Journal of Animal Research: v.8 n.1, p. 117-123. February 2018
DOI: 10.30954/2277-940X.2018.00150.19

Effect of Different Cooking Methods and Binding Materials on Proximate Composition, Physicochemical and Sensory Quality of Different Emulsion Based Chicken Products

Kiran, M.[1*], Vinayanada, C.O.[1], Jagannatha Rao, B.[1], Ravindra, B.D.[2] and Ramachandra, B.S.[2]

[1]*Department of Livestock Products Technology, Veterinary College, Bidar, Karnataka Veterinary Animal Fisheries Science University, Karnataka, INDIA*
[2]*Department of Animal Nutrition, Veterinary College, Bidar, Karnataka Veterinary Animal Fisheries Science University, Karnataka, INDIA*

[*]*Corresponding author: Kiran M.; Email: kiranm.321@rediffmail.com*

Received: 22 Nov., 2017 **Revised:** 01 Jan., 2018 **Accepted:** 13 Jan., 2018

ABSTRACT

The meat industry is focused on the development of new products with better nutritional properties and acceptable sensory quality by adopting innovative processing and cooking procedures. In this study, the effects of different cooking treatments (moist cooking, dry cooking and deep fat frying) and incorporation of binders (Rice-*Oryza sativa* and Ragi-*Eleusine coracana*) on poultry meat were investigated. The proximate composition, physicochemical and sensory acceptance (Colour, flavour, Texture, juiciness and overall acceptability) of the meat cooked using the different treatments were compared. The study revealed that moisture and fat differ significantly ($p<0.05$) among the different cooking methods. However no significant ($p<0.05$) changes observed for protein and ash. The pH of cooked products varies significantly ($p<0.05$) and pH was found to be lower in deep fat fried products. The cooking yield of deep fat fried product was significantly ($p<0.05$) lower than the dry and moist cooked products. There was no significant ($P>0.05$) difference in sensory ratings between emulsion based product prepared with different binders and also there was no significant ($P>0.05$) difference among the different cooking methods. Overall acceptability scores for all the products were more than 6.50 reflecting more than moderate acceptance of all products. The incorporation of rice and ragi as binder increased cooking yield and also gave better sensory ratings. Further, there was no significant ($P>0.05$) difference in physicochemical quality, proximate composition and sensory rating. Ragi which is known to be rich in iron can be effectively used in place of rice as binder in emulsion based chicken products.

Keywords: deep fat frying, dry cooking, moist cooking, ragi, rice

In recent years, the development of the global poultry meat market has been marked by rapid, unexpected and complex changes. This huge global demand of poultry meat is attributed to relatively low and competitive pricing in contrast to other meat, absence of religious taboo with high dietary and nutritional quality. Globally, poultry meat industry is one of the most competitive sector and is currently in its mature stage of development. Rapid urbanization, industrialization and changing lifestyle are driving meat industry to develop various meat products wherein, comminution/mincing offers a profitable solution with efficient utilization of meat and by-products (Verma *et al*., 2012). Increased global competition coupled with changes in consumer demand is causing an unprecedented spur in processing and ingredients used within the meat manufacturing sector. Finely comminuted meat products/ emulsion based products are a mixture of proteins, fat particles, water, salt and often carbohydrates. Heat treatment during different cooking can lead to undesirable modification of meat quality, such as the loss of nutritive value, mainly due to lipid oxidation, and changes in some components of the protein fraction (Rodriguez- Estrada *et al*., 1997). Consumers demand healthier meat products incorporating health benefitting additives while processing while expecting these novel meat products added with healthy additive without compromise on sensory quality.

Cereal flours are one of the commonly used ingredients in preparation of meat emulsion, starch present in the cereals is versatile and economical and has many uses as a thickener, water binder, emulsion stabilizer and gelling agent and used in the production of different meat products. Starch is often used as an inherent natural ingredient, but it is also added for its functionality. However, plenty of cereals are easily available in the market, but selection of the flour should be appropriate that it should not diminish rheological, structural, nutritional properties of the processed meat products. Finger millet (*Eleusine coracana*) is one of the ancient cereal crop used extremely in South Asia, especially in India, where it is generally called "*Ragi*". It is a low-cost gluten-free cereal and is a rich source of calcium, iron and phosphorous. It contains a good balance of amino acids (Tripathi *et al*., 2012). Finger millets are known to release sugar slowly in the blood and also diminish the glucose absorption making it millet of choice among health conscious consumers. Researchers have opined that finger millet possess many health benefits like antioxidant, antibacterial/antifungal activity, aldose reductase inhibition, nephro-protective, cholesterol and blood glucose lowering and anti-ulcerative properties (Veenashri and Muralikrishna, 2011;Varsha *et al*., 2009; Chethan *et al*., 2008; Shobana *et al*., 2010).

