Journal of Animal Research: v.9 n.4, p. 565-571. August 2019

DOI: 10.30954/2277-940X.04.2019.11

Effect of Rosemary (*Rosmarinus officinalis* L.) Leaves Extract on Quality Attributes of Chicken Powder Incorporated Fried Chicken Snacks

Ashish Saini[1]*, Anurag Pandey[1], Sanjita Sharma[2], Yellamelli Ramji Ambedkar[1], Umesh Shaligram Suradkar[1], Priyanka Meena[1], Ravi Raman[1] and Asman Singh Gurjar[1]

[1]Department of Livestock Products Technology, Post Graduate Institute of Veterinary Education and Research, Jaipur, INDIA
[2]Department of Livestock Production Management, Post Graduate Institute of Veterinary Education and Research, Jaipur, INDIA

**Corresponding author: A Saini; Email: ashish29vet@gmail.com*

Received: 26 June, 2019 **Revised:** 25 July, 2019 **Accepted:** 27 July, 2019

ABSTRACT

The present study was conducted to develop chicken meat powder (CMP) incorporated ready-to-eat shelf stable fried chicken snacks and evaluate the effect of rosemary leaves extract (RE) incorporation on physico-chemical, microbiological and sensory properties in developed product during ambient storage up to 60 days. Two different groups were made; control (without RE) and second group with RE treated (3% level). In physico-chemical properties, results showed that RE incorporation had highly significant ($p<0.01$) effect on thiobarbituric acid reactive substances (TBARs), free fatty acid (FFA) and tyrosine value. Similarly in microbiological parameter RE treated product had significantly ($p<0.05$) lower total plate count (TPC), *Staphylococcus* count (SC) and significantly ($p<0.01$) lower yeast and mold count than control. RE incorporation had highly significant effect ($p<0.01$) on sensory score (texture, flavour and overall acceptability except appearance) of the product during storage period. Therefore, it is concluded that RE incorporation into fried chicken snacks improved physico-chemical (TBARs, free fatty acid content and Tyrosine value), microbiological (Total plate count, *Staphylococcus* count and yeast and mold count) and sensory parameter (flavor, texture and overall acceptability) of the chicken snacks during 60 days storage.

Keywords: Chicken snacks, microbiological, physico-chemical, rosemary extract and sensory properties

Indian cooking and lifestyle have undergone tremendous changes in the last decades. In the newly rising era of fast and convenience foods, ready-to-eat foods are extensively admired. In Indian perspective, culture, traditions, customs, and taboos determine meat consumption to an immense level particularly in the rural societies (Devi *et al.,* 2014). High mutton price, limited accessibility of fish outside coastal regions and relatively low cost in comparison to other meat, all these helped to make poultry meat the preferred and most consumed meat in India.

Perishability of meat products has been considered as a very serious dilemma, particularly in tropical countries like India, where household refrigeration facility is sparse (Kumar *et al*., 2015). In this epoch, the energy demand for food preservation and improving the safety of preserved foods vis-à-vis convenience, development of shelf stable products is extremely preferable. There are lots of reports on the development of shelf stable intermediate moisture (IM) products (Kanatt, 2006). Preparation of chicken meat powder is an efficient way to cope up with the problem of perishability. Different meat product could be made by utilization of chicken meat powder in the preparation of chicken powder incorporated an *Idli* mix to improve the nutritional quality of the products (Bishnoi *et al.,* 2015).

Usually cereal snacks deficient in essential amino acids such as threonine, lysine and tryptophan (Jean *et al*., 1996), but incorporation of animal protein such as fish,

How to cite this article: Saini, A., Pandey, A., Sharma, S., Ambedkar, Y.R., Suradkar, U.S., Meena, P., Raman R. and Gurjar, A.S. (2019). Effect of rosemary (*Rosmarinus officinalis* L.) leaves extract on quality attributes of chicken powder incorporated fried chicken snacks *J. Anim. Res.,* **9**(4): 01-07.

pork, beef, chicken etc, significantly enhances its nutritive value especially with respect to amino acids, flavour and taste (Singh *et al*., 2015). In the food matrix, meat based snack foods are convenient, easy to carry, highly crispy, attractive, nutritionally sound, shelf-stable (Singh *et al.,* 2013). A verity of meat snacks exist in global market such as Jerky, Popped pork rind, Kilishi, Meat biscuit, Meat cookies, Meat noodles, Meat chips and Meat stick. Likewise chicken snacks are the deep fried, gram floor based, chicken meat powder incorporated shelf stable ready-to-eat meat product.

