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Storage Stability of Turkey Meat Sausage incorporated with Carrot and Radish under Refrigerated Storage

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ABSTRACT

The present study was aimed to evaluate the antioxidant and antimicrobial efficacy of raw carrot paste (RCP) and raw radish paste (RRP)each at 10 % level on aerobic packaged turkey meat sausages under refrigeration (4±1°C) for a period of 25 days. The stored sausages were evaluated for physico-chemical, microbiological and sensory characteristics at an interval of 5 days. The pH of the turkey meat sausages increased significantly ($P<0.05$) in both control and treated sausages under aerobic packaging. The results revealed that there was significant ($P<0.05$) increase in the physico-chemical parameters viz., Tyrosine value and TBARS value, as storage progressed from 0-25 days. However, the values were well below the threshold level of spoilage at the end of storage period. Standard plate counts, increased significantly ($P<0.05$) as storage period progressed from 0-25 days. Psychrophilic counts were not detected in the control and treated sausages at 0^{th} day, afterwards the psychrophilic counts increased significantly ($P<0.05$) as storage period progressed from 5-25 days. Yeast and mold counts were not detected in any of the products throughout the entire storage period. A reduction in the sensory scores of turkey meat sausages were found as the advancement of storage. Based upon the results, it can be concluded that addition of raw carrot paste (RCP) and raw radish paste (RRP) each at 10 % level would not only extends the shelf life by protecting the product longer against oxidative rancidity but also had higher acceptability than control.

Keywords: *Turkey meat sausages, Carrot Paste, Radish paste, Aerobic package, Refrigeration.*

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INTRODUCTION

Food is one of the crucial factors influencing health and well-being of the people. During recent years, consumers have changed their liking towards diet and health. Turkey meat is one of the leanest types of poultry meat because of the low fat and is a good source of protein (Castro Ferreira *et al.,* 2000). Turkey meat is an excellent source of several important vitamins and nutrients such as iron, niacin, zinc, potassium, and B complex vitamins. It contains high level of monounsaturated and polyunsaturated fats which help to lower the levels of LDL cholesterol in blood. Turkey meat is easier to digest than other types of meat, which makes it a good choice for individuals who have digestive problems (Otles and Cagindi 2008). Consumption of meat containing high amounts of polyunsaturated fatty acids (PUFAs) has increased greatly in the last decade due to recommendations of nutritionists to reduce intake of saturated fatty acids. However, a high degree of polyunsaturation accelerates oxidative processes leading to deterioration in meat flavor, color, texture and nutritional value. Turkey meat is particularly prone to oxidation due to its high PUFA content (Mercier *et al.,* 1998), its high concentration in free iron (Kanner *et al.,* 1988) and its low ability to store dietary vitamin E (Sklan *et al.,* 1983). The major strategies for preventing lipid oxidation are the use of antioxidants and restricting the access to oxygen during storage by vacuum-packaging (Shahidi and Wanasundara, 1992).

In recent years, some fruits and vegetables have gained the importance in functional foods, as they are a rich source of natural antioxidants, dietary fibers, essential minerals and vitamins (Yue, 2001). Carrot and radish are known to carry several beneficial properties which provide several health benefits to consumers. Carrot can be used as a source of dietary fibre in meat products. It has been utilised to reduce the salt content in sausages and best known for their rich content of antioxidant like beta carotene. Carotenoids represent a large group of phytochemicals that may contribute to health and disease prevention. Radish have higher amount of phenolic compounds and higher antioxidant capacity. Hence, the objective of the current study was to study the effect of carrot

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and radish paste on storage stability of Turkey meat sausages during refrigerated temperature (4±1°C).

MATERIALS AND METHODS

Source of raw material: Tom turkey birds (Broad Breasted White) of 25-30 weeks of age were procured from the Poultry Research Station, Rajendranagar, Hyderabad slaughtered and dressed adopting standard procedure at the Department of Livestock Products Technology, College of Veterinary Science, Rajendranagar, Hyderabad. Carrot and Radish were procured from local vegetable market, washed with tap water for cleaning and removal of extraneous dirt. The cleaned vegetables were peeled manually with peeler, cut into slices and were made into a paste by using a home mixer/grinder. Analytical grade chemicals and food grade additives were procured from standard companies.

