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A Study on the Quality Characteristics of Gongura Mutton Curry - An Ethnic Meat Product of Andhra Pradesh, India

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ABSTRACT

Mutton curry with gongura (Hibiscus sabdariffa L), a popular traditional Andhra Pradesh's recipe, was prepared by using deboned mutton chunks and spices. Evaluated the effect of three different levels(20,40 & 60%) of gongura incorporation on the quality of mutton curry at refrigeration temperature(4±1 ^{0} C) for 20 days based on the proximate composition, pH, thiobarbituric acid reactive substances (TBARS), free fatty acid value (FFA), sensory attributes and microbiological assay. Results were revealed that,on increase in the addition gongura level in the product, the moisture, fibre and ash contents were ($P<0.05$) increased where as protein and fat contents were($P<0.05$) decreased. Among the treatments, T_3 (Mutton curry with 60% added gongura) scored significantly ($P<0.05$) lower overall mean pH, TBARS, FFA and microbiological values than control and other treatments during the entire storage period. However, T_2 (Mutton curry with 40% added gongura) scored significantly ($P<0.05$) better scores for sensory evaluation than T_3. Irrespective of the treatments the overall mean scores of appearance, flavour, mouth coating, sourness and overall acceptability were decreased significantly ($P<0.05$) on storage. It is concluded that mutton curry with gongura has better acceptable sensory quality characteristics up to 20 days of storage at refrigeration.

Keywords: *Gongura, Mutton curry, Ethnic, Quality, Andhra Pradesh, India.*
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INTRODUCTION

The demand for processed meat products is increasing continuously with growing consumer's response and awareness about the nutrition and quality. Although increasing urbanization and change in life style have changed in the past few years, the liking for ethnic meat products still exists among people. Mutton curry is a traditional, one of the most popular and most relished meat preparations in India (Mendiratta 2008). Ethnic mutton curry in rural areas of India is formulated using different combinations of spices, condiments and also with different vegetables like cucumber, mango, gongura, tomato, fenugreek, drumstick, tender tamarind leaves etc. Among such varieties of Indian recipes, gongura holds special place for food lovers from different sources benefit more than those who limit their intake to a single source or follow a low fibre diet. The recommended amount of dietary fibre per day is 38 grams for men and 25 grams for women. But quite often, we fail to live up to these standards (New Diet Mantra 2015). Dietary fibre is generally known for reducing the energy density in foods and may thereby reduce the food intake and an increased intake of dietary fiber may have several health promoting effects (Westerlund et al. 1993; Anderson et al. 2009).The inhibition of oxidation process is very important in food stuffs. Lipid oxidation is the major quality deteriorative process in meat and meat products resulting in a variety of break down products which produce off flavours and flavours (Faustman and Cassens, 1990; Kanner, 1994). 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 (Valko et al. 2007). Consumers are getting educated with nutritional information available through different sources. This powerful influence of diet on health, well being and increasing scientific evidence confirms that specific components in diet may tend to reduce the occurrence of certain chronic diseases such as cardiovascular diseases, various cancers and neurological disorders (Ames et al. 1993). Many natural plant extracts contain primarily phenolic compounds, which are potent antioxidants (Wong et al., 1995). Leafy vegetables are important sources of dietary fibre, carotenoides, vitamins, minerals and phenolics for both infants and adults. Increased intake of leafy vegetables is generally associated with a reduced risk of cancer and cardiovascular diseases (Azevedoand Rodriguez-Amaya 2005; Kris et al. 2002 and Bahaeldeen et al. 2012).This association is based on the presence of different phyto chemicals like carotenoids, flavonoids and phenoloc acids in vegetables with either potential or proven beneficial effects on human health (Mattila and Hellstrom 2007). Hibiscus sabdariffa L (Called as gongura in colloquial language Telugu) is an annual herbaceous shrub that has many industrial, pharceutical uses in many countries all over the world. It is commonly called as Roselle and belongs to Malavaceae famiy (Bahaeldeen Babiker et al. 2012). Ethno botanical information of Hibiscus sabdariffa L plant revealed diuretic, diaphoretic, uricosuric, antibacterial agent, mild laxautive, sedative, anti hypertensive, antitussive gastrointestinal disorder treatment, hyper cholesterolemia treatment, kidney stone treatment, liver damage treatment, agent for decreasing the viscosity of the blood and the after effects of drunkenness (Duke1983 and Alarcon et al. 2012). The present study was planned to standardize the formulation of acceptable mutton curry with different levels of Hibiscus sabdariffa L (Gongura) and also to study the keeping quality at refrigeration temperature (4±1°C) for 20 days.

