209-215.

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

Sasse A, Colindres P and Brewer M S (2009) Effect of natural and synthetic antioxidants on the oxidative stability of cooked, frozen pork patties. J Food Sci 74 (1): S30- S35.

Serdaroglu M and Yildiz-Turp G (2004)The effects of ascorbic acid, rosemary extract and a-tocopherol / ascorbic acid on some quality characteristics of frozen chicken patties Electronic Journal of Polish Agricultural Universities 7(1):1- 7

Siripatrawan U and Noipha S (2012) Active film from chitosan incorporating green tea extract for shelf life extension of pork sausages. Food Hydrocolloids 27: 102–108.

Szymanczuk E H, Lipinska E and Stasiuk M (2011) The effect of rosemary preparations on the microbial quality and TBARS value of model pork batters. Acta Scientiarum Polonorum, Technologia Alimentaria 10(2): 165-174.

Taylor P W, Hamilton-Miller J M T and Stapleton P D(2005) Antimicrobial properties of green tea catechins . Food Sci Technol Bull.2: 71–81.

Townsend W E, Witnauer L P, Riloff J A and Swift L E (1968) Comminuted meat emulsions. Differential thermal analysis of fat transistion. Food Tech 22: 319-323.

Trout E S, Hunt M C, Johnson D E, Claus J R, Kastner C L and Kroff D H (1992) Characteristics of low fat ground beef containing texture modifying ingredients. Food safety inspection science. Washington DC.

Ucak I, Ozogul Y and Durmus M (2011) The effects of rosemary extract combination with vacuum packing on the quality changes of Atlantic mackerel fish burgers. Int J Food Sci and Technol 46(6): 1157–1163

Warner K and Inglett G(1997)Flavor and texture characteristics of foods containing z-trim corn and oat fibers as fat and flour replace. Cereal Food World 42(10):821-825.

Wierbicki E, Tiede M G and Burrell R G (1962) Determination of meat swelling as a method for investigating the water binding capacity of muscle proteins with low water holding forces. Fleischwirtschoft 14, 951 (C.f. Journal of Food Science 37, 860-864).

Witte, V. C., G. F. Krause and M. E. Bailey. (1970). A new extraction method for determining 2-thiobarbituric acid values for pork and beef during storage. J Food Sci 35:585-592.

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.

Yang C S, Chung J Y, Yang GY, Chhabra S K and Lee M J(2000) Tea and tea polyphenols in cancer prevention. J. Nutr 130: S472- S478.

Yildiz-Turp G and Serdaroglu M (2004) The effects of ascorbic acid, rosemary extract and a-tocopherol / ascorbic acid on some quality characteristics of chicken patties stored at 4°C for 7 days. J Food Tech 2(3):153-157.

Yuehua He and Fereidoon Shahidi (1997)Antioxidant activity of green tea and its catechins in a fish meat model system J Agri. Food Chemi 45 (11): 4262–4266.

Zandi P and Gondon M H (1999) Antioxidant activity of extracts from old tea leaves. Food Chem 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.

Table 1 : Mean ± S.E Values of percent cooking loss, emulsion stability, water holding capacity and hardness of chicken meat sausages as influenced by different treatments during refrigerated storage (4±1°C)

Days of storage	Control	Treatments		Overall mean ± S.E.
		T1	T2	
Cooking loss				
0	6.00±0.13^{a}	5.83±0.10^{a}	6.07±0.15a	5.96±0.12^{a}
2	9.50±0.31^{b}	9.42±0.29^{b}	9.77±0.12^{b}	9.56±0.24^{b}
4	12.95±0.14^{c}	12.68±0.27^{c}	13.04±0.32^{c}	12.89±0.24^{c}
6	14.64±0.22^{d}	13.83±0.11^{d}	13.93±0.09^{d}	14.13±0.14^{d}
8	19.20±0.17^{e}	18.02±0.18^{e}	18.29±0.19^{e}	18.50±0.18^{e}
Overall mean ± S.E.	12.46±0.84^{B}	11.96±0.77^{A}	12.22±0.77^{AB}	
Emulsion stability				
0	96.38±0.12^{e}	96.50±0.10^{e}	96.13±0.12^{e}	96.33±0.11^{d}
2	94.28±0.12^{d}	94.51±0.10^{d}	94.60±0.27^{d}	94.46±0.16^{c}
4	92.22±0.10^{c}	92.48±0.17^{c}	92.48±0.09^{c}	92.39±0.12^{b}
6	91.27±0.11^{b}	91.64±0.12^{b}	91.56±0.13^{b}	91.49±0.12^{b}
8	88.03±0.31^{a}	88.89±0.24^{a}	88.75±0.22^{a}	88.55±0.25^{a}
Overall mean ± S.E.	92.44±0.53^{A}	92.80±0.48^{B}	92.70±0.48^{B}	
Water holding capacity				
0	67.36±0.22e	67.88±0.23^{e}	67.47±0.17^{e}	67.57±0.20^{e}
2	62.83±0.07^{d}	62.63±0.48^{d}	62.81±0.47^{d}	62.75±0.34^{d}
4	60.95±0.48^{c}	60.87±0.47^{c}	60.82±0.32^{c}	60.88±0.42^{c}
6	58.73±0.14^{b}	58.73±0.20^{b}	58.80±0.33^{b}	58.75±0.23^{b}
8	56.20±0.27^{a}	56.87±0.20^{a}	56.94±0.35^{a}	56.67±0.27^{a}
Overall mean ± S.E.	61.21±0.71^{A}	61.40±0.72^{A}	61.37±0.69^{A}	
Hardness				
0	91.83±1.11^{e}	91.00±2.31^{e}	91.17±0.40e	91.33±1.27^{e}
2	86.17±0.48^{d}	86.00±1.39^{d}	86.17±0.60^{d}	86.11±0.82^{d}
4	80.33±1.20^{c}	80.67±1.23^{c}	80.50±0.89^{c}	80.50±1.10^{c}
6	73.50±0.56^{b}	73.00±0.45^{b}	73.17±0.91^{b}	73.22±0.64^{b}
8	67.67±1.12^{a}	67.67±0.76^{a}	67.17±0.60^{a}	67.50±0.82^{a}
Overall mean ± S.E.	79.90±1.65^{A}	79.67±1.67^{A}	79.63±1.53^{A}	