Preparation of turkey meat sausages: The turkey meat was minced using meat mincer (Model: Sirman TC 32 Colorado, Italy) using 8mm plate followed by 4mm plate. Sausages were prepared as Control sausages and Carrot and Radish incorporated each at 10 % level replacing by lean meat. Emulsion was prepared in Bowl Chopper (Model: MADO Garrant MTK 661, Germany).The fresh boneless turkey meat cut into small chunks and minced in a meat mincer (Sirman,TC 12 E, Italy) through 4 mm plate. The emulsion was prepared by chopping the minced meat along with other non-meat ingredients in a bowl chopper (Scharfen, Model No: TC 11, Germany). The minced chicken meat was mixed with salt @ 1.5 %, STPP @ 0.4 %, sodium nitrate @ 150 ppm, sodium ascorbate @ 500 ppm, sugar @ 1 % and ice flakes @ 8 % and chopped for one min followed by addition of oil @ 6 % and again chopped for one min and added corn flour @ 3 %, spice mix @ 1.6, condiment mix @ 3 % (onion and garlic: 3:1), carrot paste @10 % and radish paste @10 % respectively in T1 and T2 sausages and finally chopped for 3 min. The temperature of the emulsion was maintained between 12 to 15ºC. The emulsions of control, T1 and T2 was separately stuffed into synthetic cellulose casings (SCC21) using horizontal sausage stuffer and cooked at 80$^{R''}$C for 20 min in moist heat in pressure cooker. After cooking the sausages were cooled to room temperature and chilled under refrigeration for few minutes followed by packing in LDPE pouches (200 Gauge thickness) under aerobic packaging and storage at refrigerated (4±1°C) storage and evaluated every 5 days interval up to 25 days.

Analytical parameters: For shelf-life studies, pH was determined by following the procedure of Trout et al. (1992). Thiobarbituric Acid Reacting Substances (TBARS) value was estimated by the procedure of Tarladgis et al. (1960). Tyrosine value was estimated adopting the procedure of Strange et al. (1977). The Total plate counts (TPC), Psychrophilic counts (PPC) and Yeast and mould counts (YMC) as colony forming unit per gram (cfu/g) of turkey meat sausages stored at refrigerated temperature were estimated as per the procedure recommended by Chestnut et al. (1977).

The sensory panel consisted of six experienced faculty members of the college which evaluated various sensory attributes like colour, flavour, juiciness, tenderness and overall acceptability by using 8 point hedonic scale (Keeton 1983) where, 8=extremely good and 1=extremely poor. The experiment was repeated thrice and the samples were analyzed in duplicate.The data thus obtained was subjected to statistical analysis using SPSS MAC, version 20.0, SPSS Chicago (USA) and indicated with the level of significance of 0.05.

RESULTS AND DISCUSSION

Physico-chemical properties: Effect of incorporation of RCP and RRP on pH, TBARS and Tyrosine value (TV), has presented in Table 1.

pH: The pH of turkey meat sausages increased as storage period advanced. The increase in pH was however non significant up to 5th day of storage, but there after it was significant ($P<0.05$). The increase in pH during storage might be due to degradation of lactic acid and accumulation of protein metabolites by bacteria (Jay 1996). In the present study the pH of carrot and radish incorporated turkey meat sausages was lower than control on the day of preparation and this similar trend was followed during entire period of storage. The results of the present study were in agreement with the findings of Patil *et al.* (2004) in chicken patties, and Bhaskar Reddy *et al.* (2013) in restructured mutton slices.

Thiobarbituric Acid Reactive Substances (TBARS) value: During storage, TBARS values of control was observed to be significantly ($P<0.05$) higher as compared to that of carrot and radish incorporated turkey meat sausages. Irrespective of products made, the TBARS values increased significantly ($P<0.05$) throughout storage period of 25 days. The increase in TBARS values particularly at the end of storage is indicative of oxidative rancidity but the values on 25th day were within limit of the threshold value of TBARS value of 1-2 mg malonaldehyde/kg of meat. The increase in values throughout storage may be attributed to aerobic packaging and oxygen permeability of packaging material that led to faster lipid oxidation of product as indicated by Brewer *et al.* (1992).