The most common form of deterioration in dry meat products is oxidative rancidity; which leads to extensive flavor changes, structural damage to proteins leading to loss of freshness that discourages repeat purchases by consumers. The most effective approach to avoid oxidative deterioration of meat products is to integrate antioxidants into formulations. Antioxidants either synthetic or natural have become an indispensable group of food additives mainly because of their distinctive properties of enhancing the shelf-life of food products without any harm to sensory or nutritional qualities (Nanditha and Prabhasankar, 2008). In industrial processing, mainly synthetic antioxidants such as butylated hydroxylanisole (BHA) and butylated hydroxyltoluene (BHT) are used to prolong the storage stability of meat products. However, increasing concerns over the safety of synthetic food additives have resulted in a trend toward natural products.

Natural antioxidants extracted from herbs and spices demonstrate a variety of efficacy when used in different food applications (Bowser *et al*., 2014). Now a day's plants are the liberal source to provide man with valuable bioactive substances (Tayel and El-Tras, 2012) and thus different plant products are being evaluated as natural antioxidants to protect and enhance the overall quality of meat and meat products. These natural antioxidants from plants, in the form of extracts, have been obtained from different sources and investigated to decrease the lipid oxidation (Huang *et al*., 2011; Wojciak*et al*., 2011; Das *et al*., 2012) thus provide a good alternative to synthetic antioxidants. Among natural antioxidant sources, rosemary (*Rosmarinus officinalis* L.) is highly potent, shrubby herb, with a unique aromatic odour. Antioxidant activity in rosemary is may be due to its high phenolic compounds, such as carnosic acid, rosmarinic acid, carnosol, rosmanol, rosmariquinone and rosmaridiphenol (Riznar *et al*., 2006). There is ample amount of information existing on the utilization of rosemary extract as dietary antioxidants in different food and feed formulation as well as in different meat products like chicken frankfurters (Rinzar*et al.,* 2006), fermented lamb meat sausage (Bowser *et al.,* 2014), chicken nuggets (Teruel *et al.,* 2015), lamb patties (Baker *et al.,* 2013), turkey sausage (Jridi *et al.*, 2015), beef burger (Georgantelis *et al.,* 2007), pork sausage (Sebranek*et al.,* 2005) and chicken meat patties (Al-Hijazeen and Al-Rawashdeh, 2019). However, use of rosemary extract in shelf stable meat products is very scanty. Therefore, the present study has been undertaken develop ready-to-eat shelf stable ready to eat meat product and to explore the effect of rosemary leaves extract in chicken meat powder incorporated self stable ready to eat fried chicken snacks.

MATERIAL AND METHODS

Extract preparation

The rosemary leaves were oven dried at 50^{o}C for 12 hrs followed by grinding and sieving. Pre-weighed powdered leaves were extracted with 70% Ethanol for 24 hrs at 40^{o}C. The extract was collected and concentrated under reduced pressure in a rotary vacuum evaporator (Labconco Corporation, USA) until semi solid consistency. The semisolid mass was oven dried at 50^{o}C at overnight to obtain dried extract. The extract were reconstituted with the same solvent as used for extraction to obtain 5% solutions and stored at 4°C.