Meat cooking is one of the critical step in meat processing influencing organoleptic properties, microbial load, shelf life, digestibility and nutritive value boosting consumer acceptance. Meat eating quality can be defined in terms of the sensory attributes like tenderness, juiciness, and flavour. Types of cooking method affect the sensory properties of meat and meat products (Ashok *et al*., 2016). Cooking loss is dependent on mass transfer process during heat treatment hence different cooking methodologies will have different cooking yields (Cheng and Sun, 2008). A high cooking loss gives an expectation of a less optimal eating quality. Weight loss during cooking is an economical issue, because it directly influences quality and economic benefits. Generally, cooking loss/yield is affected by pH, cooking temperature and end point temperature, (Pearson and Dutson, 1994).

To our knowledge, there are very scant studies describing the effect of different cooking methods incorporated with different binders on emulsion based poultry meat products. Hence, this study was conducted to assess the influence of three different cooking methods (moist cooking, dry cooking and deep-fat frying) on proximate composition, physico-chemical qualities and sensory acceptance of emulsion based products.

MATERIALS AND METHODS

Preparation of meat emulsion

Freshly slaughtered poultry carcasses were obtained from local Slaughter house of Bidar, India. The basic formula of chicken emulsion are (per cent basis (w/w)): chicken meat at 62, chicken fat at 10, rice flour at 10 which is replaced by Ragi in other treatment, salt at 2, sodium tri polyphosphate at 0.05, sodium nitrite at 0.015, sodium ascorbate at 0.5, sugar at 1, ice flakes at 8, spice mixture at 2 and condiment mixture at 5. The dressed chicken was minced using a 4 mm sieve by a meat mincer. The minced meat was placed in a bowl chopper (Maschinenfabrik Dornhan®, MTK 661, Germany) and various additives *i.e* salt, sodium tripolyphosphates, sodium nitrite, sodium ascorbate and sugar were added and mixed thoroughly and chopped further for 1 minute. Then rice/ragi flour, spice mix, ice flakes and onion garlic paste were added and chopped again for 1-2 minutes until a good emulsion was formed. The emulsion prepared was subjected to different cooking treatments as below.

Moist Cooking (Nuggets)

Meat emulsion was placed in aluminum moulds, packed compactly and covered. The emulsion filled moulds were steam cooked for 30 min to achieve an internal temperature of about 85 °C. The meat blocks were cooled at room temperature and cut into nuggets of desired size (Naveena *et al*., 2011).

Dry Cooking (Patties)

To produce patties 75 mm in diameter and 15 mm in thickness, 70–75 g of the ground meat emulsion was moulded and placed in stainless steel plates pre-smeared with refined edible oil to avoid sticking and cooked in a preheated hot air oven at 175±2°C. Then the patties were turned upside down and cooked for another 5 min for adequate doneness and to improve the appearance and colour. The endpoint core temperatures ranged between 80 and 83°C (Naveena *et al*., 2011).

Deep-fat frying (croquettes)

The small portion of emulsion mix was made in the form of small balls of about 5 g were fried in pre heated sunflower oil maintained at 180 °C for 3-4 min until core temperature of croquette reaches 80 °C. After frying, samples were allowed to drain for a short time before being blotted gently with dry tissue paper to remove excess oil on the surface (Naveena *et al*., 2011).