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

Treatments : Chicken meat sausages incorporated with

T_1 : 0.2 per cent Rosemary extract, T_2 : 0.01 percent BHA

Table 2 : Mean ± S.E Values of pH, 2-TBARS values and free fatty acid values of chicken meat sausages as influenced by different treatments during refrigerated storage (4±1°C)

Days of storage	Control	Treatments		Overall mean ± S.E.
		T1	T2	
pH				
0	5.96±0.004^{a}	5.94±0.003^{a}	5.96±0.002^{a}	5.95±0.003^{a}
2	6.14±0.002^{b}	6.00±0.020^{b}	6.10±0.020^{b}	6.08±0.014^{b}
4	6.20±0.004^{b}	6.13±0.005^{b}	6.19±0.002^{b}	6.17±0.003^{b}
6	6.26±0.010^{b}	6.19±0.020^{b}	6.23±0.010^{b}	6.22±0.010^{bc}
8	6.33±0.003^{c}	6.26±0.001^{b}	6.31±0.004^{c}	6.30±0.002^{bc}
Overall mean ± S.E.	6.18±0.020^{B}	6.10±0.020^{A}	6.16±0.020^{C}	
2-TBARS values				
0	0.17±0.003^{a}	0.12±0.006^{a}	0.14±0.004^{a}	0.14±0.004^{a}
2	0.44±0.010^{b}	0.19±0.002^{a}	0.26±0.012^{b}	0.29±0.008^{ab}
4	0.98±0.010^{c}	0.35±0.010^{b}	0.50±0.020^{c}	0.61±0.013^{c}
6	1.40±0.040^{d}	0.58±0.010^{c}	0.74±0.020^{d}	0.90±0.020^{d}
8	3.14±0.040^{e}	0.94±0.010^{d}	1.54±0.010^{e}	1.87±0.020^{e}
Overall mean ± S.E.	1.23±0.200^{C}	0.44±0.050^{A}	0.64±0.090^{B}	
Free fatty acid values				
0	0.013±0.0004^{a}	0.011±0.0006^{a}	0.012±0.0006^{a}	0.012±0.0005^{a}
2	0.015±0.0001^{a}	0.012±0.0001^{a}	0.013±0.0002^{a}	0.013±0.0001^{a}
4	0.017±0.0002^{a}	0.013±0.0002^{a}	0.015±0.0004^{a}	0.015±0.0002^{ab}
6	0.020±0.0005^{a}	0.014±0.0002^{a}	0.017±0.0005^{a}	0.017±0.0004^{bc}
8	.084±0.0475^{b}	0.025±0.0004^{b}	0.028±0.0004^{b}	0.045±0.0161^{d}
Overall mean ± S.E.	0.030±0.0102^{B}	0.015±0.0009^{A}	0.017±0.0011^{A}	

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

Treatments : Chicken meat sausages incorporated with

T_1 : 0.2 per cent Rosemary extract, T_2 : 0.01 percent BHA

Table 3 : Mean ± S.E Values of standard plate count and coliform of chicken meat sausages as influenced by different treatments during refrigerated storage (4±1°C)

Days of storage	Control	Treatments		Overall mean ± S.E.
		T1	T2	
Standard plate count				
0	4.63±0.010^{a}	4.20±0.010^{b}	4.56±0.009^{b}	4.46±0.009^{b}
2	5.22±0.010^{b}	3.64±0.009^{a}	4.12±0.009^{a}	4.32±0.009^{a}
4	5.49±0.010^{c}	3.82±0.009^{a}	4.43±0.009^{b}	4.58±0.009^{b}
6	5.82±0.010^{d}	4.25±0.009^{b}	4.79±0.009^{c}	4.95±0.009^{c}
8	6.93±0.009^{e}	4.75±0.009^{c}	5.90±0.010^{d}	5.86±0.009^{d}
Overall mean ± S.E.	5.62±0.17^{C}	4.13±0.12^{A}	4.76±0.03^{B}	
Coliform count				
0	2.24±0.070^{a}	2.15±0.010b	2.17±0.01^{a}	2.18±0.03^{a}
2	6.20±0.030^{b}	1.90±0.020^{a}	2.84±0.02^{b}	3.64±0.02^{b}
4	8.02±0.020^{c}	1.98±0.010^{a}	3.21±0.02^{c}	4.40±0.07^{c}
6	8.77±0.009^{d}	3.41±0.020^{c}	3.86±0.05^{d}	5.34±0.02^{d}
8	9.61±0.070^{e}	4.59±0.009^{d}	6.17±0.01^{e}	6.79±0.02^{e}
Overall mean ± S.E.	6.99±0.17^{C}	2.81±0.12^{A}	3.65±0.03^{B}	