MATERIALS AND METHODS

Procurement of raw materials: For preparation of mutton curry with gongura, the meat from adult sheep of non- descript breeds was procured from market, Tirupati, Andhra Pradesh, India. Mutton was cut into chunk size of approximately 2.5cm x2.5cm x 2.5cm were used for preparation of mutton curry. Mean while gongura was purchased from local market, removed the leaves from stems and air dried after proper washing. Ginger, garlic and onions were peeled, washed and made paste of each separately. 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.

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Preparation of meat curry: Series of preliminary trials were conducted to standardize chunks size, gongura, spices, oil, and water levels, time of cooking etc. for preparation of mutton curry. The formulation and processing of control and other treatments of mutton curry were standardized by preliminary trials. The formulations of control and other treatments were used as per the Table 1. Mutton chunks were cooked in a pressure cooker for 20 minutes and separated the mutton chunks and cook out. Gongura also cooked with the little water for getting soften. For preparation of mutton curry, oil was heated in a pan and the onion paste was fried to golden yellow followed by the addition of ginger and garlic paste. Then the cooked meat chunks was added and allowed to cook for 2-3 minutes then added the mashed gongura paste as per formulation. Then added the salt and spice mix and mixed well. Then the prescribed was stirred well and taken out sufficiently thick gravy. The three treatments and control curry were cooled to room temperature and were packed separately in LDPE pouches for further study. All the treatments T1 (Mutton curry with 20% gongura), T2 (Mutton curry with 40% gongura) and T3 (Mutton curry with 60% gongura) along with control were evaluated for its quality at regular intervals of 0, 5, 10, 15 and 20 days at refrigeration temperature (4±1 ^{0} C) with the following parameters like physico-chemical characteristics, Microbiological evaluation and sensory evaluation.

Table 1: Formulation used for preparation of mutton curry with different levels of gongura

Ingredient	Control	T1(20%gongura)	T2(40%gongura)	T3(60%gongura)
Mutton Chunks (g)	100	100	60	40
Gongura(g)	-	20	40	60
Water(ml)	50	50	50	50
Vegetable Oil(ml)	10	10	10	10
Ginger&Garlic Paste(g)	6	6	6	6
Onion Paste(g)	9	9	9	9
Salt (g)	2	2	2	2
Dry Spicemix(g)	10	10	10	10

Chemical and physical parameters: The mutton chunks with gravy were homogenized in a mixer for sampling. Proximate composition in meat with gravy were determined (AOAC 1999) for freshly prepared mutton curry. For other parameters, the sampling was done from packets drawn periodically. Free fatty acid (FFA) (Modi et al. 2004) and thiobarbituric acid (TBA) were determined by the aqueous extraction procedure (Pikul et al. 1989) and pH by immersing a glass-calomel electrode directly into the sample using a pH meter (Cyberscan 1000, Eutech Instru- ments, Singapore).

Microbiological quality: The meat chunks of the mutton curry product were cut into pieces using a sterile knife and mixed with gravy. A 50-g sample of the mixture was placed in a sterile stomacher bag containing 450 ml of sterile saline (0.85% NaCl) solution and blended in a stomacher (model Seward Stomacher 400, Seward Medical, London, U.K.). The blended samples were then tested for standard plate counts (SPC), psychrophiles, coliform, and yeast and molds by pour-plate method as per APHA (2001) procedures.

Sensory quality: The whole mutton curry product in a packet was warmed in a hot pan (80–90ºC) for 3–4 min. The coded samples were subjected to sensory quality evaluation by 10 in-house trained panellists using a 9-point hedonic scale (ASTM 1996; Modi et al. 2003). The mean score for each attribute (color, flavor, mouth feel, consistency of gravy, meat texture and overall quality) was reported.

Statistical analysis: The experiment had a completely randomized design with six replicates. Preparation of mutton curry in six batches on different days represented the replicates. The mean values for all parameters were examined for significance as a function of storage period by analysis of variance. When significance ($P<0.05$) was observed, means separation was accomplished by Duncan's multiple range test using STATISTICA software (Statsoft 1999).

