Journal of
Advanced Veterinary Research
Volume 2 (2012) 107-112 **Original Research**

Studies on the Effect of Pomegranate Rind Powder Extract as Natural Antioxidant in Chicken Meat Balls During Refrigerated Storage

Savala Chandralekha[1], Angalakuditi Jagadeesh Babu[2*], P.R. Sreenivasa Moorthy[1], Balakrishnan Karthikeyan[1]

[1] Department of Livestock Products Technology and [2] Department of Veterinary Public Health, College of Veterinary Science, Tirupati – 517 502 (A.P.)

(Recieved 4 Jun 2011/ Accepted 6 April 2012)

Abstract

Trials were conducted to study the effect of pomegranate rind powder extract as natural antioxidant in chicken meat balls during refrigerated storage. Significantly ($p<0.05$) lower values for cooking loss, pH and 2-thiobarbituric acid (2-TBARS) values and higher values for emulsion stability were obtained due to the incorporation of pomegranate rind powder extract at 5 percent level followed by 2.5 percent level than the other treatments. There was a significant ($p<0.05$) increase in cooking loss, pH, 2-TBARS values and free fatty acid content as the storage period progressed from 0 to 8 days, however emulsion stability of chicken meat balls decreased significantly ($p<0.05$) during the course of refrigeration. Microbial quality evaluation revealed that chicken meat balls incorporated with pomegranate rind powder extract at 5 percent level had significantly ($p<0.05$) lower standard plate count during refrigerated storage and a significant ($p<0.05$) increase in microbial load was observed. Organoleptic evaluation indicated that addition of pomegranate rind powder extract at 5 and 2.5 percent levels to chicken meat balls registered significantly ($p<0.05$) higher sensory scores for various eating quality attributes than the other treatments. However there was a significant ($p<0.05$) in all the organoleptic attributes of the product as the storage period increased.

Keywords: Chicken meat balls, pomegranate rind powder extract, chemical antioxidants, quality studies.

Introduction

Poultry meat occupies an unique place in human diet by virtue of its specific nutritional characteristics. It is particularly suited for processing due to its bland flavour, which can be enhanced by condiments. In recent years, the consumption of poultry meat has risen drastically. To ensure the continued growth and competitiveness of this industry, it is essential that the quality and safety of poultry meat products are maintained during processing.

The transformation in the meat eating habits, lack of time for food processing at home, fast moving world, changes in the preferences for variety and taste of meat foods has lead to a shift from hot meat consumption to convenience and ready to eat meat products such as meat balls, sausages, nuggets, patties, loaves etc. They are gaining higher degree of importance due to its demand, urbanization, changing lifestyles etc.

The appearance, eating quality and shelf life of meat products are the major determinants of its appeal to consumers. Meat products typically spoil due to oxidative rancidity and microbial spoilage. Processed meats such as meat balls are highly susceptible to oxidative rancidity as they are highly manipulated during manufacturing.

The addition of antioxidants such as Butylated Hydroxy Anisole (BHA), Butylated Hydroxy Tolune (BHT) and Propylgallate are being used to preserve flavour and colour and to prevent destruction of vitamins in meat products. Use of such chemical additives are minimal with growing awareness among the consumers about chemical additives and also due to current legal limitations. There has been an increased interest in the use and research on natural antioxidants of plant origin (Namiki, 1990; Pokorny, 1991; Madhavi and Salunkhe, 1995). Hence the present investigation was planned to study the effect of pomegranate rind powder extract as natural antioxidant in chicken meat balls during refrigerated storage.

Materials and methods

Separate batches of chicken meat balls were prepared incorporating pomegranate rind powder ex-

*Corresponding author: Angalakuditi Jagadeesh Babu
Address: Department of Veterinary Public Health, College of Veterinary Science, Tirupati – 517 502 (A.P.)
E-mail address: drjagadeeshvet@yahoo.co.uk

