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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.

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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.

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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