Formulation of fried chicken snacks

Chicken meat powder (CMP) was prepared by mincing of spent hen meat in meat mincer (Nova Pvt. Ltd.). Minced meat was pressure cooking for 15 min and air dried at 80^{o}C for 9 hrs and pulverized in mixer (Maharaja White line, India). The dough was prepared by mixing gram flour, spice mix, table salt and rosemary extract (RE) was mixed with CMP. Subsequently, chicken broth was added in to mix to make dough at approx. 40 percent of the formulation and kept it for 10-15 min for conditioning. Later on, the dough was filled in the vermicelli maker machine for preparations of product. Afterward deep fried at 190^{o}C temperature for 45 sec. for fried chicken snacks preparation. RE incorporation could not produce

any significant effect in sensory properties of the product, therefore products with highest (3%) level of RE was selected for further analysis. For the storage study RE treated as well as control sample of fried chicken snacks stored at ambient temperature in Aluminium/Polyethylene laminates bag for physicochemical, microbiological and sensory evaluation up to 60 days in each 15 days interval.

Analytical methods

Sample from both groups was taken in triplicate for physiochemical, microbiological and sensory analysis.

Physico-chemical analysis

The thiobarbituric acid reactive substances (TBARs), free fatty acid (FFA) content and tyrosine value of value of CMP incorporated fried chicken snacks was analyzed by the method of Witte *et al.* (1970), Koniecko (1979) and Strange *et al.* (1977), respectively.

Microbiological analysis

Total plate count (TPC), *Staphylococcus* count (SC), coliform count and yeast and mold count in the samples were determined following the methods described by APHA (1984).

Sensory analysis

The sensory properties (appearance, texture, flavor and overall acceptability) of both control and RE treated product stored at ambient temperature were carried out by 9 point hedonic scale to the method of Wichchukita and O'Mahonyc, (2014) by panelists consisting of faculty member and postgraduate students of the department at each 15 days interval up to 60 days.

STATISTICAL ANALYSIS

The experiments were replicated thrice and obtained data were analyzed using Statistical Software Packages (SPSS 16.0) following the procedure of Snedecor and Cochran (1994). P-value less than 0.05 at 5% level and 0.01 at 1% of significance were considered as statistically significant and highly significant respectively. The data were subjected to analysis of variance by ANOVA during storage study.

RESULT AND DISCUSSION

Physico-chemical parameter

The mean values of physico-chemical parameter of control and treatment groups are presented in Table 1. RE incorporation significantly ($p<0.01$) reduced the TBARs number of RE treated product as compare to control during entire storage period. The increase in TBARs value was very diminishin RE treated product and remained lowest (0.73 mg malonaldehyde (MDA) kg^{-1} sample)

Table 1: Effect of RE incorporation on the physico-chemical parameters of fried chicken snacks

Parameters	Storage period (days)				
Physico-chemical	0	15	30	45	60
TBARs value (mg malonaldehyde/kg)					
C	0.26 ± 0.17^{eA}	0.46 ± 0.13^{dA}	0.55 ± 0.32^{cA}	0.75 ± 0.05^{bA}	0.82 ± 0.02^{aA}
RE treated	0.25 ± 0.17^{eA}	0.38 ± 0.07^{dB}	0.50 ± 0.16^{cB}	0.68 ± 0.09^{bB}	0.73 ± 0.09^{aB}
Tyrosine value (mg/100g of sample)					
C	2.11 ± 0.04^{eA}	3.61 ± 0.04^{dA}	5.29 ± 0.04^{cA}	6.66 ± 0.03^{bA}	7.65 ± 0.08^{aA}
RE treated	1.98 ± 0.02^{eA}	3.11 ± 0.06^{dB}	4.52 ± 0.03^{cB}	5.83 ± 0.04^{bB}	7.03 ± 0.03^{aB}
Free fatty acid value (% of oleic acid)					
C	0.14 ± 0.09^{dA}	0.22 ± 0.05^{cA}	0.25 ± 0.02^{bA}	0.29 ± 0.07^{bA}	0.31 ± 0.01^{aA}
RE treated	0.14 ± 0.05^{dA}	0.19 ± 0.06^{dB}	0.22 ± 0.05^{cB}	0.26 ± 0.03^{bB}	0.27 ± 0.05^{aB}

Mean ±S.E. with different superscripts within each column (capital letters) and each row (small letters) differed highly significantly ($p<0.01$), significantly ($p<0.05$) C=control, RE=rosemary leaves extract treated sample; n = 6 for each group.