Among the three types of turkey meat sausages lower TBRAS value was observed in radish incorporated sausages as compare to control and carrot incorporated sausages throughout storage period, which might be due to antioxidant activity of carotenoids present in radish. Similar observations were recorded by Sugita *et al.* (1993) in pork sausages incorporated with dried radish chip extract (DRCE). The results of the present study were in agreement with the findings of Bhosale (2011) in chicken nuggets who revealed that the reduction in the TBARS value to the presence of antioxidant activity of carotenoids present in the carrot and sweet potato.

Tyrosine value: The results of the present study indicated an increasing trend in tyrosine values of turkey meat sausages during storage, but it was not significant upto 5th day of storage, whereas there was a significant ($P<0.05$) increase thereafter. The tyrosine content was highest in control, least in radish paste added sausages and in between in carrot added sausages. The increase in tyrosine values during storage may be attributed to breakdown of proteins. The reduction in tyrosine value of carrot and radish incorporated sausages could be due to the prevention of de-amination of amino acid by these vegetables thereby preventing the spoilage. Similar to the findings of this study Biswas *et al.* (2011) and Ahamed *et al.* (2007) also observed significant ($P<0.01$) increase in the tyrosine value with increase in storage period (4±1ºC) of duck patties and enrobed beef meat cutlets respectively.

Microbiological quality: Total plate count and Psychrophilic count of turkey meat sausages during refrigerated (4±1R"C) storage are presented in Table 1.

Total plate count: Control had higher total plate count than carrot and radish incorporated sausages, which might be due to higher counts in meat than carrot and radish, Radish incorporated turkey meat sausages had lower TPC which might be due to their antimicrobial effect. Antimicrobial effect of radish chip extract in pork sausages was reported by Sugita *et al.* (1993). The count however, increased significantly ($P<0.05$) with the progress of refrigerated storage of 25 days. There was steady increase in count upto 15th day of storage, but afterwards the count increased considerably.

Table 1: Physico-chemical and microbial characteristics of turkey meat sausages incorporated with carrot and radish paste during refrigeration (4±1R°C) temperature (Mean±SE)

Treatments	Storage days					
	0	5	10	15	20	25
			pH			
C	6.28±0.03^{aE}	6.30±0.01^{aE}	6.34±0.06^{aD}	6.39±0.02^{aC}	6.44±0.07^{aB}	6.48±0.11^{aA}
T1	6.25±0.05^{aE}	6.27±0.12^{aE}	6.31±0.03^{aD}	6.36±0.04^{bC}	6.39±0.03^{bB}	6.43±0.02^{bA}
T2	6.23±0.06^{E}	6.24±0.04^{aE}	6.27±0.04^{bD}	6.32±0.13^{cC}	6.36±0.05^{bB}	6.39±0.04^{cA}
			TBARS Value (mg malonaldehyde/kg)			
C	0.31±0.03^{aE}	0.44±0.05^{aDE}	0.56±0.01^{aCD}	0.69±0.05^{aBC}	0.78±0.04^{aB}	0.92±0.06^{aA}
T1	0.26±0.02^{bD}	0.37±0.04^{bCD}	0.45±0.03^{bC}	0.57±0.05^{bB}	0.63±0.02^{bB}	0.77±0.05^{bA}
T2	0.22±0.04^{bE}	0.30±0.02^{cDE}	0.36±0.04^{cCD}	0.43±0.01^{cBC}	0.52±0.02^{cB}	0.64±0.03^{cA}
			Standard Plate Count (log CFU/g)			
C	2.82±0.16^{aF}	3.26±0.22^{aDE}	3.88±0.23^{aCD}	4.46±0.38^{aBC}	5.12±0.18^{aAB}	5.84±0.29^{aA}
T1	2.54±0.23^{bD}	2.94±0.22^{aD}	3.12±0.21^{bCD}	3.81±0.25^{bBC}	4.45±0.35^{bB}	5.36±0.15^{bA}
T2	2.13±0.10^{cE}	2.45±0.19^{bDE}	2.98±0.27^{bCD}	3.22±0.18^{cC}	3.86±0.16^{cB}	4.83±0.22^{cA}
			Psychrophilic Count (log CFU/g)			
C	ND	2.78±0.21^{aD}	3.58±0.23^{aC}	4.32±0.24^{aB}	4.84±0.22^{aB}	5.62±0.30^{aA}
T2	ND	2.46±0.22^{aD}	2.82±0.22^{bD}	3.56±0.20^{bC}	4.27±0.20^{bB}	5.24±0.20^{bA}
T2	ND	1.96±0.17^{bD}	2.36±0.08^{cD}	3.18±0.17^{cC}	3.76±0.19^{cB}	4.76±0.19^{cA}

Means with different superscripts in the same row (upper case letters) and column (lower case letters) differed significantly ($P<0.05$).

