



# Evaluation of Chicken Skin with Fat as Sunflower Oil Replacer on Quality Aspects of Patties Prepared from Spent Female Buffalo Meat

**Kandeepan Gurunathan**

ICAR-National Research Center on Meat, Chengicherla, Boduppall Post, Hyderabad, Telangana-500092, INDIA

\*Corresponding Author: [drkandee@gmail.com](mailto:drkandee@gmail.com)

## How to cite this paper:

Gurunathan, K. (2023). Evaluation of Chicken Skin with Fat as Sunflower Oil Replacer on Quality Aspects of Patties Prepared from Spent Female Buffalo Meat. *International Journal of Livestock Research*, 13 (2), 28-41.

**Received** : Sep 30, 2022

**Accepted** : Feb 24, 2023

**Published** : Feb 28, 2023

Copyright © Gurunathan, 2023

This work is licensed under the Creative Commons Attribution International License (CC BY 4.0). <http://creativecommons.org/licenses/by/4.0/>



## Abstract

*The poultry industry offers certain valuable by-products such as chicken skin with fat that have vast applications in meat food product development. Vegetable oils are commonly used for emulsion-based meat products due to their ease of storage and handling during processing. The research was undertaken to replace vegetable oil with animal fat for improving the nutritional value and sensory attributes of buffalo meat patties to ensure the viable use of animal by-products in meat products. The buffalo meat patties were replaced with chicken skin with fat (CSF) for sunflower oil (SFO) during the emulsion formation. The results of the cooked products have shown significantly ( $P<0.05$ ) higher values for pH, moisture, shear force, appearance, flavor, texture, and juiciness in chicken skin with fat-added buffalo meat patties. Whereas the yield, emulsion stability, increase in height, fat, cholesterol, and energy were significantly ( $P<0.05$ ) higher in sunflower oil-added buffalo meat patties. Hence it is concluded that the replacement of sunflower oil (SFO) by chicken skin with fat (CSF) in buffalo meat patties is a healthy alternative since it produced lower fat, cholesterol, and energy with improved appearance, flavor, texture, and juiciness in meat product.*

**Keywords:** Buffalo, Chicken Skin with Fat, Meat, Patties, Quality, Sunflower Oil

## Introduction

Buffaloes (*Bubalus bubalis*) play an indispensable protagonist in the livelihood of billions of people in Asia, Africa, Europe, and South America. Buffalo meat production internationally is 4.95 million tonnes (FAOSTAT, 2019) which is 1.2% of worldwide meat production (FAOSTAT, 2017). Among the global buffalo meat production, Asia contributes 90.8%, Africa 8.5%, Europe 0.5%, and South America 0.2%. India, Pakistan, and China top the list of buffalo meat-producing countries with 1.61, 1.09, and 0.66 million tonnes, respectively (FAOSTAT, 2019). The world meat supply was 43.22 kg/capita/yr in 2013 (FAOSTAT, 2013). Meat consumption in 2030 is projected to reach 45.3kg/capita/yr (Bruinsma, 2003). Since the demand for lean red meat worldwide has been increasing steadily, buffalo meat products are anticipated to attract consumer preference due to their leanness. Hence buffalo meat products are considered to have a strong perspective to meet the increasing per capita meat consumption in the world. Buffalo meat has high protein and low cholesterol, ascertaining the meat to be the healthiest among the red meats consumed worldwide. Buffalo meat has specific exceptional attributes such as lower intramuscular fat, cholesterol, calories, higher essential amino acids,  $\beta$ -carotene, Vitamin B12, iron, and zinc content (Kandeepan *et al.*, 2013).

Chicken skin with fat is an abundant poultry industry by-product. This animal fat can be used in many ways in food processing and product development. Chicken skin consists of a thick dermis (inner) layer and a thin epidermis (outer) layer with a lipids content of about 45% (Cliché *et al.*, 2003). The lipids of the chicken epidermis include wax diesters (34%), triglycerides (32%), sterols (11%), phospholipids (11%), and other minor lipids (Wertz *et al.*, 1986). The United States Department of Agriculture (USDA) National Nutrient Database states that there are 32 g of total fat in 100 grams of chicken skin. In chicken skin, saturated fat makes up about 30 percent of the total fat, about 42 percent of the fats are monounsaturated and 21 percent are polyunsaturated. One hundred grams of chicken skin also contains a small number of trans fats and chicken skin cholesterol content is 109 milligrams (USDA, 2021). Vegetable oil is commonly used in meat products due to its ease of handling and storage. The use of animal fat such as chicken skin fat for replacing vegetable fat is a viable strategy to properly utilize the animal by-product which is a cost-effective measure for the processed food industry.