at 60 days as compare with control (0.82 mg MDA kg^{-1} sample). Rosemary extracts had phenolic antioxidants which react with lipid or hydroxyl radicals and converted them into stable products (Trindade *et al.,* 2007). This result was similar with the study of Baker *et al.* (2013) and Al-Hijazeen and Al-Rawashdeh, (2019) in karadi lamb patties and chicken meat patties, respectively treated with rosemary extract. Sebranek *et al.* (2005) reported that 1000 mg/kg of RE was effective as BHA/BHT on TBARS values using precooked-frozen sausage. However, during the storage period consistence increase in TBA value of both groups were observed. This might be due to auto-oxidation of lipids over a period time and increased microbial population. Similar results have been found by other workers (Modi *et al*., 2004; Talukder *et al*., 2016) in chicken nuggets and mutton snack respectively.

Rosemary extract has highly significant ($p<0.01$) effect on FFA of the product. The initial FFA value was found to be 0.14 (oleic acid %) for both groups, but at the end of storage period (Table 1) RE treated sample (0.27) has significantly lower FFA value than the control (0.31). A similar significant observation was founded by Kenar *et al*. (2010) and Ucak *et al*. (2011) in mackerel fish burgers and sardine fillets, respectively. Guran *et al*. (2015) also reported similar result in fish patties treated with rosemary extract. Although during the storage period consistent increase in FFA value of product in both groups was observed. However RE treated group has diminish increase pattern as compare to control. It may be due to the natural antioxidants prevent lipid oxidation (Indumathi and Reddy, 2015). The Findings were in accordance with Kashyap *et al*. (2012) in chicken meat patties incorporated with natural antioxidants. Similarly Indumathi and Reddy (2015) reported lower FFA value as control in chicken meat nuggets treated with green tea, guava leaves and curry leaves during storage. Increase in FFA value with storage time was observed by Modi *et al*. (2007) and Idowu *et al*. (2010) in kebab mix and kilishi, respectively.

Results of the study reveled that RE has highly significant ($p<0.01$) effect on tyrosine value of the product. Initially tyrosine value of both groups was 2.11 and 1.98 mg/100g and reached up to 7.65 and 7.03 mg/100g of sample respectively for control and RE treated group respectively (Table 1). Increase in tyrosine value during storage period might be due to increase in microbial load and enhance production of proteolytic enzymes in the late logarithmic phase of microbial growth causing autolysis (Thomas *et al*., 2010). In the entire storage period RE treated group has significantly lower tyrosine value than the C. The lower values of treated sample attributed due to the antioxidant activity of RE. Similar result was observed by Khare *et al*. (2016) in chicken cut-up parts treated with natural antioxidants.

Microbiological analysis

Microbial attributes of the control and RE treated product are presented in Table 2. Results of the study indicated

Table 2: Effect of RE incorporation on the microbiological parameters of fried chicken snacks

Parameters	**Storage period (days)**				
Microbiological	0	15	30	45	60
Total plate count (log_{10} cfu/g)					
C	2.24 ± 0.23^{eA}	2.47 ± 0.06^{dA}	2.83 ± 0.11^{cA}	3.04 ± 0.21^{bA}	3.74 ± 0.17^{aA}
RE treated	2.24 ± 0.02^{eA}	2.34 ± 0.18^{dB}	2.56 ± 0.13^{cB}	2.83 ± 0.06^{bB}	3.13 ± 0.02^{aB}
Staphylococcus count (log_{10} cfu/g)					
C	1.55 ± 0.07^{eA}	1.78 ± 0.18^{dA}	2.01 ± 0.04^{cA}	2.27 ± 0.05^{bA}	2.51 ± 0.20^{aA}
RE treated	1.53 ± 0.03^{eA}	1.68 ± 0.03^{dB}	1.84 ± 0.02^{cB}	2.10 ± 0.04^{bB}	2.33 ± 0.07^{aB}
Coliform count (log_{10} cfu/g)					
C	ND	ND	ND	ND	ND
RE treated	ND	ND	ND	ND	ND
Yeast and mold count (log_{10} cfu/g)					
C	ND	ND	1.45 ± 0.05^{cA}	1.88 ± 0.14^{b}	2.07 ± 0.03^{aA}
RE treated	ND	ND	1.34 ± 0.03^{cB}	1.72 ± 0.01^{bB}	1.83 ± 0.01^{aB}