Analytical procedures

The samples were analysed for the proximate composition, following AOAC procedures (AOAC, 1980). Moisture content was determined by the oven drying method (AOAC 950.46). Total Kjeldhal method (AOAC, 928.08) and Soxhlet method (AOAC, 991.36) were used to determine protein content and lipid contents respectively, and total ash content was determined by using muffle furnace (AOAC, 920.153). The pH of raw and cooked meat samples were determined by homogenizing 10 g of sample with 50 mL distilled water and pH of suspension was recorded by immersing the combined glass electrode of digital pH meter. The weights of samples were recorded before (raw weight) and after cooking. Cooked weight was divided by raw weight and the result was multiplied by 100 to get percent cooking yield. The TBA value of raw and cooked product were determined by using the extraction method described by Witte *et al.* (1970) with slight modifications. Four-gram sample was homogenized with 20% trichloroacetic acid solution (20 mL) and the slurry was centrifuged (Eppendrof, Centrifuge 5430R, Germany) at 3,000 g for 10 min. Two milliliters of supernatant was mixed with equal volume of freshly prepared 0.1% Thiobarbituric acid (TBA) in glass test tubes and heated in water bath at 100 °C for 30 min followed by cooling under tap water. The absorbance of the mixture was measured at 532 nm using UV-VIS spectrophotometer (Agilent Technologies, Cary 60 UV-Vis, Malaysia) and the TBA values were calculated using a TBA standard curve and expressed in mg MDA/kg.

Sensory evaluation

Samples were evaluated for changes in sensory attributes (appearance, flavor, texture, juiciness, and overall acceptability) by about ten semi experienced faculty panel of the Veterinary College, Bidar. The attributes were evaluated using an 8-point descriptive scale (Keeton, 1983) where 8 denoted extremely desirable and 1 denoted extremely poor.

Statistical analysis

The overall experiment was replicated on three separate occasions and the data generated for different quality characteristics were compiled and analyzed. The data were subjected to analysis of variance, (two way analysis of variance), least significant difference, paired t-test (Snedecor and Cochran, 1994) and Duncan's multiple range test using SPSS (SPSS version 13.0 for windows; SPSS Inc., Chicago, IL) for comparing the means to find significant ($P < 0.05$) differences between binders used, cooking method applied and their interactions for the parameters under study.

RESULTS AND DISCUSSION

Cooking is one of the most important factors that affect the quality of meat product due to a series of chemical and physical reactions, as cooking produces certain texture and flavour compounds affecting physico-chemical traits and sensory acceptability of meat products. The results of proximate composition analysis (moisture, fat, protein and ash) and changes in physico-chemical parameters like pH, TBARS and cooking yield of chicken meat incorporated with different binders (Rice and Ragi) as affected by different cooking (moist cooking, dry cooking and deep fat frying) are summarized in Table 1.

The cooking treatment significantly modified the proximate composition of samples, while binding material had no effect on the proximate composition. Cooking methods influences the nutritive values of meat. A cooking method that produces a high-quality meat products having favourable texture and taste are generally chosen by consumers (King and Whyte, 2006) and this cooking has an important effect on the nutritional properties (Kondjoyan *et al*., 2014). Heat treatment during cooking can cause nutritive value loss. Statistically significant

Table 1: The variation in proximate composition and physico-chemical changes (Mean±SE) in emulsion based chicken products incorporated with different binders subjected to different cooking methods

Binder	Cooking Method	Moisture (%)	Fat (%)	Protein (%)	Ash (%)	pH	TBA value	Cooking Yield (%)
Rice	Raw	—	—	—	—	5.68±0.09[cd]	0.49±0.02	—
	Moist Cooking	71.05±0.25[c]	3.32±0.11[a]	16.74±0.12[ab]	1.93±0.10	5.34±0.04[a]	0.48±0.01	74.62±1.52[d]
	Dry cooking	67.31±0.25[b]	4.71±0.20[b]	17.06±0.08 [bc]	2.02±0.15	5.45±0.14[abc]	0.45±0.03	72.94±2.05[cd]
	Deep fat frying	52.80±0.63[a]	9.42±0.08[d]	16.97±0.05[bc]	2.17±0.13	5.29±0.10[a]	0.44±0.02	67.46±0.92[a]
Ragi	Raw	—	—	—	—	5.86±0.05[e]	0.46±0.04	—
	Moist cooking	70.38±0.73[c]	3.58±0.17[a]	15.74±0.12[a]	1.95±0.16	5.37±0.04[ab]	0.49±0.03	70.59±1.12[bc]
	Dry cooking	67.31±0.25[b]	5.60±0.49[c]	16.40±0.51[ab]	2.08±0.05	5.65±0.12[bcd]	0.52±0.01	69.07±1.86[ab]
	Deep fat frying	53.8±0.55[a]	9.22±0.28[d]	17.97±0.44[c]	2.20±0.13	5.50±0.07[abc]	0.47±0.04	67.60±0.72[a]