tract at 2.5 percent (T1) and 5 percent (T2), BHA at 0.005 percent (T3) and 0.01 percent (T4) and BHT at 0.005 percent (T5) and 0.01 percent (T6) along with the Bengal gram flour at 10 percent level. These meat balls were packed in low density polyethylene bags and stored at refrigeration temperature (4±1^{0}C) up to 8 days. The samples were drawn at an interval of 2 days and were analyzed for physico –chemical characteristics, microbial counts and organoleptic quality along with control. Cooking loss was estimated by recording difference between the pre and post cooking weight of meat balls and expressed in percentage. Emulsion stability was determined as per the procedure of Townsend *et al*. (1968). The pH of the samples was determined by following the procedure of Jay (1964). The 2-thiobarbituric acid (2-TBARS) reactive substances value of the sample was determined by following the procedure of Tarladgis *et al*. (1960). The methodology adopted by Pearson (1973) was followed to determine the free fatty acids present in the refrigerated samples. The mesophilic counts per gram of chicken meat balls at refrigerated temperature was estimated as per the technique recommended by Chestnut *et al.* (1977) Sensory evaluation of the product was carried out on a 9 point hedonic scale by a semi trained five members taste panel. The data obtained in the present study was analyzed statistically as per the methods outlined by Snedecor and Cochran (1994).

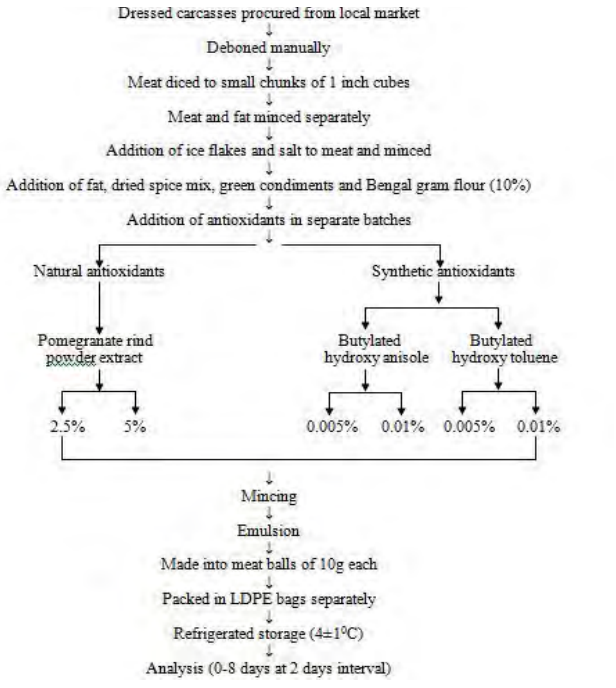

Fig. 1. Flow chart for the preparation of chicken meat balls incorporated with various levels of antioxidants.

The steps for preparation of chicken meat balls incorporated with various levels of antioxidants were illustrated in Fig. 1.

Results

Percent cooking loss of chicken meat balls incorporated with pomegranate rind powder extract at 5 percent level was significantly ($p<0.05$) lower than the other treatments and it was increased for 8 days during the refrigerated storage.

The overall mean pH values of chicken meat balls incorporated with 5 percent pomegranate rind powder extract had significantly ($p<0.05$) lower values than the other formulations and the pH was increased significantly ($p<0.05$) during refrigerated storage for 8 days.

Values of 2-thiobarbituric acid of chicken meat balls with pomegranate rind powder extract at 5 percent level were significantly ($p<0.05$) lower than the other formulations.

The overall mean free fatty acid values (percent oleic acid) of chicken meat balls increased gradually with increasing storage period.

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Among the treatments chicken meat balls incorporated with pomegranate rind powder extract at 5 percent level showed significantly ($p<0.05$) lower counts than the others.

Results are summarized in tables 1, 2 and 3

Discussion

Percent cooking loss of chicken meat balls incorporated with pomegranate rind powder extract at 5 percent level was significantly ($p<0.05$) lower than the other treatments and it was increased for 8 days during the refrigerated storage. This might be due to lowering of water binding capacity and loss of moisture during storage. Similar findings were observed by Johnton *et al*. (2005) in ground beef patties, and by Naveena *et al.* (2007) in microwave cooked chicken patties in refrigerated storage.

