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Optimization of Cooking Time of Chicken Meat Loaf Prepared with Oven Cooking

Sanjay Singh[1], Vikas Pathak[1], Meena Goswami[1], Arun Kumar Verma[2], Rajkumar V[2], and Renu Kumari[3]

[1]Department of Livestock Products Technology, College of Veterinary Sciences and AH, DUVASU, Mathura, India
[2]Division of Goat Products Technology Laboratory, Central Institute for Research on Goats, Makhdoom, Farah- Mathura, UP, India
[3]Department of Animal Nutrition, College of Veterinary and animal Science, GBPUAT, Pantnagar, Uttarakhand, India

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- *Corresponding author.
- *E-mail address:*dr.goswami2008@yahoo.co.in (Meena Goswami)

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ABSTRACT

The present study was carried out to effect of oven cooking at 180°C for 15 minutes (OC1), 20 minutes (OC2) and 25 minutes (OC3) on various physico-chemical properties, texture profile analysis, colour parameter, mineral content as well as sensorial properties of chicken meat loaf. There was no significant difference in pH, protein and ash content among the treatments. Cooking yield, moisture content, fat retention, water activity and moisture retention values decreased significantly ($P<0.05$); however fat, carbohydrate and cholesterol content increased significantly ($P<0.05$) with increased time of cooking. The values of all textural parameters except gumminess and resilience increased significantly ($P<0.05$) with increased time of cooking. Lightness and yellowness values decreased significantly ($P<0.05$); however redness value increased significantly ($P<0.05$) with increased time of cooking. There was no significant difference in zinc, chromium and magnesium content among the treatments. Potassium, sodium, calcium, copper, manganese, iron and phosphorous content increased significantly ($P<0.05$) with increased time of cooking; however no significant difference was observed in copper content between OC1 and OC2. OC2 had significantly ($P<0.05$) higher sensory scores except saltiness and mouth coating scores. Therefore, it was concluded that well acceptable chicken meat loaf could be prepared by oven cooking 180°C for 20 minutes.

Key words: Chicken meat loaf, oven cooking, Texture, mineral content.

INTRODUCTION

Meat is considered as a source of high quality protein. Meat is a very good source of animal protein that consists of essential amino acid, minerals, vitamins and essential fatty acids (Lawrie 1991). Meat provides calories from fat, proteins and limited quantities of carbohydrate (Judge et al. 1990). Lean meat contains from 15 to 20% of protein, which varies inversely with percentage of fat. As per DAHD (2019), total meat production in India was 8.11 million tons in 2018-19, with contribution of buffalo, cattle, sheep, goat, pig and poultry as 19.05%, 4.02%, 8.36%, 13.53%, 4.98% and 50.06%, respectively. Poultry is the most prolific meat producer, accounting for almost half (DAHD 2019) of total meat production in India. When foods are prepared to be

eaten, there are significant changes in the flavor as well as in the nutritional composition of the food. Cooking of meat is essential to achieve a palatable and safe product (Tornberg, 2005) as it enhances flavour and tenderness, inactivates pathogenic microorganisms (Broncano et al. 2009; Rodriguez- Estrada et al. 1997), denature proteins and increases the digestibility and bioavailability of nutrients (Meade et al. 2005). Time plays an important role in the characteristics of cooked muscle-based food products (Sobral et al. 2018). Cooked meat flavor is influenced by water-soluble components that contribute to taste; it is the volatile compounds formed during cooking that produce the aroma attributes that contribute the characteristic flavors of meat. Based on sensory evaluation, eight general odor qualities (buttery, caramel, burnt, green, fragrant, oily/fatty, nutty and meaty) have been used to describe cooked meat odor (Mottram 1998). Therefore, meat composition combined with a specific cooking methodology (time and temperature) is one of the factors that mostly affect the final quality of meat products (Chiavaro et al. 2009). Generally, dry and moist cooking methods have been used for processed meat products. Fat plays a pivotal role in the formation of stable emulsion and imparts a better texture, juiciness and flavour to the comminuted meat products (Kumar and Sharma, 2004). Whereas, the method of cooking determines its compositional, processing determinants and sensory attributes especially appearance and color and juiciness of the meat product. Therefore, the present study was conducted to evaluate the effect of oven cooking on physico-chemical properties, Textural parameters, colour parameters, mineral analysis and sensory properties of chicken meat loaf. The objective of the present study was to evaluate the effect of oven cooking on quality characteristics of chicken meat loaf.