Mean values bearing same superscripts within same row do not differ significantly (P>0.05)

differences in the moisture content were observed between the studied cooking treatments. Highest moisture content was seen with moist cooking with least moisture in deep fat frying. This lowest moisture content in deep fat frying might be due to heat and mass transfer of oil and air promoting moisture loss. Total lipid was highest during deep fat frying might be due to oil absorption during the frying process (Richa *et al*., 2016). The water evaporation, melting of fats and loss of soluble proteins affects moisture and lipid content during cooking (Barbantia and Pasquini, 2005). The moisture content observed in current study is similar to other researchers in beef patties (Serdaroglu, 2006) and emulsion nuggets (Thomas *et al*., 2006). The fat content was found to be highest in deep fat fried products with least fat content in moist cooked nuggets. The fat content was found to vary inversely with moisture content, the same has been reported by Moreira *et al*. (1995) who concluded that the moisture content of any product greatly influences final oil content. The least fat content in moist cooked products might be due to uniform heating of the product leading to moisture evaporation during microwave heating (Ngadi *et al*., 2006). Higher fat content of deep-fat fried products observed might be due to loss of moisture (Gerber *et al*., 2009; Tornberg, 2005). The protein content in meat products may be influenced by water and fat loss during cooking but primarily it depends on the protein content of raw meat. High protein content was seen in deep fat fried products in contrast to other cooking methods in ragi enriched products. Whereas, in products incorporated with rice flour moist cooking had least protein content. The protein content observed in current study is in agreement with previous studies (Serdaroglu, 2006; Thomas *et al*., 2006; Kumar and Sharma, 2004, Verma *et al*., 2010, Verma *et al*., 2012). There was no significant effect of different cooking methods on ash content of all products. The pH was more in raw emulsion in contrast to cooked products. The deep fat fried and moist cooked rice based products had least pH among all samples. There was no significant (P>0.05) variation pH of cooked products incorporated with different binders but Ragi incorporated raw emulsion had significantly (P<0.05) higher pH in contrast to all samples. The observed pH in current study is in agreement with findings of other researchers (Liao *et al*., 2010; Ashok *et al*., 2016; Verma *et al*., 2010). The higher value of pH in Ragi incorporated cooked products is consistent with findings of Siddiqui and Khan (2011).

Moist cooking had highest cooking yield compared with dry cooking and deep-fat frying indicating higher cooking temperature would bring higher cooking loss (Combes *et al*., 2003) due to higher moisture retention. In dry cooking and deep-fat frying there is loss in form of evaporative and drip losses (Badiani *et al*., 1998). The lower yield of deep fat fried products was consistent with Juárez *et al*. (2010) who reported that frying led to the highest moisture loss. However this results disagrees with findings of other works on deep fat fried products (Alfaia *et al*., 2010; Serrano *et al*., 2007). The findings of present study were similar to the results of Naveena *et al*. (2014), who indicated that croquettes had lower water activity than nuggets and patties. The yield of nuggets and patties were contrasted by other reports (Verma *et al*., 2010; Nisar *et al*., 2010).

The degree of oxidation in meat and shelf life of meat products are indicated by TBARS value. As per the

Table 2: The variation in Sensory profile (Mean±SE) in emulsion based chicken products incorporated with different binders subjected to different cooking methods

Sensory Profile	Cooking Method	Rice	Ragi
Colour	Moist cooking	7.00±0.29	6.70±0.42
	Dry cooking	6.90±0.35	6.80±0.25
	Deep fat frying	6.90±0.28	6.40±0.27
Flavour	Moist cooking	6.83±0.47	7.05±0.30
	Dry cooking	6.85±0.33	6.35±0.35
	Deep fat frying	6.65±0.28	6.55±0.35
Texture	Moist cooking	6.89±0.31	6.50±0.52
	Dry cooking	7.10±0.31	6.60±0.43
	Deep fat frying	6.80±0.33	6.50±0.37
Juiciness	Moist cooking	6.83±0.33	6.85±0.39
	Dry cooking	7.25±0.25	6.95±0.32
	Deep fat frying	6.85±0.26	6.85±0.30
Overall acceptability	Moist cooking	7.56±0.24	7.50±0.27
	Dry cooking	7.40±0.22	7.10±0.31
	Deep fat frying	7.30±0.30	6.90±0.31