RESULTS AND DISCUSSION

The proximate composition of freshly prepared mutton curry with gongura was given in Table 2. Results revealed that the moisture, fiber and ash contents ofthe product were increased with the increase in addition of gongura, which indicates that highest moisture, fiber and ash content were observed in the product added with 60 g of gongura (T3) thanthe other treatments and control. This might be due to the high moisture, fiber and ash content of gongura leaves. The protein and ether extract content of T3 product was significantly ($P < 0.01$) increased with the increased addition of gongura, and this finding revealed that lowest protein and fat contents were observed in the product added with 60 g of gongura (T3) than other treatments and control. This might be due to the reduction in meat content and increase in gongura in the formulation of T3 curry. These results were in agreement with Rajkumar et al. 2010, Zhang et al. 2011; Kandeepan et al. 2011.

Table 2: Effect of incorporation of different levels of gongura on the proximate composition of freshly prepared mutton curry (Mean ± S.E).

Parameter	Control	T1(20%Gongura)	T2(40%Gongura)	T3(60%Gongura)
Moisture	50.1±0.021[a]	55.7±0.040 [b]	59.2±0.015 [c]	62.7±0.028 [d]
Crude protein	27.0±0.022 [a]	23.8±0.013 [b]	21.2±0.017 [c]	18.9±0.015 [d]
Crude fiber	0.01±0.015 [a]	1.10±0.031 [b]	1.20±0.015 [b]	1.60±0.020 [c]
Ether extract	12.9±0.011 [a]	7.20±0.041 [b]	5.00±0.022 [c]	4.80±0.030 [d]
Total ash	2.00±0.014 [a]	2.50±0.012 [b]	2.80±0.019 [c]	3.10±0.028 [d]

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

According to the results obtained in this study, T3 sample (Mutton curry 60% added Gongura) scored significantly (P<0.05) lower overall mean pH values than control and other treatments during entire storage period (Fig. 1).

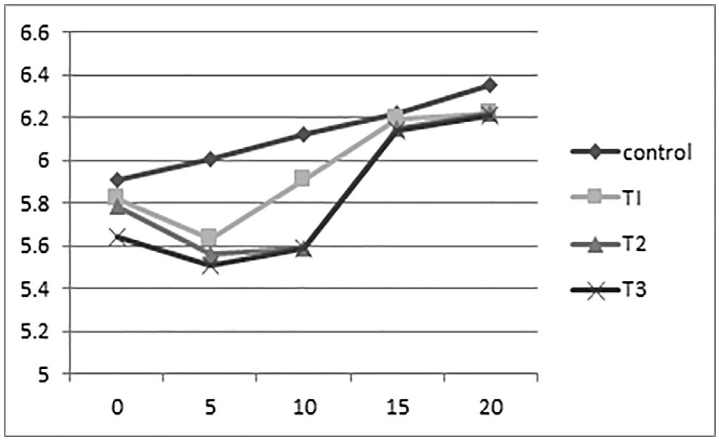

Fig. 1: Effect of incorporation of different levels of gongura on the pH values of mutton curry during refrigeration storage (4 ± 1°C)

These results were in accordance with Zhang et al. 2011 and Karabacak and Bozkurt 2008. Further also observed overall increase in the mean pH values (P<0.51) as storage period advances irrespective of the treatments. Which might be due to the accumulation of metabolites by bacterial action in meat and also due to formation of ammonia by degradation protein and amino acid (Jay 1996). These results were in accordance with Kandeepan et al. 2011in buffalo meat curry; Karabacak and Bozkurt 2008 in sucuk and Modi et al. 2006 in chicken curry. Results revealed that, T3 samples had significantly (P<0.05) lower thio barbituric acid reactive substance (TBARS) values than the other treatments and control (Fig. 2). This might be due to gongura (H. Sabdariffa) leaves which were rich in naringin, rutin, syringic acid, and caffeic acid which have good antioxidant properties (Zhang et al. 2011).