Mean ±S.E. with different superscripts within each column (capital letters) and each row (small letters) differed highly significantly ($p<0.01$), significantly ($p<0.05$) C=control, RE=rosemary leaves extract treated sample and ND= not detected; n = 6 for each group.

that RE has significant ($p<0.05$) effect over TPC and SC of the products in entire storage period. Initial TPC of the product was estimated 2.24 log cfu g^{-1} for both groups and it reached up to 3.74 and 3.13 log cfu g^{-1} at the end of the study for C and RE treated product respectively. Rinzar *et al*. (2006) reported similar findings in chicken frankfurters. Similarly the initial SC of the product was observed 1.55 log cfu g^{-1} for both groups and reached up to 2.51, 2.33 log cfu g^{-1} for C and RE treated product respectively at the end of storage period. Although TPC and SC increased along with storage period but increment was slower RE treated product as compare to C. Antimicrobial activity of rosemary might be due to carnosic acid, which is a major bioactive compound of the rosemary extract (Tavassoli and Djomeh, 2011). Coliform could not be founded in both groups during storage period; it might be due to absence of post processing contamination during handling of the product.

Yeast and molds were not detected on day 0 and 15 in both groups, but they appeared on the 30th day of storage in both C and RE treated product. RE incorporation has significant ($p<0.01$) effect on the Yeast and mold count of the product. At the end of storage period RE treated product (1.83) has significantly lower yeast and mold than the C (2.07) log cfu g^{-1} of sample (Table 2). Similar results reported by Singburaudom (2015) in plant pathogenic fungi. Diminish yeast and mold count in RE treated product might be due to high phenolic content of the rosemary extract (Moghtader *et al*., 2011).

Sensory evaluation

Data relating to various sensory attributes of control and RE treated product are presented in Table 3. In sensory parameter expect appearance, RE incorporation has significant ($p<0.01$) effect on flavour, texture and overall acceptability score of the product. Although in both groups consistent decrease in sensory score were observed, but RE treated product found comparatively higher sensory score than the control. The flavour score of RE treated group at 60th day (6.08) was higher than 45th day of control (5.98). The decrease in overall acceptability during storage is due to increase in lipid oxidation and degradation of proteins. The decline in overall acceptability scores indirectly influenced over the scores of flavor, appearance, texture and other sensory attributes (Singh *et al*., 2011). The progressive decrease in sensory scores could be correlated with an increase succeeding storage days, which favour oxidative rancidity, thereby

Table 3: Effect of RE incorporation on the sensory parameters of fried chicken snacks

Parameters	Storage period (days)				
Sensory	0	15	30	45	60
Appearance					
C	7.71±0.04^{bA}	7.64±0.02^{A}	7.55±0.02^{A}	7.43±0.20^{aA}	7.26±0.01^{aA}
RE treated	7.74±0.01^{bA}	7.65±0.02^{bA}	7.56±0.01^{aA}	7.50±0.02^{aA}	7.41±0.02^{aA}
Texture					
C	7.76±0.01^{cA}	7.23±0.07^{cA}	6.93±0.07^{bA}	6.32±0.04aA	5.73±0.15aA
RE treated	7.78±0.01^{dA}	7.43±0.05^{cB}	7.06±0.04^{cB}	6.58±0.06^{bB}	6.14±0.04^{aB}
Flavor					
C	7.82±0.01^{eA}	7.17±0.02^{dA}	6.35±0.03^{cA}	5.98±0.07^{bA}	5.39±0.06^{aA}
RE treated	7.85±0.03^{eA}	7.35±0.03^{dB}	6.53±0.03^{cB}	6.29±0.06^{bB}	6.08±0.04^{aB}
Overall acceptability					
C	7.79±0.06^{dA}	7.37±0.04^{dA}	6.28±0.04^{cA}	6.22±0.06^{bA}	5.73±0.07^{aA}
RE treated	7.84±0.02^{eA}	7.42±0.06^{dA}	6.87±0.03^{cB}	6.35±0.03^{bB}	6.06±0.04^{aB}