MATERIALS AND METHODS

The experiments were conducted in Department of Livestock Products Technology, College of Veterinary Sciences and Animal Husbandry, U.P. Pt. Deen Dayal Upadhyaya Pashu Chikitsa Vigyan Vishwavidyalaya Evam Go-Anusandhan Sansthan, Mathura, 281001 (UP), India.

Source of Raw Material

Live birds were procured from Department of Poultry Science, DUVASU Mathura and slaughtered in Meat Processing Laboratory of Department of Livestock Products Technology as per standard procedure following Halal method. The hot carcass was kept in refrigerator at 4±2^{0}C for 4-6 hours. The meat was deboned, trimmed-off separable fat and connective tissue. The samples were kept for conditioning in a refrigerator at 4±2^{o}C for 6–8 h and then frozen at -18^{o}C till further use. Other ingredients such as refined wheat flour, condiments, food grade refined oil, salt, spice mix were purchased from local market of Mathura. Low density Polyethylene (LDPE) bags of 200 gauges were sourced from local market and sterilized by exposing to U.V. light for 30 minutes before use. All the chemicals used in the study were of analytical grade and procured from HiMedia laboratories (P) Ltd, Mumbai. Different ingredients for preparation of spice mix were taken in in the desired ratio, dried at 45±2°C for 2 hours followed by grinding (Inalsa ® make) and sieving through the mesh. Different spices mixes were prepared and one spice mix was finally selected on the basis of flavour, aroma and taste. The spice mix was stored in pre-sterilized low-density polyethylene bags of 200 gauges and used as per requirement. The formulation of standardized spice mix is given in footnote of Table 1.

Table 1. Composition of spice mix

S. No.	Spices	Percentage (%)
	Black cardamom (Badi elaichi)	05
	Cinnamon (Dalchini)	05
	Caraway seed (Ajwain)	07
	Clove (Laung)	05
	Red chilli	08
	Coriander (Dhania)	18
	Cumin (Jeera)	16
	Black pepper (Kalimirch)	10
	Fennel seed (Soanf)	07
	Dried ginger powder (Soanth)	08
	Mace (Javitri)	03
	Nutmeg (Jaifal)	02
	Green cardamom (Choti elaichi)	02
	Star anise	02
	White pepper	02
	Total	100

Preparation of chicken meat loaf

Chicken meat loaf was prepared as per method followed by Devatkal et al. (2004) with slight modifications. Frozen deboned meat was thawed at refrigeration temperature overnight. Thawed lean meat was cut into smaller chunks and minced in electrical meat mincer (Sirmen mincer, MOD-TC 32 R10U.P. INOX, Marsango, Italy) with 6mm followed by 4 mm sieve size plate. Meat emulsion was prepared in Sirman Bowl Chopper (MOD C 15 2.8G 4.0 HP, Marsango, Italy). The minced meat was blended with

salt, sodium tri polyphosphate for 1.5 minute. Water in the form of crushed ice was added and blending continued for 1 minute. This was followed by addition of refined vegetable oil and blended for another 1 to 2 minutes. Then spice mixture, condiments and other ingredients were added and again mixed for 1.5 to 2 minutes to get the desired emulsion. Adequate care was taken to maintain temperature below 18°C by preparing the emulsion in cool hours of morning, by addition of meat and other ingredients in chilled/partially thawed form and by addition of crushed ice. About 300 g of emulsion was filled into the glass molds. The height and width of the chicken meat loaf was determined by Vernier Callipers (Mitutoyo ®). The following abbreviations were used for present experiment: OC1- chicken meat loaf prepared by oven cooking at 180°C for 15 minutes, OC2- chicken meat loaf prepared by oven cooking at 180°C for 20 minutes, OC3- chicken meat loaf prepared by oven cooking at 180°C for 25 minutes. Core temperature was measured by using a probe thermometer (Labware Scientific, Inc, USA). The chicken meat loaf was cooled at ambient temperature, packed in pre sterilized low-density polyethylene pouches and stored at refrigerated temperature (4±2°C). The formulation used for preparation of chicken meat loaf is given in Table 2.