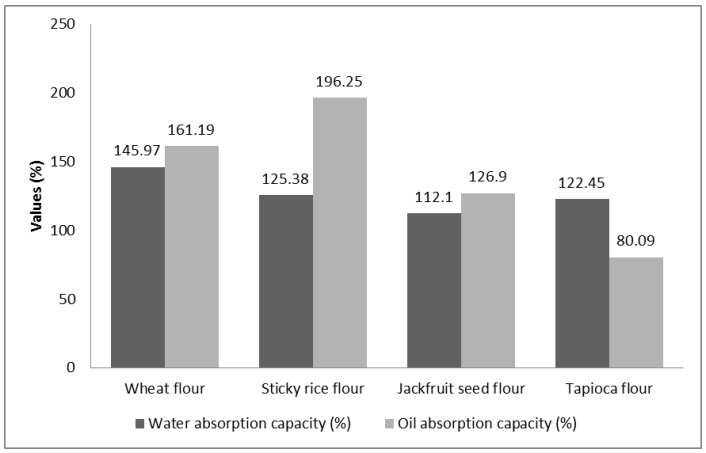

Fig. 2: Effect of incorporation of different levels of gongura on TBARS values of mutton curry during storage at refrigeration (4 ± 1^{0}C) temperature

During the entire storage period there was a significant (P<0.05) increase in the overall mean TBA values of control and all treatments during the 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 Kandeepan et al. (2011) buffalo meat curry and Modi et al. (2006). 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 of T3 had significantly (P<0.05) lower than control and other treatments (Fig. 3). This might be due to the gongura (H. Sabdariffa) leaf contain different phenolic and flavonoids components which have antioxidant properties (Zhang et al. 2011). The overall mean free fatty acid values for all treatments and control (P<0.01) were increased gradually with increased storage period. This increase might be due to progressive oxidation of lipids during storage. The results were in agreement with Kandeepan et al. (2011) buffalo meat curry and Modi et al. (2006) in chicken curry.

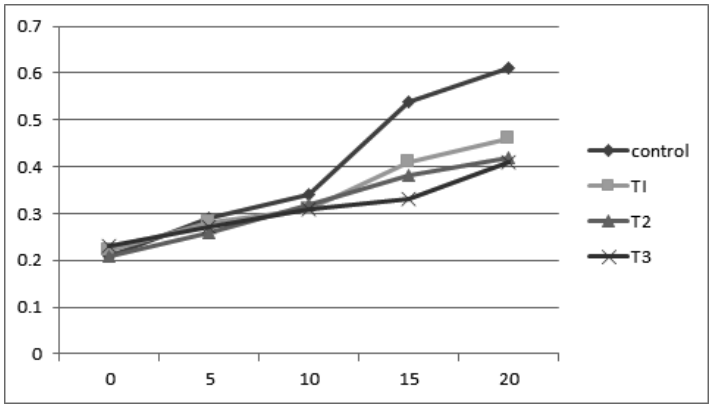

Fig. 3: Effect of incorporation of different levels of gongura on FFA values of mutton curry during storage at refrigeration (4 ± 1°C) temperature

As per the results obtained in the microbiological counts of the study, significantly (P<0.05) higher standard plate and Psychrophilic counts were observed for control compared to the treatments (Table 3). Among the treatments, T3 observed lower counts than others though it was not significant. This might be due to the antimicrobial activity of gogura leaves (Zhang et al. 2011). Overall mean bacterial counts (log10 cfu/g) gradually increased (P>0.05) up to 10th day then there was a significant (P<0.05) increase in counts were observed with increase in storage period during refrigeration irrespective of the treatments. This might be due to the permissive temperature and relative availability of moisture and nutrients for the growth of bacteria. These results were in accordance with Balange et al. (2003) and Kandeepan et al. (2011).

Table 3: Effect of incorporation of different levels of gongura on the microbiological properties of mutton curry during storage at refrigeration temperature (4±1 °C) (Mean ± S.E)

Treatments	Storage days					Overall treatment Mean
	0	5	10	15	20	
Standard plate count (log10cfu/g of meat)						
Control	2.72±0.02	3.09±0.02	3.28±0.03	4.07±0.01	4.95±0.01	3.62±0.02^{A}
T1	2.76±0.01	2.92±0.03	3.04±0.01	3.28±0.03	3.84±0.02	3.16±0.04^{B}
T2	2.71±0.01	2.90±0.01	3.01±0.06	3.17±0.01	3.54±0.06	3.06±0.04^{B}
T3	2.72±0.04	2.56±0.01	2.65±0.02	3.01±0.06	3.57±0.01	2.90±0.06^{B}
Overall days mean	2.72±0.04 ^{a}	2.86±0.04 ^{a}	2.99±0.04 ^{a}	3.38±0.04 ^{b}	3.97±0.04^{c}	
Psychrophiles (log10cfu/g of meat)						
Control	1.22±0.04	1.56±0.01	1.65±0.02	2.43±0.02	2.57±0.02	1.88±0.07^{A}
T1	1.21±0.04	1.43±0.02	1.57±0.02	2.11±0.02	2.29±0.02	1.72±0.02^{B}
T2	1.24±0.03	1.39±0.07	1.61±0.04	2.04±0.02	2.17±0.02	1.69±0.07^{B}
T3	1.21±0.03	1.33±0.02	1.63±0.02	2.02±0.02	2.12±0.02	1.66±0.02^{B}
Overall days mean	1.22±0.02 ^{a}	1.40±0.02 ^{a}	1.60±0.02 ^{a}	2.12±0.02 ^{b}	2.26±0.02 ^{c}	