Mean ±S.E. with different superscripts within each column (capital letters) and each row (small letters) differed highly significantly ($p<0.01$), significantly ($p<0.05$) C=control, RE=rosemary leaves extract treated sample; n = 21 for each group.

increasing the physico-chemical and microbiological parameter leads to a decrease in sensory scores. Mishra *et al*. (2015) also reported similar results in meat ring. In general RE treated product was highly favored by panelist because of their desirable sensory score (flavour, texture and overall acceptability).

CONCLUSION

From this study it can be concluded that a ready-to-eat shelf stable meat product can be made by chicken meat powder incorporation in the gram flour. Rosemary leaves extract incorporation improved physico-chemical (TBARs, Free fatty acid content and Tyrosine value), microbiological (Total plate count, *Staphylococcus* count and yeast and mold count) and sensory score (flavor, texture and overall acceptability) of the fried chicken snacks.

REFERENCES

Al-Hijazeen, M. and Al-Rawashdeh, M. 2019. Preservative effects of rosemary extract (*Rosmarinus officinalis* L.) on quality and storage stability of chicken meat patties. *Food Sci. Tech.,* **39**(1): 27-34.

APHA 1984. Compendium of Methods for Microbiological Examination of Foods, 2nd ed. (ed. M.L. Speck) Am. Pub. Health Assoc., Washington, D.C.

Baker, I.A., Alkass, J.E. and Saleh, H.H. 2013. Reduction of oxidative rancidity and microbial activities of the Karadi lamb patties in freezing storage using natural antioxidant extracts of rosemary and ginger. *Int. J. Agri. Food Res.,* **2**(1): 31-42.

Bishnoi, S., Khanna, N., Bishnoi, N., Tewari, A., Ghadwal, S. and Ahlawat, S.S. 2015. Development of chicken meat powder incorporated instant Idli mixes. *J. Anim. Res.,* **5**(3): 527-532.

Bowser, T.J., Mwavita, M., Al-Sakini, A., McGlynn, W. and Maness N.O. 2014. Quality and shelf-life of fermented lamb meat sausage with rosemary extract. *Food Sci. J.,* **8**: 22-31.

Das, A.K., Rajkumar, V., Verma, A.K. and Swarup, D. 2012. *Moringa oleiferia* leaves extract: a natural antioxidant for retarding lipid peroxidation in cooked goat meat patties. *Int. J. Food Sci. Tech.*, **47**: 585-591.

Devi, S.M., Balachandar, V., Lee, S.I. and Kim, I.H. 2014. An Outline of Meat Consumption in the Indian Population- A Pilot Review. *Korean J. Food Sci. An.,* **34** (4): 507-515.

Georgantelis, D., Blekas, G., Katikou, P., Ambrosiadis, I. and Fletouris, D.J. 2007. Effect of rosemary extract, chitosan and a-tocopherol on lipid oxidation and colour stability during frozen storage of beef burgers. *Meat Sci.*, **75**: 256–264.

Guran, H.S., Oksuztepe, G., Coban, O.E. and Incili, G.K. 2015. Influence of different essential oils on refrigerated fish patties produced from bonito fish. *Czech J. Food Sci.,* **1**: 37-44.

Huang, B., He, J., Ban, X., Zeng, H., Yao, X. and Wang, Y. 2011. Antioxidant activity of bovine and porcine meat treated with extracts from edible lotus (*Nelumbo nucifera*) rhizome knot and leaf. *Meat Sci.,* **87**: 46-53.

Idowu, A.O., Omobuwajo, T.O. and Falade, K.O. 2010. Production proximate analysis and shelf-life studies of ready-to-eat rice and kilishi. *African J. Food Sci.*, **4**(5): 264-268.