Table 2. Formulation for preparation of chicken meat loaf

Ingredients	Percentage (%)
Chicken	74.2
Refined vegetable oil	8.0
Ice flakes	8.0
Salt	1.5
Dry spices mix	2.0
Condiments	3.0
Refined wheat flour	3.0
STPP	0.3
Total	100

Analytical procedure

Developed chicken meat loaf was evaluated for various physico-chemical properties– pH (Trout et al. 1992), cooking yield (Murphy et al. 1975), proximate analysis (AOAC, 1995), fat retention (Murphy et al. 1975), water activity by Aqua LAB 3 TE8220, Inc. Pullman, WA water activity meter, moisture retention by El-Magoli et al. (1996), cholesterol estimation (Zaltkis et al. 1953), texture profile analysis (Bourne, 1978), Instrumental colour analysis (Hunter and Harold, 1987) and mineral profile (Horowitz, 1965). Sensory evaluation was evaluated by using 8 point hedonic scale with 8 point as extremely desirable and 1 as extremely poor (Keeton, 1983).

Statistical analysis

The data obtained in the study on various parameters were statistically analyzed on 'SPSS-16.0' software package as per standard methods of Snedecor and Cochran (1994). Duplicate samples were drawn for each parameter and the experiment was replicated thrice (n=6). Sensory evaluation was performed by a panel of seven member judges three times, so total observations being 21 (n=21) Data were subjected to one way analysis of variance, homogeneity test and Duncan's Multiple Range Test (DMRT) for comparing the means to find the effects between samples.

RESULTS AND DISCUSSION

Physico-chemical properties

The effect of oven cooking on physico-chemical properties of chicken meat loaf is presented in Table. 3. There was no significant difference in pH, protein and ash content among the treatments.

Cooking yield, moisture content, fat retention, moisture retention and water activity values decreased significantly ($P<0.05$) with increased time of oven cooking. Increased cooking time resulted in more moisture loss as well as lower cooking yield and water activity. Pawar et al. (2000) also reported the inverse relationship between cooking time and moisture content in various meat products. M**urphy et al. (2001) also observed higher** moisture losses in cooked chicken breast patties with increase in oven air temperature. The decreased fat retention might also be attributed to some fat moving to lean portion of meat during the cooking process (Brugiapaglia and Destefanis 2012). Fat, carbohydrate and cholesterol content increased significantly ($P<0.05$) with increased time of oven cooking, whereas no significant difference was observed in carbohydrate content between OC1 and OC2. Similar findings were witnessed by Nisar et al. (2010) in buffalo meat patties cooked with oven heating at 175±2°C for different time period.

Textural parameters

The effect of oven cooking on physico-chemical properties of chicken meat loaf is presented in Table. 4. The values of all textural parameters increased significantly ($P<0.05$) with increased time of oven cooking except gumminess and resilience. Hardness values of OC3 were significantly ($P<0.05$) higher than OC1; however values of OC2 were comparable to both OC1 and OC3. Springiness and

Table 3. Effect of oven cooking time on physico-chemical properties (Mean±SE) of chicken meat loaf

Parameters	OC1	OC2	OC3	Treatment Mean
pH	6.28±0.05	6.32±0.03	6.35±0.04	6.32±0.02
Cooking yield (%)	92.45^{a}±0.05	90.12^{b}±0.05	88.33^{c}±0.04	90.30±0.40
Moisture (%)	64.84^{a}±0.09	63.89^{b}±0.06	59.89^{c}±0.04	62.87±0.52
Protein (%)	16.84±0.05	16.90±0.05	16.94±0.05	16.89±0.03
Fat (%)	9.51^{c}±0.04	9.71^{b}±0.04	9.91^{a}±0.04	9.71±0.04
Carbohydrate (%)	7.66^{b}±0.03	8.32^{b}±0.05	11.95^{a}±0.04	9.31±0.02
Ash (%)	1.15±0.06	1.18±0.06	1.31±0.06	1.21±0.04
Fat retention (%)	86.01^{a}±0.04	85.82^{b}±0.05	85.40^{c}±0.05	85.74±0.70
Water activity (a_w)	0.975^{a}±0.01	0.969^{b}±0.01	0.966^{c}±0.01	0.970±0.01
Moisture retention (%)	59.95^{a}±0.09	57.58^{b}±0.05	52.91^{c}±0.05	56.81±0.71
Cholesterol (mg/100g)	79.88^{c}±0.28	80.74^{b}±0.33	83.23^{a}±0.45	81.28±0.33