Among the treatments chicken meat balls incorporated with 5 percent pomegranate rind powder extract had higher emulsion stability which might be due to the denaturation of myofibrillar proteins associated with increased storage period and cooking loss and might be due to the presence of high

Table 1. Percent cooking loss, emulsion stability and pH of chicken meat balls as influenced by different treatments during refrigerated storage

Days of storage	Control	Treatments						Overall mean
		T1	T2	T3	T4	T5	T6	
Percent cooking loss								
0	20.07±0.12	18.58±0.14	17.25±0.10	18.12±0.12	18.80±0.20	18.43±0.19	19.16±0.14	18.80±0.20^{a}
2	20.71±0.17	18.98±0.19	17.95±0.10	18.83±0.16	19.31±0.17	19.17±0.13	19.64±0.19	19.37±0.18^{b}
4	21.50±0.18	19.59±0.25	18.95±0.23	19.93±0.14	20.21±0.14	20.12±0.12	20.40±0.13	20.22±0.17^{c}
6	23.20±0.10	20.98±0.12	20.54±0.20	21.73±0.17	21.81±0.16	21.62±0.21	21.69±0.18	21.75±0.17^{d}
8	24.32±0.20	22.11±0.10	21.71±0.16	22.89±0.20	22.96±0.17	22.79±0.17	22.38±0.14	22.90±0.17^{e}
Overall mean	21.96±0.52^{A}	20.05±0.44^{F}	19.28±0.55^{G}	20.30±0.59^{E}	20.61±0.52^{C}	20.42±0.53^{D}	20.74±0.45^{B}	
Percent emulsion stability								
0	88.01±0.05	86.99±0.10	87.49±0.19	85.49±0.13	84.30±0.18	84.53±0.16	83.11±0.14	85.87±0.37^{a}
2	87.55±0.13	86.40±0.21	87.03±0.12	84.69±0.16	83.59±0.25	83.70±0.11	82.60±0.26	85.22±0.38^{b}
4	87.29±0.15	85.59±0.23	86.31±0.17	84.17±0.16	83.29±0.20	82.69±0.15	81.81±0.18	84.52±0.40^{c}
6	86.92±0.14	84.64±0.18	85.47±0.20	83.07±0.13	83.22±0.25	81.63±0.16	80.80±0.17	83.58±0.44^{d}
8	86.10±0.13	83.04±0.24	84.37±0.12	81.86±0.24	81.23±0.26	80.29±0.19	79.65±0.12	82.43±0.46^{e}
Overall mean	87.17±0.21^{A}	85.40±0.43^{C}	86.13±0.37^{B}	83.86±0.42^{D}	82.92±0.36^{E}	82.56±0.50^{F}	81.59±0.41^{G}	
pH								
0	5.95±0.05	5.76±0.04	5.73±0.02	5.82±0.06	5.81±0.06	5.98±0.03	5.97±0.04	5.85±0.02^{a}
2	6.01±0.09	5.78±0.09	5.75±0.04	5.90±0.06	5.89±0.05	6.03±0.02	6.02±0.03	5.91±0.02^{b}
4	6.06±0.04	5.86±0.08	5.81±0.06	5.99±0.04	5.96±0.07	6.10±0.01	6.09±0.02	5.98±0.02^{c}
6	6.12±0.07	5.98±0.15	5.92±0.09	6.03±0.03	6.04±0.03	6.15±0.02	6.11±0.02	6.06±0.02^{d}
8	6.23±0.09	6.08±0.08	6.01±0.09	6.20±0.01	6.18±0.02	6.29±0.08	6.23±0.09	6.18±0.02^{e}
Overall mean	6.07±0.03^{C}	5.89±0.04^{F}	5.84±0.03^{G}	5.99±0.03^{D}	5.97±0.03^{E}	6.11±0.03^{A}	6.08±0.03^{B}	

percent of pomegranate rind powder which might have been responsible for binding of water. The results are in accordance with Nag *et al.* (1998) in chicken nuggets extended with rice flour stored at refrigeration temperature.

The overall mean pH values of chicken meat balls incorporated with 5 percent pomegranate rind powder extract had significantly ($p<0.05$) lower values than the other formulations and the pH was increased significantly ($p<0.05$) during refrigerated storage for 8 days which might be due to the accumulation of metabolites by bacterial action in meat in addition to protein and amino acid degradation resulting in formation of ammonia and consequent increase in pH. The results are in agreement with Biswas *et al*. (2004) in pre cooked pork patties and Georgantelis *et al*.(2007) in refrigerated pork sausages.

Values of 2-thiobarbituric acid chicken meat balls with pomegranate rind powder extract at 5 percent level were significantly ($p<0.05$) lower than the other formulations. This might be due to large amount of phenolics contained in pomegranate which acts as reductones by donating electrons and reacting with free radicals to convert them to more stable products and terminate free radical chain reactions. The results are in accordance with Naveena *et al*. (2007) in microwave cooked chicken patties and Naveena *et al.* (2008) in refrigerated cooked chicken patties.