C-Control, T1-Carrot incorporated sausages, T2- Radish incorporated sausages

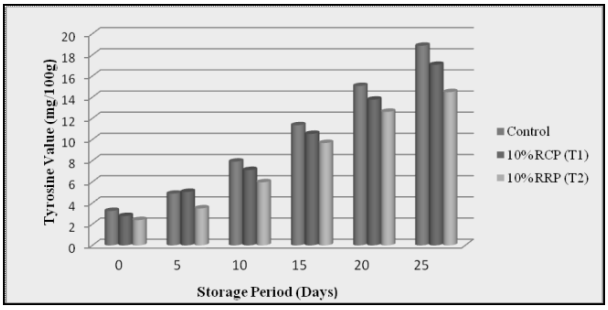

Fig. 1 Effect of incorporation of carrot and radish paste on the Tyrosine value of aerobic packed Turkey meat sausages during refrigeration (4±1R″C) temperature.

At the end of storage, the TPC was below the incipient spoilage level of 6.70 log cfu / (Vonholy and Holzapfel 1991). The findings are in partially agreement with the observations of Patil *et al.* (2004) for chicken patties.

Psychrophilic count: Psychrophilic counts were not detected in both control as well as in treated groups on day 0. It might be due to sufficient heat treatment during cooking. Psychrophlic counts were detected on 5th day and thereafter showed a significant ($P<0.05$) increase which may be attributed to growth preference of psychrophilic organisms during storage at refrigeration temperature. Lower psychrophilic count were recorded for radish and carrot incorporated turkey meat sausages as compared to control which might be due lower level of nutrition provided by treated products to microorganisms and lower pH of carrot and radish attributed to reduction of pH of product was unfavourable for the growth of vegetative bacterial cells. Among all the treatments, radish incorporated sausages had lower bacterial count compared to carrot incorporated sausages and control. It shows that the antimicrobial property of radish (Esaki and Onozaki 1982) was more effective against psychrophiles compared to carrot. Similar observations were reported by Yadav and Sharma (2004) in low fat chevon rolls and Devatkal et al. (2004) in liver-vegetable loaves.

Yeast and mold count: Yeast and mold counts were not detected on the day of preparation as well as at any point of storage periods which might be due to good hygienic conditions at the time of processing as well as post processing handling. Similar findings were reported by Biswas et al. (2004) in precooked pork patties and Yadav *et al.* (2018) in chicken sausages.

Sensory evaluation: Sensory evaluation of control and sausages with RCP and RRP was conducted for attributes such as appearance, flavor, texture, juiciness and overall acceptability using 9-point hedonic scale and their scores are presented in Table 2. The sensory scores for appearance of turkey meat sausages during storage was stable upto 10th day of storage. Thereafter it declined significantly ($P<0.05$) which might be due to pigment breakdown and lipid oxidation resulting in non-enzymatic browning. It could also be partly attributed to the surface dehydration in aerobic packaging. These findings were in consonance with Yadav *et al.* (2018) in chicken sausages. Among the treatments, the appearance scores of carrot incorporated turkey meat sausages was higher than radish incorporated turkey meat sausages and control. The flavour score was stable upto 5th day thereafter declined significantly ($P<0.05$) with increase in storage period which might be due to increased oxidation of fat, which had detrimental effect on the flavour and firmness of the product. However radish incorporated turkey meat sausages had significantly higher flavour score than control and carrot incorporated turkey meat sausages which might be attributed to raw radish. Similar reduction in flavour scores during storage were reported by Patil *et al.* (2004) in chicken patties and Yadav *et al.* (2018) in chicken sausages.