TBARS values of the different samples chicken emulsion subjected to different cooking had same fat and lipid stability. The lowest rate of lipid oxidation was observed in meat which has been subjected to high temperature of cooking (deep fat frying) with all rates of oxidation process were comparable. The lower oxidation as indicated by low TBA value might be combined effect of a relatively high temperature and a shorter cooking time. The TBARS values obtained were similar to those found by Prathyusha *et al*. (2016), Naveena *et al*. (2014) in nuggets and patties respectively. Similar results have been noticed by Serrano *et al*. (2007) who found that cooking method has no effect on TBARS values in restructured meat products.

A sensory profile analysis of meat is a method for description of the eating quality in an objective way. The eating quality attributes of any meat product is a combination of appearance, odour, flavour and texture including tenderness and juiciness. The results of sensory evaluation of emulsion based chicken products shows that different cooking methods had no significant effect on colour, flavour, texture, juiciness and overall acceptability (Table 2). The changes in eating quality attributes with different cooking techniques have been well documented (Dransfield *et al*., 1985; Heymann *et al*., 1990; Wood *et al*., 1995). Though Ragi had black colour which was assumed to hinder acceptance of the product, the sensory scoring ruled out this assumption indicating equal sensory acceptance of ragi incorporated products. Overall acceptability scores for all the products were more than 6.50 reflecting more than moderate acceptance of all products. The higher granular size of ragi crystalline granules confers therapeutic advantage to ragi by slowing down digestion, which is of great help in controlling diabetes and obesity (Mohana *et al*., 2005).

CONCLUSION

The effects of different cooking treatments and incorporation of binders in chicke based emulsion meat products were investigated. There was no significant difference in sensory ratings between emulsion based product prepared with different binders and also there was no significant difference among the different cooking methods. Overall acceptability scores for all the products were more than 6.50 reflecting more than moderate acceptance of all products. Understanding of this changes helps small enterprenuers to fix the price of livestock products. Ragi, which has been demonstrated to be rich source of iron, bio-available calcium, vitamins and other nutraceuticals can be incorporated at 10% level with out affecting sensory acceptance of any emulsion based products. The obtained results warrant a need for follow-up research to investigate in detail all observed significant factors affecting emulsion based chicken products subjected to different cooking process.

ACKNOWLWDGEMENTS

The financial assistance from KVAFSU, Karnataka, India under staff research project (DR/Kvafsu/Staff-Research project/2015-17/Ani sci-12) is acknowledged.

REFERENCES

AOAC, 1980. Official methods of analysis of the Association of Official Analytical Chemists (ed. W. Harwitz), 13th Ed. Washington, D.C.

Alfaia, C.P.M., Alves, S.P., Lopes, A.F., Fernandes, M.F.E., Costa, A.S.H., Fontes, C.M.G., Castro, A.M.L.F., Bessa, R.J.B. and Prates, A.M.J. 2010. Effect of cooking methods on fatty acids, conjugated isomers of linoleic acid and nutritional quality of beef intramuscular fat. *Meat Sci.,* **84**: 769–777.

Ashok, K.P., Riar, C.S., Sanjay, Y. and Singh, P.K. 2016. Effect of cooking methods on lipid oxidation, microbiological and sensory quality of chicken nuggets under refrigerated storage. *Cogent Food Agri.,* **2**: 1-8.

Badiani, A., Nanni, N., Gatta, P.P., Bitossi, F., Tolomelli, B. and Manfredini, M. 1998. Nutrient content and retention in selected roasted cuts from 3-month-old ram lambs. *Food Chem.,* **61**: 89–100.

Barbantia, D. and Pasquini, M. 2005. Influence of cooking conditions on cooking loss and tenderness of raw and marinated chicken breast meat. *LWT- Food Sci. Tech*., **38**: 895–901.