The overall mean free fatty acid values (percent oleic acid) of chicken meat balls increased gradually with increasing storage period. This might be due to progressive oxidation of lipids during storage. The results are in agreement with Panda *et al*. (1993) in deep fat fried quail, Kanatt *et al.* (1998) in chicken meat during chilled storage.

Among the treatments chicken meat balls incorporated with pomegranate rind powder extract at 5 percent level showed significantly ($p<0.05$) lower counts than the others, which might be due to the presence of certain antimicrobials like gallic acid

Table 2. Values of 2-TBARS, free fatty acid and standard plate count of chicken meat balls as influenced by different treatments during refrigerated storage

Days of storage	Control	Treatments						Overall mean
		T1	T2	T3	T4	T5	T6	
2-TBARS values								
0	0.42±0.01	0.13±0.01	0.11±0.02	0.51±0.04	0.47±0.03	0.57±0.06	0.51±0.04	0.38±0.02^{a}
2	0.58±0.04	0.29±0.02	0.24±0.03	0.58±0.04	0.51±0.04	0.66±0.05	0.66±0.05	0.49±0.02^{b}
4	0.69±0.03	0.36±0.02	0.32±0.01	0.70±0.01	0.69±0.03	0.80±0.07	0.72±0.03	0.61±0.02^{c}
6	1.04±0.08	0.57±0.06	0.49±0.02	0.87±0.02	0.83±0.03	0.98±0.05	0.94±0.06	0.81±0.03^{d}
8	1.25±0.03	0.80±0.07	0.69±0.03	0.98±0.05	0.95±0.06	1.14±0.05	1.04±0.08	0.96±0.03^{e}
Overall mean	0.79±0.07^{A}	0.43±0.05^{a}	0.37±0.04^{a}	0.73±0.04^{b}	0.69±0.04^{b}	0.83±0.05^{B}	0.77±0.05^{C}	
Free fatty acid values								
0	0.038±0.010	0.037±0.012	0.033±0.010	0.035±0.009	0.028±0.007	0.035±0.007	0.033±0.008	0.034±0.005^{a}
2	0.067±0.011	0.048±0.011	0.044±0.011	0.046±0.010	0.041±0.007	0.047±0.008	0.044±0.007	0.047±0.007^{b}
4	0.085±0.010	0.066±0.011	0.056±0.012	0.060±0.005	0.053±0.007	0.059±0.009	0.055±0.009	0.061±0.010^{c}
6	0.124±0.025	0.078±0.013	0.069±0.013	0.073±0.009	0.071±0.006	0.078±0.007	0.075±0.010	0.082±0.013^{d}
8	0.169±0.027	0.099±0.014	0.079±0.012	0.093±0.007	0.082±0.007	0.099±0.011	0.088±0.005	0.105±0.017^{e}
Overall mean	0.097±0.012^{A}	0.065±0.007^{B}	0.056±0.006^{C}	0.062±0.005^{b}	0.055±0.005^{a}	0.063±0.006^{C}	0.059±0.005^{a}	
Standard plate count values								
0	4.63±0.01	4.20±0.01	4.09±0.009	4.56±0.01	4.53±0.01	4.58±0.01	4.53±0.009	4.47±0.03^{a}
2	5.22±0.01	4.30±0.009	4.20±0.01	5.01±0.009	5.00±0.01	5.08±0.009	4.95±0.009	4.89±0.06^{b}
4	5.49±0.01	4.90±0.009	4.71±0.01	5.42±0.01	5.36±0.009	5.35±0.009	5.32±0.009	5.27±0.04^{c}
6	5.82±0.01	5.20±0.009	5.05±0.009	5.87±0.009	5.82±0.009	5.80±0.008	5.79±0.01	5.66±0.04^{d}
8	6.93±0.009	5.68±0.009	5.55±0.01	6.70±0.009	6.65±0.009	6.81±0.009	6.76±0.01	6.54±0.08^{e}
Overall mean	5.62±0.17^{A}	4.85±0.12^{B}	4.72±0.12^{a}	5.51±0.16^{C}	5.47±0.16^{b}	5.52±0.17^{B}	5.47±0.17^{b}	

and ellagic acids which had a check on microbial growth. The overall mean bacterial count (log10 cfu/g) increased significantly ($p<0.05$) with increase in storage period. This might be due to the permissive temperature and relative availability of moisture and nutrients for the growth of mesophilic bacteria. The results are in accordance with Nag et al., (1998) in chicken nuggets during refrigerated storage.