Indumathi, J. and Reddy, B.O. 2015. Effect of different natural antioxidant extracts on the shelf-life of functional chicken meat nuggets. *Int. J. Adv. Res.,* **3**(6): 820-828.

Jean, I.J., Work, R., Camire, M.E., Briggs, J., Barrett, A.H. and Bushway, A.A. 1996. Selected properties of extruded patato and chicken meat. *J. Food Sci.*, **61**(4): 783-789.

Jridi, M., Siala, R., Fakhfakh, N., Ayadi, M.A., Elhatmi, M., Taktak, M.A., Nasri, M. and Zouari, N. 2015. Effect of rosemary leaves and essential oil on turkey sausage quality. *Acta Alimentaria*., **44**(4): 534–541.

Kanatt, S.R., Chawla, S.P., Chander, R. and Sharma, A. 2006. Development of shelf-stable, ready-to-eat (RTE) shrimps (*Penaeus indicus*) using γ-radiation as one of the hurdles. *LWT-Food Sci. Tech.*, **39**(6): 621-626.

Kaner, M., Ozogul, Y. and Kuley, E. 2010. Effects of rosemary and sage tea extracts on the sensory, chemical and microbiological changes of vacuum-packed and refrigerated sardine (*Sardina pilchardus*) fillets. *Int. J. Food Sci. Tech.*, **45**: 2366-2372.

Kashyap, A., Thind, S.S. and Kaur, A. 2012. Development of chicken meat patties incorporating natural antioxidants. *Int. J. Food Sci. Tech.*, **2**(2): 27- 40.

Khare, A.K., Abraham, Rao,V.A. and Babu, R.N. 2016. Utilization of carrageenan, citric acid and cinnamon oil as an edible coating of chicken fillets to prolong its shelf-life under refrigeration conditions. *Vet. World*, **9**(2): 166-175.

Konieko, E.K. 1979. In: Handbook for meat Chemists. Chap.6, Avery Publishing Group Inc., Wayne, New Jersy, USA, 68-69.

Kumar, Y., Singh, P., Tanwar, V.K., Ponnusamy, P., Singh, P.K. and Shukla, P. 2015. Augmentation of quality attributes of chicken tikka prepared from spent hen meat with lemon juice and ginger extract marination. *Nutri. Food Sci.*, **45**(4): 606-615.

Mishra, B.P., Chauhan, G., Mendiratta, S.K., Rath, P.K. and Nayar, R. 2015. Storage stability of aerobically packaged

extended dehydrated chicken meat rings at ambient temperature. *Turkish J. Vet. Anim. Sci.*, **39**(4): 493-500.

Modi, V.K., Mahendrakar, N.S., Sachindra, N.M. and Narasimha, R.D. 2004. Quality of nuggets prepared form fresh and smoked spent layer chicken meat. *J. Muscle Foods*, **15**: 195-204.

Modi, V.K., Sachindra, N.M, and Nagegowda, P., Mahendrakar, N. S. and Narasimha R.D. 2007. Quality changes during the storage of dehydrated chicken kebab mix. *J. Food Sci. Tech.,* **42**: 827-835.

Moghtader, M., Salari, H. and Farahm, A. 2011. Evaluation of the antifungal effects of rosemary oil and comparison with synthetic borneol and fungicide on the growth of *Aspergillus flavus*. *J. Ecol. Nat. Environ.*, **3**(6): 210-214.

Nanditha, B. and Prabhasankar, P. 2008. Antioxidants in bakery products: a review. *Crit. Rev. Food Sci.*, **49**(1): 1-27.

Rinzar, k., Celan, S., Knez, Z., Skerget, M., Bauman, D. and Gleasar, R. 2006. Antimicrobial and antioxidative activity of rosemary extract in chicken Frankfurters. *J. Food Sci.,* **71**(7): 425-429.