Some of the researchers have worked on different aspects of the development of buffalo meat patties. Buffalo meat was used for the preparation of patties by incorporating various ingredients to improve its quality and shelf-life. Functional properties of buffalo meat patties from hot-boned meat with added phosphate and sodium chloride were better than those of chilled meat with added phosphate and Sodium chloride (Anjaneyulu *et al.*, 1989). The addition of phosphate to the formulation of patties improved water holding capacity, emulsifying capacity, emulsion stability, and patty yield and reduced cooking loss and patty shrinkage than that of sodium hydroxide, indicating specific activity of phosphate in the meat system (Anjaneyulu *et al.*, 1990). Soybean oil was found to disperse in fine droplets whereas buffalo fat formed relatively larger globules and was encircled by a thick protein matrix. The phosphate blend significantly stabilized the flavor of pre-cooked patties for 18 days by inhibiting oxidative rancidity (Anjaneyulu and Sharma, 1991).

Buffalo meat patties containing chilled buffalo fat and whole egg liquid lowered mouth-coating properties and improved acceptability (Pati *et al.*, 1993). The addition of salt and polyphosphates increased pH, water holding capacity, emulsion stability, emulsifying capacity, yield, and sensory properties of patties but reduced cooking loss, irrespective of the method of meat handling (Anjaneyulu *et al.*, 1994). Significant increases in protein, fat, and TBA values and a decrease in moisture content were observed in buffalo meat patties with increasing age of calves and could be frozen and stored for up to 4 months (Bawa and Sekhon, 2000). Microwave ovens reduced cooking time compared to hot air ovens and gave more uniform heating of buffalo meat products such as kebabs and patties (Hoda *et al.*, 2002). Low-fat patties, at a grind size of 3 mm, recorded a significantly higher cooking yield, height gain, moisture content, protein content, and lower shear force value (Suman and Sharma, 2003). Kandeepan *et al.*, . (2009) compared the quality and shelf-life attributes of different age and gender groups of buffalo meat patties stored at refrigeration temperature. Younis and Ahmad (2018) developed buffalo meat patties with the incorporation of 6% apple pomace powder.

But there is no information available on the replacement of vegetable oil with animal fat in buffalo meat patties. Therefore, research was undertaken to replace sunflower oil with chicken skin with fat for the formulation of buffalo meat patties and compare the quality aspects of physicochemical, microbial, and sensory attributes.

## Materials and Methods

### Ingredients

The buffalo meat was obtained from spent female buffaloes (about 12 years old) from the local meat market of Bareilly district, Uttar Pradesh state, India. The meat samples used in the study were collected from the *longissimus lumborum* (LL) muscle of the buffaloes, similar in conformation, and slaughtered according to the traditional halal method. The meat was obtained within six hours of slaughter, packed in low-density polyethylene (LDPE) bags, transported in an ice box, and conditioned at  $4\pm 1^\circ\text{C}$  (Godrej Cold Gold, India) for about 24 h for control premature shortening. Later, the separable fat and connective tissue were removed. The meat was portioned, packed in LDPE bags, and transferred to a freezer (Vest Frost, Denmark) maintained at  $-18\pm 1^\circ\text{C}$  until processed. The chicken skin with fat (CSF) was obtained from the local poultry meat market of Bareilly district, Uttar Pradesh state, India, packed in LDPE bags, and frozen until processed. The frozen meat and fat were thawed at  $4\pm 1^\circ\text{C}$  for 12 h before use in the product development. The meat samples and chicken skin with fat for product preparation were ground separately in a mincer (Santos, France).