Chicken meat balls incorporated with pomegranate rind powder extract secured significantly ($p<0.05$) higher colour scores than all other treatments but the scores were decreased during storage. This might be due to oxidative fading and moisture loss. Similar results were reported by Kala *et al.* (2007) in refrigerated chicken patties.

Flavour scores of chicken meat balls incorporated with pomegranate rind powder extract at 2.5 percent and 5 percent levels secured significantly ($p<0.05$) higher scores but the scores decreased significantly ($p<0.05$) during storage and this reduction in flavour scores might be due to the overall reduction in the quantum of volatile flavour components and due to fat oxidation during storage. The results are in agreement with Kala *et al*. (2007) in refrigerated chicken patties.

Chicken meat balls incorporated with pomegranate rind powder extract at 5 percent level secured significantly ($p<0.05$) higher juiciness scores but these scores were decreased during storage. Evaporative losses leading to decline in moisture content might be responsible for the result. Similar findings were noticed by Reddy (2008) in refrigerated spent hen meat nuggets.

Significantly ($p<0.05$) higher scores for tenderness were obtained by chicken meat balls incorporated with pomegranate rind powder extract at 5 percent level. These scores were decreased during storage and it might be due to the relative reduction in moisture content and juiciness of the product that led to hardening of the product. The results are in agreement with Kala *et al.* (2007) in refrigerated

Table 3. Organoleptic attributes of chicken meat balls as influenced by different treatments during refrigerated storage.