Cheng, Q. and Sun, D.W. 2008. Factors affecting the water holding capacity of red meat products: A review of recent research advances. Crit. Rev. *Food Sci. Nutr*., **48**: 137–159.

Chethan, S., Dharmesh, S.M. and Malleshi, N.G. 2008. Inhibition of aldose reductase from cataracted eye lenses by finger millet (*Eleusine coracana*) polyphenols. *Bioorg. Med. Chem.,* **16**: 10085–10090.

Combes, S., Lepetit, J. Darche, B. and Lebas, F. 2003. Effect of cooking temperature and cooking time on Warner–Bratzler tenderness measurement and collagen content in rabbit meat. *Meat Sci*., **66**: 91–96.

Dransfield, E., Nute, G.R., Mottram, D.S., Rowan, T.G. and Lawrence, T.L.J. 1985. Pork quality from pigs fed on low glucosinate rapeseed meal: influence of level in the diet, sex and ultimate pH. *J. Sci. Food Agri*., **36**: 546–556.

Gerber, N., Scheeder, M.R.L. and Wenk, C. 2009. The influence of cooking and fat trimming on the actual nutrient intake from meat. *Meat Sci*., **81**: 148–154.

Heymann, H., Hedrick, H.B., Karrasch, M.A., Eggeman, M.K. and Ellersieck, M.R. 1990. Sensory and chemical characteristics of fresh pork roasts cooked to different endpoint temperatures. *J. Food Sci*., **55**: 613–617.

Juárez, M., Failla, S., Ficco, A., Peña, F., Avilés, C. and Polvillo, O. 2010. Buffalo meat composition as affected by different cooking methods. *Food Bioprod. Process*., **88**: 145–148.

Keeton, J.T. 1983. Effects of fat and NaCl/Phosphate levels on the chemical and sensory properties of pork patties. *J. Food Sci*., **48**: 878–881.

King, N.J and Whyte. R., 2006. Does it look cooked? a review of factors that influence cooked meat color. *J. Food Sci.,* **71(4)**: R31– R40.

Kondjoyan, A., Kohler, A., Realini, C.E., Portanguen, S., Kowalski, R., Clerjon, S., Gatellier, P., Chevolleau, S., Bonny, J.M. and Debrauwer, L. 2014. Towards models for the prediction of beef meat quality during cooking. *Meat Sci*., **97(3)**: 323–331.

Kumar, M and Sharma B.D.. 2004. The storage stability and textural, physico-chemical and sensory quality of low-fat ground pork patties with Carrageenan as fat replacer. *Int. J. Food Sci. Tech*., **39(1)**: 31–42.

Liao, G.Z., Wang, G.Y., Xu X.L. and Zhou, G.H., 2010. Effect of cooking methods on the formation of heterocyclic aromatic amines in chicken and duck breast. *Meat Sci*., **85**: 149–154.

Mohana, B.H., Anitha, G. Malleshia, N.G. and Tharanathan, R.N. 2005. Characteristics of native and enzymatically hydrolyzed ragi (*Eleusine coracana*) and rice (*Oryza sativa*) starches. *Carbpoly*., **59**: 43–50.

Moreira, R.G., Palau, J. and. Sun, X., 1995. Deep-fat frying of tortilla chips. An Engineering approach. *J. Food Techn*., **49(4)**: 146–150.

Naveena, B.M., Muthukumar, M., Anjaneyulu, A.S.R.,. Sen, A.R and Kondaiah. N. 2011. Value added chicken products an entrepreneur guide. 1st Ed. Hind Publications, Hyderabad, India.

Naveena, B.M., Muthukumar, M., Sen, A.R., Praveen, K.Y. and Kiran, M. 2014. Use of cinnamaldehyde as a potential antioxidant in ground spent hen meat. *J. Food Process. Preserv.*, **38(4)**: 1911–1917.

Ngadi, M., Dirani, K. and Oluka, S. 2006. Mass transfer characteristics of chicken nuggets. Int. *J. Food Eng*., **2(3)**. 1-16.

Nisar, M.P.U., Chatli, M.K., Sharma, D.K. and Sahoo, J. 2010. Effect of cooking methods and fat levels on the physico-chemical, processing, sensory and microbial quality of buffalo meat patties. *Asian-Aust*. *J. Anim. Sci*., **23(10)**: 1380-1385.