Texture of turkey meat sausages decreased significantly ($P<0.05$) with increase in the storage period in all the samples which might be due to loss of moisture leading to hardening and also due to breakdown of fat and protein. However turkey meat sausages incorporated with vegetables had a better texture compared to control. Irrespective of storage period, radish incorporated turkey meat sausages exhibited high scores. Present findings were corroborated with the results of Ahamed *et al.* (2007) and Yadav *et al.* (2018) in chicken sausages. The juiciness scores of turkey meat sausages decreased marginally up to 5th day of storage, but thereafter the juiciness decreased significantly ($P<0.05$) during entire storage period. The reduction in juiciness scores might be due to loss of moisture from the product during storage. Irrespective of storage, carrot and radish incorporated turkey meat sausages recorded significantly ($P<0.05$) higher scores over control but did not differ significantly among them. These findings were in agreement with Ahamed *et al.* (2007) in buffalo meat cutlets and Yadav *et al.* (2018) in chicken sausages. Similar decreasing trend was observed for overall acceptability of sausages during storage. The scores for overall acceptability were significantly higher for radish incorporated turkey meat sausages indicating that the overall quality was much better than that of control as well as carrot incorporated turkey meat sausages. Sensory evaluation of control and treatments was discontinued on 20th day as they showed slight sliminess on the product.

CONCLUSION

Incorporation of vegetables has a great potential for improvement of nutritional value of developed products besides several health beneficial effects. Based on the results it was concluded that turkey meat sausages incorporated with carrot and radish were senosorially acceptable up to 15th day of refrigerated storage (4 + 1°C). Therefore, addition of carrot and radish has a great potential to be used in preparation of turkey meat sausages with good acceptability, lower microbial load and health benefits.

Table 2: Sensory scores of turkey meat sausages incorporated with carrot and radish paste during refrigeration (4±1R°C) temperature (Mean±SE)

Treatments	Storage days					
	0	5	10	15	20	25
			Appearance			
C	7.22±0.01^{cA}	7.12±0.06^{cA}	7.06±0.01^{cA}	6.66±0.03^{cB}	NA*	NA*
T1	7.48±0.03^{aA}	7.34±0.12^{aA}	7.21±0.05^{aA}	6.96±0.02^{aB}	NA*	NA*
T2	7.36±0.03^{bA}	7.27±0.04^{bA}	7.14±0.02^{bA}	6.82±0.07^{bB}	NA*	NA*
			Flavour			
C	7.46±0.04^{aA}	7.35±0.01^{aA}	6.83±0.12^{cB}	6.38±0.16^{cC}	NA*	NA*
	7.27±0.02^{bA}	7.17±0.03^{bA}	6.92±0.07^{aB}	6.51±0.09^{aC}	NA*	NA*
	7.38±0.04^{cA}	7.27±0.02^{cA}	7.04±0.04^{bB}	6.76±0.04^{bC}	NA*	NA*
			Texture			
	7.06±0.07^{bA}	6.97±0.05^{bA}	6.86±0.03^{bA}	6.42±0.04^{bB}	NA*	NA*
	7.34±0.02^{aA}	7.20±0.14^{aA}	7.08±0.17^{aA}	6.73±0.12^{aB}	NA*	NA*
	7.35±0.02^{aA}	7.23±0.06^{aA}	7.14±0.02^{aA}	6.82±0.07^{aB}	NA*	NA*
			Juiciness			
	6.94±0.05^{bA}	6.85±0.03^{bA}	6.42±0.11^{bB}	6.34±0.02^{bB}	NA*	NA*
	7.18±0.06^{aA}	6.96±0.14^{aA}	6.81±0.07^{aB}	6.64±0.13^{aB}	NA*	NA*
	7.23±0.03^{aA}	7.0±0.08^{aA}	6.85±0.02^{aB}	6.73±0.01^{aB}	NA*	NA*
			Overall Acceptability			
C	7.23±0.03^{bA}	7.16±0.04^{bA}	6.94±0.07^{cA}	6.33±0.11^{cB}	NA*	NA*
T1	7.33±0.04^{aA}	7.23±0.01^{aA}	7.07±0.15^{aA}	6.59±0.02^{aB}	NA*	NA*
T2	7.41±0.02^{aA}	7.34±0.14^{aA}	7.12±0.03^{bA}	6.69±0.04^{bB}	NA*	NA*

Means with different superscripts in the same row (upper case letters) and column (lower case letters) differed significantly ($P<0.05$)

NA* = Not acceptable organoleptically

C-Control, T1-Carrot incorporated sausages, T2- Radish incorporated sausages

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