OC1-chicken meat loaf prepared by oven cooking at 180°C for 15 minutes
OC2-chicken meat loaf prepared by oven cooking at 180°C for 20 minutes
OC3-chicken meat loaf prepared by oven cooking at 180°C for 25 minutes
Overall means bearing different superscripts in a row (a, b, c, d.....) differ significantly (P<0.05)
n= 6 for each treatments

Table 4. Effect of oven cooking time on textural parameters (Mean±SE) of chicken meat loaf

Parameters	OC1	OC2	OC3	Treatment mean
Hardness (N/cm^2)	12.04^{b}±0.02	12.12^{ab}±0.05	12.20^{a}±0.04	12.12±0.02
Springiness (mm)	27.03^{b}±0.03	27.05^{b}±0.04	27.20^{a}±0.03	27.09±0.02
Cohesiveness (Ratio)	0.69^{b}±0.06	0.78^{b}±0.05	0.83^{a}±0.04	0.77±0.03
Gumminess (N/cm^2)	6.88±0.05	6.84±0.04	6.79±0.04	6.83±0.02
Chewiness (N/cm)	155.45^{b}±0.04	155.49^{a}±0.04	155.53^{a}±0.05	155.49±0.03
Resilience (Ratio)	0.54±0.04	0.62±0.05	0.59±0.04	0.59±0.02

OC1-chicken meat loaf prepared by oven cooking at 180°C for 15 minutes
OC2-chicken meat loaf prepared by oven cooking at 180°C for 20 minutes
OC3-chicken meat loaf prepared by oven cooking at 180°C for 25 minutes
Overall means bearing different superscripts in a row (a, b, c, d.....) differ significantly (P<0.05)
n= 6 for each treatments

cohesiveness values increased significantly (P<0.05) with increased time of oven cooking; however there was no significant difference between OC1 and OC2.

Chewiness values of OC2 and OC3 were significantly (P<0.05) higher than OC1, but no significant difference was observed between OC2 and OC3. Higher textural parameters values with increased time of oven cooking might be due to more moisture loss resulting into hardness of product. As per Choi et al. (2008), water holding capacity, cooking time and temperature, emulsion stability, gelling ability and the inclusion of non-meat components affected the textural properties of meat products. Myofibrillar and connective tissue proteins (collagen and elastin) influence muscle tissue toughness, and when heated, these proteins denature, resulting in cell membrane destruction, fiber shrinkage, myofibrillar and sarcoplasmic protein aggregation and gelling, and connective tissue shrinkage and solubilization (Tornberg, 2005; Yu et al. 2017). Similar findings were also reported by Pawar et al. (2000) in chicken patties and Rababah et al. (2006) in composite flour containing functional biscuits baked for different time.

Colour parameters

The effect of oven cooking on physico-chemical properties of chicken meat loaf is presented in Table. 5. Lightness and yellowness values decreased significantly (P<0.05) whereas redness values increased significantly (P<0.05) with increased time of oven cooking, however no significant difference was observed in yellowness values between OC2 and OC3.

Higher redness values with increased time of oven cooking were probably due to proper cooking and non enzymatic browning reaction of chicken meat loaf. This finding was in agreement with Lara et al. (2011) who

Table 5. Effect of oven cooking time on colour parameters (Mean±SE) of chicken meat loaf

Parameters	OC1	OC2	OC3	Treatment mean
Lightness (*L*)	45.04^{a}±0.03	44.05^{b}±0.05	42.94^{c}±0.05	44.01±0.21
Redness (*a*)	11.22^{c}±0.06	12.00^{b}±0.07	12.52^{a}±0.04	11.91±0.13
Yellowness (*b*)	8.73^{a}±0.04	8.30^{b}±0.07	8.09^{b}±0.08	8.37±0.07

OC1-chicken meat loaf prepared by oven cooking at 180°C for 15 minutes
OC2-chicken meat loaf prepared by oven cooking at 180°C for 20 minutes
OC3-chicken meat loaf prepared by oven cooking at 180°C for 25 minutes
Overall means bearing different superscripts in a row (a, b, c, d.....) differ significantly (P<0.05)
n= 6 for each treatments