Days of storage	Control	Treatments						Overall mean
		T1	T2	T3	T4	T5	T6	
Colour								
0	7.70±0.20	7.80±0.17	7.80±0.17	7.60±0.23	7.55±0.11	7.35±0.13	7.35±0.15	7.60±0.06^{a}
2	7.50±0.18	7.40±0.18	7.40±0.18	7.50±0.11	7.30±0.14	7.25±0.12	7.30±0.14	7.25±0.06^{b}
4	7.40±0.15	7.50±0.15	7.20±0.17	7.30±0.14	7.00±0.13	7.00±0.12	7.05±0.13	7.11±0.05^{c}
6	7.30±0.14	7.20±0.13	7.50±0.11	6.90±0.26	6.85±0.20	6.80±0.20	6.75±0.16	7.08±0.05^{d}
8	6.75±0.16	6.80±0.22	6.30±0.20	6.70±0.25	6.65±0.24	6.65±0.24	6.60±0.23	6.61±0.07^{e}
Overall mean	7.33±0.08^{B}	7.34±0.08^{A}	7.24±0.09^{C}	7.20±0.09^{D}	7.07±0.08^{E}	7.01±0.07^{F}	7.01±0.07^{G}	
Flavour								
0	7.30±0.25	7.60±0.23	7.70±0.23	7.30±0.20	7.25±0.20	7.30±0.20	7.10±0.16	7.12±0.13^{a}
2	6.60±0.18	6.90±0.26	7.40±0.18	6.60±0.13	6.60±0.13	7.00±0.12	6.65±0.24	6.72±0.06^{b}
4	5.90±0.21	5.90±0.21	6.60±0.18	6.15±0.18	6.10±0.16	6.25±0.19	6.10±0.16	6.22±0.06^{c}
6	5.80±0.17	6.00±0.17	6.50±0.23	5.90±0.14	5.85±0.15	6.00±0.17	5.75±0.16	6.15±0.06^{d}
8	5.80±0.17	6.35±0.20	5.85±0.18	5.75±0.14	5.70±0.14	5.90±0.14	5.60±0.13	5.91±0.05^{e}
Overall mean	6.28±0.10^{F}	6.55±0.11^{B}	6.81±0.11^{A}	6.34±0.09^{D}	6.30±0.09^{E}	6.49±0.09^{C}	6.24±0.09^{G}	
Juiciness								
0	7.00±0.27	7.40±0.23	7.50±0.23	7.25±0.20	7.20±0.18	7.30±0.14	7.10±0.16	7.19±0.07^{a}
2	6.90±0.16	6.60±0.18	6.60±0.21	7.20±0.18	7.00±0.12	7.10±0.16	6.95±0.24	6.93±0.06^{b}
4	6.50±0.18	6.60±0.15	7.10±0.16	6.55±0.21	6.55±0.24	6.65±0.24	6.60±0.13	6.76±0.06^{c}
6	6.40±0.18	7.00±0.22	7.10±0.21	6.40±0.21	6.30±0.17	6.40±0.21	6.50±0.22	6.68±0.07^{d}
8	6.35±0.23	6.30±0.20	5.85±0.24	6.20±0.17	5.00±0.14	6.00±0.17	5.85±0.15	5.94±0.07^{e}
Overall mean	6.63±0.09^{E}	6.78±0.09^{B}	6.83±0.11^{A}	6.72±0.09^{C}	6.41±0.09^{G}	6.69±0.09^{D}	6.60±0.09^{F}	
Tenderness								
0	6.60±0.25	7.40±0.23	7.40±0.21	6.80±0.23	6.80±0.23	6.70±0.25	6.60±0.13	7.08±0.07^{a}
2	6.90±0.16	6.70±0.20	7.00±0.14	6.65±0.24	6.60±0.13	6.50±0.22	6.50±0.22	6.86±0.06^{b}
4	6.40±0.18	6.70±0.23	6.90±0.16	6.50±0.22	6.55±0.21	6.35±0.19	6.30±0.17	6.58±0.05^{c}
6	6.40±0.18	6.80±0.22	7.00±0.20	6.35±0.19	6.30±0.17	6.20±0.17	6.00±0.17	6.56±0.05^{d}
8	6.35±0.20	6.30±0.26	6.20±0.23	6.20±0.17	6.20±0.17	6.10±0.16	5.90±0.14	6.19±0.07^{e}
Overall mean	6.53±0.09^{C}	6.78±0.10^{B}	6.90±0.09^{A}	6.50±0.09^{D}	6.49±0.08^{E}	6.37±0.09^{F}	6.26±0.08^{G}	
Overall acceptability								
0	7.10±0.26	7.80±0.17	7.80±0.20	7.30±0.14	7.30±0.14	7.20±0.18	7.00±0.13	7.21±0.07^{a}
2	6.70±0.25	6.80±0.28	7.50±0.18	7.15±0.16	6.10±0.16	7.00±0.13	6.95±0.11	6.88±0.07^{b}
4	5.80±0.24	6.00±0.30	6.60±0.23	6.25±0.19	6.00±0.17	6.20±0.17	5.95±0.13	6.15±0.07^{c}
6	5.70±0.14	6.00±0.14	6.10±0.16	5.90±0.14	5.70±0.14	5.75±0.14	5.60±0.11	6.03±0.05^{d}
8	5.15±0.16	5.20±0.18	5.75±0.25	5.50±0.11	5.40±0.11	5.35±0.13	5.30±0.10	5.44±0.05^{e}
Overall mean	6.09±0.11^{G}	6.36±0.13^{C}	6.75±0.12^{A}	6.42±0.09^{B}	6.10±0.09^{F}	6.30±0.09^{D}	6.16±0.08^{E}	

chicken patties.

The overall mean scores of acceptability were higher for chicken meat balls incorporated with pomegranate rind powder extract at 5 percent level, as the storage period increased the scores were decreased. The decreasing trend might be due to the lowering scores of colour, flavour, juiciness and tenderness of the product during storage. Similar trend in mean overall acceptability scores during storage was reported by Kala *et al.* (2007) in refrigerated chicken patties.

Conclusion

Chicken meat balls incorporated with pomegranate rind powder extract at 5% level recorded lower values for cooking loss, pH, total counts and 2 – TBARS and higher values for emulsion stability, where as free fatty acid content was significantly ($p<0.05$) lower in BHA (0.01%) treated product. Organoleptic evaluation indicates that addition of pomegranate rind powder extract at 5 and 2.5% levels to chicken meat balls registered significantly ($p<0.05$) higher sensory scores for various eating quality attributes. Considering the results obtained in the study, it may be concluded that addition of pomegranate rind powder extract at 2.5 and 5% levels would not only protect the chicken meat balls against oxidative rancidity than the chemical antioxidants but also with higher acceptability and lower microbial counts.

Acknowledgments

Authors are sincerely grateful for the facilities provided by the Associate Dean, College of Veterinary Science, Tirupati for conducting this research.

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