Means with different superscripts in a row and column wise differ significantly (P< 0.05).

The overall mean scores (Table 4) of appearance, flavour, mouth coating, sourness and overall acceptability between treatments and control differed significantly (P<0.05) However, T2 samples secured significantly (P<0.05) higher scores for appearance, mouth coating and overall acceptability than the all other treatments.

Table 4: Effect of incorporation of different levels of gongura on the oganoloeptic properties of mutton curry during storage at refrigeration temperature (4±1 ° C) (Mean ± S.E)

Treatments	Storage days					Overall treatment Mean
	0	5	10	15	20	
Appearance						
Control	7.72±0.05	7.69±0.01	7.27±0.02	6.68±0.01	6.15±0.01	7.10±0.08 ^{A}
T1	7.96±0.06	7.82±0.02	6.94±0.01	6.48±0.03	6.17±0.01	7.07±0.01 ^{A}
T2	7.91±0.08	8.00±0.06	7.55±0.05	6.73±0.02	6.34±0.09	7.30±0.01 ^{B}
T3	7.36±0.08	7.14±0.05	6.91±0.01	6.64±0.02	6.14±0.04	6.83±0.01 ^{A}
Overall days mean	7.73±0.02^{a}	7.66±0.08^{a}	7.16±0.02^{b}	6.63±0.01^{b}	6.20±0.01^{c}	
Flavor						
Control	7.65±0.05	7.22±0.02	7.18±0.02	6.32±0.01	5.15±0.01	6.70±0.11 ^{A}
T1	7.56±0.06	7.85±0.01	7.72±0.09	6.66±0.03	5.92±0.01	7.14±0.03 ^{B}
T2	7.60±0.03	7.32±0.02	6 .95±0.09	6.49±0.02	5.83±0.08	6.83±0.02 ^{A}
T3	7.46±0.08	7.84±0.05	6.91±0.01	6.64±0.02	5.57±0.04	6.88±0.06 ^{A}
Overall days mean	7.56±0.02^{a}	7.55±0.06^{a}	7.19±0.03^{a}	6.52±0.21^{b}	5.61±0.01^{c}	
Mouth coating						
Control	7.27±0.05	6.88±0.01	6.49±0.03	5.91±0.01	5.55±0.02	6.42±0.05 ^{A}
	7.66±0.06	6.94±0.03	6.92±0.02	6.38±0.03	5.14±0.03	6.60±0.06 ^{A}
	7.46±0.08	6.91±0.01	6.84±0.05	6.64±0.02	5.57±0.04	6.68±0.05 ^{B}
	7.46±0.08	6.91±0.06	6.84±0.05	6.44±0.02	5.57±0.04	6.64±0.05 ^{B}
Overall days mean	7.46±0.08 ^{a}	6.91±0.01 ^{a}	6.77±0.05 ^{a}	6.34±0.02 ^{a}	5.45±0.04 ^{a}	
Sourness						
Control	7.17±0.05	6.89±0.02	6.58±0.01	6.37±0.01	6.15±0.01	6.42±0.09 ^{A}
	7.96±0.06	7.72±0.01	7.04±0.01	6.58±0.03	6.46±0.02	7.15±0.04 ^{B}
T2	7.41±0.08	7.50±0.02	7.31±0.05	6.97±0.02	6.40±0.09	7.11±0.05 ^{B}
T3	7.16±0.08	7.14±0.05	6.91±0.01	6.64±0.02	6.24±0.04	6.81±0.05 ^{B}
Overall days mean	7.42±0.08 ^{a}	7.31±0.05 ^{a}	6.96±0.01 ^{a}	6.64±0.02^{b}	6.31±0.04^{c}	
Overall acceptability	7.26±0.09	7.15±0.05	6.91±0.03	6.22±0.01	6.02±0.08	6.71±0.03 ^{A}
Control						
T1	7.79±0.01	7.11±0.02	6.95±0.03	6.41±0.05	6.11±0.01	6.87±0.05 ^{B}
T2	7.92±0.05	7.48±0.05	7.23±0.04	6.96±0.09	6.26±0.04	7.17±0.06 ^{C}
T3	7.46±0.08	7.84±0.05	6.91±0.01	6.64±0.02	6.17±0.04	7.00±0.06 ^{B}
Overall days mean	7.60±0.08 ^{a}	7.39±0.05 ^{a}	7.00±0.01 ^{a}	6.55±0.02 ^{b}	6.14±0.04 ^{c}	