Table 6. Effect of oven cooking time on mineral content (Mean±SE) of chicken meat loaf

Mineral (ppm)	OC1	OC2	OC3	Treatment mean
Zinc	28.16±3.14	30.33±1.54	34.16±1.81	30.88±1.37
Potassium	4510.20^{c}±3.76	4611.20^{b}±4.05	4850.70^{a}±2.90	4657.30±2.68
Calcium	116.17^{b}±4.16	121.50^{ab}±1.72	129.50^{a}±2.23	122.39±2.06
Copper	5.20^{b}±0.21	5.43^{b}±0.29	6.40^{a}±0.27	5.67±0.19
Sodium	1215.80^{c}±2.63	1218.90^{b}±2.73	1229.00^{a}±2.23	1221.23±1.77
Manganese	12.62^{c}±0.02	13.38^{b}±0.02	13.68^{a}±0.01	13.22±0.10
Iron	20.53^{c}±0.04	21.26^{b}±0.02	21.91^{a}±0.02	21.23±0.13
Chromium	0.70±0.05	0.73±0.02	0.77±0.02	0.73±0.02
Phosphorus	1804.50^{c} ±2.27	1825.20^{b}±2.03	1840.20^{a}±2.90	1823.30±3.78
Magnesium	227.67±3.30	229.17±2.71	232.50±1.47	229.58±1.49

OC1-chicken meat loaf prepared by oven cooking at 180°C for 15 minutes
OC2-chicken meat loaf prepared by oven cooking at 180°C for 20 minutes
OC3-chicken meat loaf prepared by oven cooking at 180°C for 25 minutes
Overall means bearing different superscripts in a row (a, b, c, d.....) differ significantly (P<0.05)
n= 6 for each treatments

noticed decreased lightness with higher redness values of biscuits with increase in oven temperature, independent of heat transfer mode of oven temperature to the product (>190˚C). Rodas-González et al. (2017) also reported significantly (P<0.05) higher redness values and lower lightness values with increased time of oven cooking in lean beef products.

Mineral content

The effect of oven cooking on physico-chemical properties of chicken meat loaf is presented in Table. 6. There was no significant difference in zinc, chromium and magnesium content among the treatments.

Potassium, sodium, calcium, copper, manganese, iron and phosphorous content increased significantly (P<0.05) with increased time of oven cooking, however no significant difference was observed in copper content among the treatments. As per Lombardi-Boccia et al. (2005), cooked chicken breast meat contained 0.58±0.10 mg/100g Fe, 0.90±0.10 mg/100g Zn and 0.06±0.10 mg/100g Cu. Calcium content of OC2 was comparable to both OC1 and OC3. Higher mineral content with increased cooking time might be related to more moisture loss and higher ash content as also observed in present study. Lombardi-Boccia et al. (2005) also observed that cooked meat showed a higher level of trace elements concentration as compared to raw meat samples due to the moisture losses occurred during cooking. Casey et al. (2003) evaluated mineral profile (mg/100g) of lean meat in *longissimus* muscle and reported that meat was an excellent source of minerals in terms of sodium, iron, copper and zinc content.

Sensory evaluation

The effect of oven cooking on physico-chemical properties of chicken meat loaf is presented in Table. 7. Colour and appearance, flavour, texture and juiciness scores of OC2 were significantly (P<0.05) higher than OC1; however scores of OC3 were comparable to OC1 and OC2.

Table 7. Effect of oven cooking time on sensory scores (Mean±SE) of chicken meat loaf

Attributes	OC1	OC2	OC3	Treatment mean
Colour and appearance	7.02^{b}±0.08	7.32^{a}±0.08	7.10^{ab}±0.38	7.15±0.05
Flavour	7.01^{b}±0.08	7.30^{a}±0.08	7.21^{ab}±0.08	7.17±0.05
Texture	7.04^{b}±0.08	7.35^{a}±0.08	7.25^{ab}±0.08	7.21±0.05
Juiciness	7.00^{b}±0.07	7.26^{a}±0.07	7.14^{ab}±0.07	7.13±0.04
Saltiness	7.03±0.07	7.23±0.07	7.13±0.07	7.13±0.04
Mouth coating	7.04±0.05	7.25±0.08	7.15±0.07	7.15±0.04
Meat flavour intensity	7.06^{b}±0.08	7.35^{a}±0.08	7.24^{b}±0.07	7.22±0.04
Overall acceptability	7.04^{b}±0.05	7.25^{a}±0.08	7.14^{b}±0.07	7.14±0.04