Sebranek, J.G., Sewalt, V.J.H., Robbins, K.L., and Houser, T.T.A. 2005. Comparison of a naturalrosemary extract and BHA/BHT for relative antioxidant effectiveness in pork sausage. *Meat Sci.*, **69**(2): 289-296.

Singburaudom, N. 2015. Hydroxychavicol from Piper betel leave is an antifungal activity against plant pathogenic fungi. *J. Biopest.*, **8**(2): 82-92.

Singh, V.P., Sanyal, M.K., Dubey, P.C. and Mendirtta, S.K. 2011. Quality assessment of vacuum packaged chicken snacks stored at room temperature. *J. Stored Prod. Postharvest Res.*, **2**(6): 120-126.

Singh, P., Sahoo, J., Chatli, M.K. and Biswas, A.K. 2013. Effect of clove powder and modified atmosphere packaging on storage quality of chicken meat caruncles during ambient storage (35±2°C) conditions. *J. Vet. Pub. Hlth.*, **11**(1): 51-55.

Singh, P., Sahoo, J., Chatli, M.K. and Biswas, A.K. 2015. Effect of different fillers on the physico-chemical and sensory attributes of chicken meat caruncles. *J. Ani. Res.,* **5**(1): 167-173.

Singh, P., Sahoo, J., Talwar, G., Chatli, M.K. and Biswas, A.K. 2015. Development of chicken meat caruncles on the basis of sensory attributes: process optimization using response surface methodology. *J. Food Sci. Technol.,* **52**(3): 1290-1303.

Snedecor, G.W. and Cochran, W.G. 1994. Statistical Methods. 8th Edn, Iowa State University press, Ames, Iowa.

Strange, E.D., Benedict, R.C., Smith, J.L. and Swift, C.E. 1977. Evaluation of rapid tests for monitoring alterations in meat quality during storage: I. Intact meat. *J. Food Prot.,* **40**(12): 843-847.

Talukder, S., Mendiratta, S.K., Soni, A., Singh, T.P., Chhangte, L., Kumar, R.R. and Malav, O.P. 2015. Development and quality characterization of mutton snack. *Nutri. Food Sci.*, **45**(6): 873-882.

Tavassoli, S. and Djomeh, Z.E. 2011. Total phenols, antioxidant potential and antimicrobial activity of methanol extract of rosemary (*Rosmarinus officinalis L.*). *Global Vet.,* **7**(4): 337-341.

Tayel, A.A. and El-Tras, W.F. 2012. Plant extracts as potent bio preservatives for *Salmonella typhimurium* control and quality enhancement in ground beef. *J. Food Saf.*, **32**: 115-121.

Teruel, M.R., Garrido, M.D., Espinosa, M.C. and Linares, M.B. 2015. Effect of different format-solvent rosemary extracts (*Rosmarinus officinalis*) on frozen chicken nuggets quality. *Food Chem.*, **172**: 40-46.

Thomas, R., Anjaneyulu, A.S. and Kondaiah, N. 2010. Quality of hurdle treated pork sausages during refrigerated (4±1°C) storage. *J. Food Sci. Tech.*, **47**(3): 266-272.

Trindade, R.A., Mancini-filho, S., Sabundjian, I.T., Nunes, T.C.F., Rogvschi, V.D. and Villavicencio, A.L.C.H. 2007. Changes on lipids profile in beef burgers prepared with rosemary extracts and submitted to e-beam processing. INAC, Santos, SP, Brazil.

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. Tech.*, **46**: 1157–1163.

Wichchukita, S. and O'Mahonyc, M. 2014. The 9- point hedonic scale and hedonic ranking in food science: some reappraisals and alternatives. *J. Food Sci. Agri.,* **95**(11): 2167-2178.

Witte, V.C., Krause, G.F. and Bailey, M.E. 1970. A new extraction method for determining 2-thiobarbituric acid values of pork and beef during storage. *J. Food Sci.*, **35**(5): 582-585.

Wojciak, K.M., Dolatowski, Z.J. and Okon, A. 2011. The effect of water plant extracts addition on the oxidative stability of meat products. *Acta Sci. Pol. Tech. Aliment.*, **10**: 175-188.