Means with different superscripts in a row and column wise differ significantly (P< 0.05).

Although, T1 samples scoured better for flavour and sourness scores than T2 but difference is not significant. Irrespective of the treatments the overall mean scores of appearance, flavour, mouth coating, sourness and overall acceptability were decreased significantly (P<0.05) on storage. The reduction in sensory scores of stored product might be due to free radicals formed in lipid oxidation process can oxidize haem pigments to metmyoglobin which causes the discoloration of product during storage, oxidative fading and moisture loss. These results were in agreement with Kandeepan et al. (2011) in buffalo meat curry; Kim et al. (2011) in refrigerated low-fat pork sausages with tomato powder and Das et al. (2011) in antioxidant effect of curry leaf (Murray koenigii) powder on quality of ground and cooked goat meat.

CONCLUSION

On the basis of the above study, it can be concluded that mutton curry prepared with three different levels of gongura was physico-chemically, microbiologically and organoleptically better acceptable up to 20 days of storage at refrigeration temperature(4±1° C) compared to the control. However, mutton curry added with 40% gongura scoured better for sensory evaluation among the three different levels.

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COMPETING INTERESTS: The authors have no known competing interests.

ETHICS STATEMENT: Not Applicable

REFERENCES

Alarcon-Alonso J, Zamilpa A, Aguilar FA, Herrera-Ruiz M, Tortoriello J, Jimenez-Ferrer E (2012) Pharmacological characterization of the diuretic effect of Hibiscus sabdariffa Linn (Malvaceae) extract. J. of Ethnopharmacology, 139(3): 751–756.

Ames BN, Shigenaga MK, Hagen TM (1993) Oxidants, antioxidants and the degenerative disease of aging. Proceedings of National Academy of Sci., 90:7915-7922.

Andersson KE, Immerstrand T, Sward K (2009) Effects of oats on plasma cholesterol and lipoproteins in C57BL/6 mice are substrain-specific. British J. of Nutri. 103:513-521.

AOAC (1999) Official Methods of Analysis, 5th Revision, 16th Ed., Association of Official Analytical Chemists, Washington, DC.

APHA (2001) Compendium of Methods for the Microbiological Examination of Foods, 4th Ed., American Pubic Health Association, Washington, DC.

ASTM (1996) American Society for Testing Materials. Manual Series MNL 26, 2nd Ed., American Society for Testing and Materials, Philadelphia, PA.

Azevedo-Meleiro CH, RodriguezAmaya DB (2005b). Carotenoids of endive and New Zealand spinach as affected by maturity, season and minimal processing. J. of Food Composition and Analysis, 18: 845-855.

Balange AK, Joshi VR, Pagarkar AU (2003) preparation of pasteurized fish ball in curry and its storage study at 0 to 2°C . J. of the Indian Fisheries Association, 30: 141-148.

Bahaeldeen Babiker Mohamed, Abdelatif Ahmed Sulaiman, Abdelhafiz Adam Dahab (2012) Roselle (Hibiscus sabdariffa L.) in Sudan, Cultivation and Their uses. Bull. Environ. Pharmacol. Life Sci. 1 (6): 48 – 54.

Chandralekha, S (2010) Effect of natural and synthetic antioxidants in chicken meat balls M.V.Sc thesis, submitted to C.V.Sc., Sri Venkateswara Veterinary University, Tirupati.

Das AK, Rajkumar V, Dwivedi D (2011) Antioxidant effect of curry leaf (Murraya koenigii) powder on quality of ground and cooked goat meat. Inter. Food Res. J. 18: 563-569.