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

Treatments : Chicken meat sausages incorporated with

T_1 : 0.2 per cent Rosemary extract, T_2 : 0.01 percent BHA

Table 4 : Mean ± S.E Values of organoleptic characteristics of chicken meat sausages as influenced by different treatments during refrigerated storage (4±1°C)

Days of storage	Control	Treatments		Overall mean ± S.E.
		T1	T2	
Colour				
0	8.52±0.01^{e}	8.42±0.02^{e}	8.43±0.01^{d}	8.89±0.01e
2	8.39±0.01^{d}	8.44±0.01^{d}	8.40±0.06^{d}	8.41±0.02^{d}
4	8.11±0.03^{c}	8.21±0.02^{c}	8.14±0.02^{c}	8.15±0.02^{c}
6	7.78±0.03^{b}	7.93±0.02^{b}	7.86±0.05^{b}	7.85±0.03^{b}
8	7.64±0.01^{a}	7.75±0.02^{a}	7.71±0.02^{a}	7.70±0.01^{a}
Overall mean ± S.E.	8.09±0.06^{A}	8.15±0.05^{B}	8.11±0.06^{A}	
Flavour				
0	7.98±0.35^{d}	8.05±0.02^{d}	8.18±0.06^{d}	8.07±0.04^{d}
2	7.79±0.36^{c}	7.90±0.12^{c}	8.12±0.03^{d}	7.93±0.17^{c}
4	7.68±0.16^{c}	7.90±0.03^{c}	7.85±0.01^{c}	7.81±0.06^{c}
6	7.22±0.21^{b}	7.67±0.01^{b}	7.59±0.01^{b}	7.49±0.07^{b}
8	7.00±0.18^{a}	7.30±0.06^{a}	7.23±0.01^{a}	7.17±0.08^{a}
Overall mean ± S.E.	7.53±0.13^{A}	7.76±0.06^{B}	7.79±0.07^{B}	
Juiciness				
0	8.54±0.01^{d}	8.54±0.01^{c}	8.54±0.01d	8.54±0.01^{e}
2	8.37±0.01^{c}	8.38±0.01^{b}	8.34±0.01^{c}	8.36±0.01^{d}
4	8.25±0.01^{c}	8.26±0.01^{b}	8.24±0.01c	8.25±0.01^{c}
6	7.83±0.02^{b}	7.83±0.02^{a}	7.77±0.01^{b}	7.81±0.01^{b}
8	7.58±0.02^{a}	7.69±0.03^{a}	7.46±0.03^{a}	7.57±0.02^{a}
Overall mean ± S.E.	8.11±0.07^{B}	8.14±0.06^{B}	8.07±0.07^{A}	
Tenderness				
0	8.21±0.21^{e}	8.47±0.03^{d}	8.40±0.04^{e}	8.36±0.09^{e}
2	7.91±0.23^{d}	8.33±0.02^{c}	8.22±0.04^{d}	8.15±0.09^{d}
4	7.60±0.22^{c}	7.85±0.02^{b}	7.83±0.02^{c}	7.76±0.08^{c}
6	7.27±0.21^{b}	7.71±0.03^{b}	7.67±0.02^{b}	7.55±0.08^{b}
8	6.97±0.21^{a}	7.50±0.03^{a}	7.47±0.02^{a}	7.31±0.08^{a}
Overall mean ± S.E.	7.59±0.12^{A}	7.97±0.07^{B}	7.92±0.07^{B}	
Overall acceptability				
0	8.19±0.22^{e}	8.45±0.02e	8.37±0.06^{e}	8.33±0.10^{e}
2	7.87±0.34^{d}	8.29±0.05^{d}	8.23±0.02^{d}	8.13±0.13^{d}
4	7.68±0.20^{c}	8.06±0.07^{c}	8.00±0.06^{c}	7.91±0.11c
6	7.44±0.21^{b}	7.78±0.04^{b}	7.73±0.03^{b}	7.65±0.09^{b}
8	7.17±0.20^{a}	7.36±0.05^{a}	7.31±0.04^{a}	7.28±0.09^{a}
Overall mean ± S.E.	7.66±0.11^{A}	7.98±0.07^{B}	7.92±0.07^{B}	

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

Treatments : Chicken meat sausages incorporated with

T_1 : 0.2 per cent Rosemary extract, T_2 : 0.01 percent BHA