Pearson, A.M. and Dutson, T.R. 1994. Quality attributes and their measurement in meat, poultry and fish products. Blackie Academic and Professional, UK.

Prathyusha, K.E., Nagamallika, R. Eswara, B. and Srinivas, R.T. 2016. Evaluation of edible polymer coatings enriched with grape seed extract on chicken meat nuggets. *J. Meat Sci.,* **1(2)**: 40-44.

Richa, R., Debashis, B., Praveen, K. P., Subha, G., Nirupama, D. and Shashank, S. 2016. Evaluation of various cooking methods on the nutritional and biochemical attributes and consumer appeal of chevon: A review. *Int. J. Sci. Envt. Tech*., **5(3)**: 1520 – 1529.

Rodriguez-Estrada, M.T., Penazzi, G. Caboni, M.F. Bertacco, G. and Lercker, G.1997. Effect of different cooking method on some lipid and protein components of hamburgers. *Meat Sci*., **45(3)**: 365–375.

Serdaroglu, M. 2006. The characteristics of beef patties containing different levels of fat and oat flour. *Int.J. Food Sci. Tech*., **41**: 147–153.

Serrano, A., Librelotto, J., Cofrades, S., Saánchez-Muniz, F.J. and Jiménez-Colmenero, F. 2007. Composition and physicochemical characteristics of restructured beef steaks containing walnuts as affected by cooking method. *Meat Sci*., **77**: 304–313.

Shobana, S., Harsha, M.R., Platel, K. Srinivasan, K. and Malleshi, N.G. 2010. Amelioration of hyperglycaemia and its associated complications by finger millet (*Eleusine coracana*) seed coat matter in streptozotocin-induced diabetic rats. *Br. J. Nutr*., **104(12)**: 1787–1795.

Siddiqui, M. and Khan, M.A. 2011. Comparative study on quality evaluation of buffalo meat slices incorporated with finger millet, oats and chickpea. 11th International Congress on Engineering and Food. www.icef11.org/main.php?fullpaper&categ=FPE. Accessed March 2017.

Snedecor, G.W. and Cochran, W.G. 1994. Statistical methods, 8th Ed. Iowa State University Press, Ames, Iowa.

Thomas, R., Anjaneyulu, A.S.R. and Kondaiah, N. 2006. Quality and shelf life evaluation of emulsion and restructured buffalo meat nuggets at cold storage (4±1 °C). *Meat Sci*., **72(3)**: 373-379.

Tornberg, E. 2005. Effect of heat on meat proteins – implications on structure and quality of meat products. *Meat Sci*., **70(3)**: 493–508.

Tripathi, B., Platel, K. and Srinivasan, K. 2012. Double fortification of sorghum (Sorghum bicolor L. Moench) and finger millet (*Eleucine coracana* L. *Gaertn*) flours with iron and zinc. *J. Cereal Sci*., **55(2):** 195–201.

Varsha, V., Asna, U. and Nagappa, G.M. 2009. Evaluation of antioxidant and antimicrobial properties of finger millet polyphenols (*Eleusine coracana*). *Food Chem*., **114(1)**: 340-346.

Veenashri, B.R. and Muralikrishna, G. 2011. In vitro anti-oxidant activity of xylo-oligosaccharides derived from cereal and millet brans -A comparative study. *Food Chem*., **126(3)**: 1475-1481.

Verma, A.K., Sharma B.D and Rituparna, B. 2010. Effect of sodium chloride replacement and apple pulp inclusion on the physico-chemical, textural and sensory properties of low fat chicken nuggets. *Food Sci. and Tech*., **43**: 715–719.

Verma, A.K., Pathak, V. and Singh, V.P. 2012. Incorporation of chicken meat in rice flour based noodles and its effects on physicochemical and sensory qualities. *Int. J. Current Res*., **4(12)**: 461-466.

Witte, V.C., Krause, G.F. and Baily, M.E.. 1970. A new extraction method for determination 2-thiobarbituric acid values of pork and beef during storage. *Food Sci*., **35**: 582–585.

Wood, J.D., Nute, G.R.,. Fursey, G.A.J. and Cuthbertson, A. 1995. The effect of cooking conditions on the eating quality of pork. *Meat Sci*., **40**: 127–135.