OC1-chicken meat loaf prepared by oven cooking at 180°C for 15 minutes
OC2-chicken meat loaf prepared by oven cooking at 180°C for 20 minutes
OC3-chicken meat loaf prepared by oven cooking at 180°C for 25 minutes
Overall means bearing different superscripts in a row (a, b, c, d.....) differ significantly (P<0.05)
n= 21 for each treatments

Higher flavour and juiciness scores in OC2 might be due to peculiar mouth feel provided by the fat present on the surface of product on proper cooking in OC2, which was attributable to softer touch and consequently better juiciness in finished product. There was no significant difference in saltiness and mouth coating scores among the treatments. Meat flavour intensity and overall acceptability scores of OC2 were significantly (P<0.05) higher than OC1 and OC3; however there was no significant difference between OC1 and OC3. Higher sensory scores of OC2 might be due to proper cooking of the product resulting in production of flavour generating volatile substances. OC1 and OC3 were not much liked by sensory panelists due to under and over cooking of product respectively. Similar findings were also reported by Nisar et al. (2010) in buffalo meat patties, Nayak (2015) in chevon patties and Goswami et al. (2015) in carabeef cookies. In the present study, OC2 was well accepted by sensory panelists due to appropriate texture, juiciness and meaty flavour of the product. Therefore, OC2- chicken meat loaf prepared by oven cooking at 180°C for 20 minutes was selected as the best treatment.

CONCLUSION

From the obtained results it can be concluded that the oven cooking had a significant effect on the physico-chemical and sensory quality of cooked chicken meat loaf. Cooking yield, moisture content, fat retention, water activity and moisture retention values decreased significantly (P<0.05); however fat, carbohydrate and cholesterol content increased significantly (P<0.05) with increased time of cooking. The values of all textural parameters except gumminess and resilience increased significantly (P<0.05) with increased time of cooking. Lightness and yellowness values decreased significantly (P<0.05); however redness value increased significantly (P<0.05) with increased time of cooking. All mineral content except zinc, chromium and magnesium increased significantly (P<0.05) with increased time of cooking. OC2 had significantly (P<0.05) higher sensory scores except saltiness and mouth coating scores. Therefore it was concluded that well acceptable chicken meat loaf was prepared by oven cooking at 180°C for 20 minutes without any adverse effect on physic-chemical and sensory properties.

REFERENCES

AOAC (1995) Official Methods of Analysis, 16th Edn. Association of Official Analytical Chemists, Washington, D C

Bourne MC (1978) Texture profile analysis. Food Technol 32: 62-66

Broncano JM, Petrón MJ, Parra V, Timón ML (2009) Effect of different cooking methods on lipid oxidation and formation of free cholesterol oxidation products (COPs) in Latissimus dorsi muscle of Iberian pigs. Meat Sci 83(3): 431-437

Brugiapaglia A, Destefanis G (2012) Effect of cooking method on the nutritional value of Piemontese beef. In Proceedings of the 58th International Congress of Meat Science and Technology.

Casey NH, Van NWA, Webb EC (2003) Goat meat In:Caballero, Academic Press, London 2937-2944

Chiavaro E, Rinaldi M, Vittadini E, Barbanti D 2009 Cooking of pork Longissimus dorsi at different temperature and relative humidity values: Effects on selected physico-chemical properties. J Food Eng 93(2): 158-165

Choi YS, Choi JH, Han DJ, Kim HY, Lee MA, Lee ES, Jeong JY, Paik HD, Kim CJ (2008) Effects of rice bran fiber on quality of low-fatTtteokgalbi. Food Sci Biotechnol 17(5): 959-964

DAHD (2019) Department of animal husbandry and dairying, government of India. *http://www.dahd.nic.in*.