Faustman C, Cassens R G (1990) The biochemical basis for discoloration in fresh meat: A review. J. of Muscle Foods, 1:217-243.

James A. Duke (1983) Handbook of Energy Crops. unpublished.

Jay JM (1996) Antioxidants. In Modern food microbiology (4th ed.) New Delhi, India: CBS Publishers and Distributors: 265–266.

Kandeepan G, Anjaneyulu ASR, Napa Kondaiah , Sanjod kumar Mendiratta (2011) Comparison of quality attributes of buffalo meat curry at different storage temperature. Acta sci. Pol., technol. Aliment. 10(1): 83-95.

Kanner J (994) Oxidative processes in meat and meat products: Quality implications. Meat Sci. 36(1–2): 169-189.

Karabacak Sencil, Bozkurt Huseyin (2008)Effects of Urtica dioica and Hibiscus sabdariffa on the quality and safety of sucuk (Turkish dry-fermented sausage). Meat Sci. 78: 288-296.

Kim IS, Jin SK, Mandal PK, Kang SN (2011) Quality of low-fat pork sausages with tomato powder as colour and functional additive during refrigerated storage. J. of Food Sci. and Techn. 48(5): 591–597.

Kris-Etherton PM, Harris WS, Appel LJ (2002) Fish consumption, fish oil, omega-3 fatty acids, and cardiovascular disease. American Heart Association. Nutrition Committee. Erratum in Circulation 107(3):512.

Mattila P, Hailstorm, J (2007) Phenolic acids in potatoes, vegetables, and some of their products. J. of Food Composition and Analysis, 20: 152–160.

Mendiratta SK, Kondaiah N, Anjaneyulu ASR, Sharma BD (2008) Comparisons of Handling Practices of Culled Sheep Meat for Production of Mutton Curry.Asian-Aust. J. Anim.

Sci.Vol. 21 (5): 738 – 744.

Modi VK, Mahendrakar NS, Narasima Rao D, Sachindra NM (2003) Quality of burger containing legume flours as binders. Meat Sci. 66: 143–149.

Modi V, Mahendrakar N, Narasimha Rao D, Sachindra, N (2004) Quality of buffalo meat burger containing legume flours as binders. Meat Sci. 66(1): 143–149.

Modi VK, Sachindra NM, Sathisha AD, Mahendrakar NS, Narasimha Rao D (2006) Changes in Quality of Chicken Curry During Frozen Storage. J. of Muscle Foods 17: 141–154.

New Diet Mantra (2015) Dietary Fiber from Various Food Sources could be more Beneficial NDTV Food, Modified: July 15: 13:43 IST.

Pikul J, Leszczynski DE, Kummerow FA (1989) Evaluation of three modified TBA methods for measuring lipid oxidation in chicken meat. J. of Agricultural Food Chem. 37: 1309–1313.

Rajkumar V, Dushyanthan K, Arun K. Das (2010) Retort pouch processing of Chettinad style goat meat curry – a heritage meat product. J. of Food Science and Technology, 47(4):372–379.

Valko M, Leibfritz D, Moncol J, Cronin MT, Mazur M, Telser J (2007) Free radicals and antioxidants in normal physiological functions and human disease. Intern. J.of Biochem. and Cell Biol. 39:44- 84.

Westerlund E, Andersson R and Aman P (1993) Isolation and chemical characterization of water-soluble mixed beta-glucans and arabinoxylans in oat milling fractions. Carbohydrate Polymers 20: 115-123.

Wong JW, Hashimoto K, Shibamoto T (1995) Antioxidant activities of rosemary and sage extracts and vitamin E in a model meat system. J. of Agri. Food Chem. 43:2797-2712.

Zhang Min, Navam S Hettiarachchy, Ronny Horax, Arvind Kannan, Apputhury Praisoody M. D, Arumugam Muhundan, Chandrasekhara Reddy Mallangi (2011) Phytochemicals, antioxidant and antimicrobial activity of Hibiscus sabdariffa, Centella asiatica, Moringa oleifera and Murraya koenigii leaves. J. of Medicinal Plants Res.5(30):6672- 6680.

Zheng W, Wang SY(2001) Antioxidant activity and phenolic compounds in selected herbs. J. of Agriculture and Food Chemistry, 49: 5165-5170.