Devatkal S, Mendiratta SK, Kondaiah N (2004) Quality characteristics of loaves from buffalo meat, liver and vegetables. Meat Sci 67: 377-383

El-Magoli SB, Laroia S, Hansen PTM (1996) Flavour and texture characteristics of low fat ground beef patties formulated with whey protein concentrate. Meat Sci 42: 179-193

Goswami M, Sharma BD, Mendiratta SK, Pathak V, Kumar RR, Talukdar S, Sharma H (2015) Standardization of formulation and processing conditions for development of nutritional carabeef cookies. Nutri Food Sci 45(5): 677-687

Horowitz HW (1965) Unseparate but Unequal- The Emerging Fourteenth Amendment Issue in Public School Education. UCLA Law Review 13: 147

Hunter RS, Harold RW (1987) The Measurement of Appearance, 2nd ed." by, John Wiley & Sons, New York, 411

Judge ME, Aberte E, Forrest J, Hedrick H, Market R (1990) Principles of Meat Science 2nd edition. Kedall/ Hunt, Iowa

Keeton JT (1983) Effect of fat and sodium chloride phosphate levels on the chemical and sensory properties of pork patties. J food Sci 48: 878-881

Kumar M, Sharma BD (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 39: 31-42

Lara E, Cortés P, Briones V, Perez M (2011) Structural and physical modifications of corn biscuits during baking process. LWT-Food Sci Technol 44(3): 622-630

Lawrie RA (1991) Meat science, 5th edition, Pergamon Press Ltd. Heading Ton Hill Hall, Oxford.

Lombardi-Boccia G, Lanzi S, Aguzzi A (2005) Aspects of meat quality: trace elements and B vitamins in raw and cooked meats. J Food Compos Anal 18(1): 39-46

Meade SJ, Reid EA, Gerrard JA (2005) The impact of processing on the nutritional quality of food proteins. J AOAC Int 88(3): 904-922

Mottram DS (1998) Flavour formation in meat and meat products: a review. Food chem 62(4): 415-424

Murphy EW, Criner PE, Grey BC (1975) Comparison of methods for calculating retention of nutrients in cooked foods. J Agri Food Chem 23: 1153-1157

Murphy RY, Johnson ER, Duncan LK, Clausen EC, Davis MD, March JA (2001) Heat transfer properties, moisture loss, product yield, and soluble proteins in chicken breast patties during air convection cooking. Poult Sci, 80(4): 508-514

Nayak NK (2015) Development and quality assessment of functional chevon patties. Ph.D. Thesis submitted to DUVASU, Mathura (U.P.).

Nisar PU, Chatli MK, Sharma DK, Sahoo J (2010) Effect of cooking methods and fat levels on the physico-chemical, processing, sensory and microbial quality of buffalo meat patties. Asian-Australasian J Anim Sci 23(10): 1380-1385

Pawar VD, Khan FA Agarkar BS (2000) Quality of chevon patties as influenced by different methods of cooking. J Food Sci Technol 37(5): 545-548

Rababah TM, Al-Mahasneh MA, Ereifej KI (2006) Effect of chickpea, broad bean, or isolated soy protein (ISP) additions on the physico chemical and sensory properties of biscuits. J Food Sci 71: 438-442

Rodas-González A, Huerta-Leidenz N, Jerez-Timaure N (2017) Benchmarking Venezuelan quality grades for grass-fed cattle carcasses. Meat Muscle Bio 1(1)

Rodriguez-Estrada MT, Penazzi G, Caboni MF, Bertacco G, Lercker G (1997) Effect of different cooking methods on some lipid and protein components of hamburgers. Meat Sci 45(3): 365-375

Snedecor GW, Cochran WG (1994) Statistical methods, 6th Edn. Allied Pacific Pvt. Ltd., Bombay 557

Sobral MMC, Cunha SC, Faria MA, Ferreira IM (2018) Domestic cooking of muscle foods: Impact on composition of nutrients and contaminants. Compr Rev Food Sci Food Saf 17: 309-333

Tornberg EVA (2005) Effects of heat on meat proteins–Implications on structure and quality of meat products. Meat Sci 70(3): 493-508

Trout ES, Hunt MC, Johson DE, Clan JR, Castner CL, Kroff DH (1992) Characteristics of low fat ground beef containing texture modifying ingredients. J Food Sci 57: 19-24

Yu TY, Morton JD, Clerens S, Dyer JM (2017) Cooking induced protein modifications in meat. Compr Rev Food Sci Food Saf 16(1): 141-159

Zaltkis A, Zak B, Boyle AJ (1953) A new method for the direct determination of serum cholesterol. J lab clin med 41: 486-492