All the non-meat ingredients such as refined salt (Tata salt, Tata chemicals Ltd. Mumbai), refined sunflower oil (SFO) (Fortune, Adani Wilmar Ltd., Ahmedabad, India), spice mix ingredients, vegetables, and refined wheat flour (maida) were procured from the local market. A fine paste of onion and garlic in a ratio of 3:1 was used as a condiments mix. Food additives that are to be incorporated in the formulations were procured of food-grade quality from reputed firms i.e. sodium tripolyphosphate (Central Drug House (P) Ltd, New Delhi, India) and sodium nitrite (E-Merck (India) Ltd, Mumbai, India). Spice ingredients, free from extraneous matter, were dried in a hot air oven at  $50^\circ\text{C}$  for 4 hrs. The ingredients were ground in a home mixer (Remi Equipments, India) and sieved through a fine mesh. The powders were mixed in suitable proportions to make a spice mix for buffalo meat patties (Table 1).

### Processing of Buffalo Meat Emulsion

The buffalo meat patties were prepared as per the formulation given in Table 2. The buffalo meat patties were made from a standardized formulation. The deboned meat was cut into cubes of about 3 cm and ground using 13 mm followed by 8 mm plates in a seydelmann meat grinder (Model WD114, Stuttgart, Germany). The meat emulsion of about 1.0 kg each from different groups were prepared using a Seydelmann food cutter (model K10 Ras, Stuttgart, Germany). To the ground lean buffalo meat, salt, sodium nitrite, and sodium tripolyphosphate were added and chopped for about 2 min. The chilled water/ice flakes were added and chopped for 1 min. The condiment mix was then added and chopped again for 1 min. The sunflower oil (SFO)/chicken skin with fat (CSF) was slowly incorporated while chopping which was continued till the complete dispersion of the oil in the batter (3-4 min). The spice mix and refined wheat flour (maida) were added and chopping was continued for another 1 min to get a fine viscous emulsion. The temperature of the emulsion varied from  $5-10^\circ\text{C}$ . The quality of meat emulsion was evaluated by determining pH and emulsion stability.

### Processing of Buffalo Meat Patties

The patty was made with 75 g of meat emulsion using a glass Petri dish (74 mm x 12 mm internal dimension). 10 patties were made from each trial separately for SFO and CSF incorporated buffalo meat patty emulsion. The patties were placed on a tray spread with oil-smearred butter paper and broiled in preheated ( $180\pm 1^\circ\text{C}$ ) hot air oven (Widsons Scientific Works, Delhi, India). The patties were turned after 15 minutes and cooked till the internal temperature reached  $80^\circ\text{C}$  as recorded by the probe thermometer (Oakton, China). The patties were cooled to room temperature and the product yield and dimensions were recorded. The buffalo meat patties were vacuum packaged in Nylon-LDPE laminates using a Rochermatic packaging machine (Model VM195, Osnabruck, Germany). A total of thirty samples of buffalo meat patties for each CSF and SFO added group was used to study the various physicochemical, microbial, and sensory characteristics.

### Analytical Methods

#### i. *Physicochemical parameters*

The pH of the buffalo meat patties was determined as per the method of Trout *et al.*, . (1992). The pH probe was

calibrated with standard buffer solutions of pH 4.0, 7.0 & 9.2. Then pH of the homogenates was recorded by immersing a combined glass electrode of a digital pH meter (Model CP 901, Century Instruments Ltd, Chandigarh). The emulsion stability was determined by the procedure of Kondaiah *et al.*, (1985). The weight of the meat product before and after cooking was recorded and the percentage of cooked mass was expressed as emulsion stability. The cooking yield was calculated using the formula below.

$$\text{Cooking yield (\%)} = \frac{\text{Weight of cooked meat product}}{\text{Weight of raw meat product}} \times 100$$

The thickness of the cooked patties was recorded using Vernier Callipers at three different points to get the average thickness. The height (internal) of the mould was taken as the thickness of raw patties. The gain in height was calculated below.

$$\text{Gain in height (\%)} = \frac{\text{Thickness of cooked patties} - \text{Thickness of raw patties}}{\text{Thickness of raw patties}} \times 100$$

The diameter of the cooked patties was recorded using Vernier Callipers at two different points to obtain the average diameter. The internal diameter of mould was taken as the diameter of raw patties. The reduction in diameter was calculated as follows.

$$\text{Decrease in diameter (\%)} = \frac{\text{Diameter of raw patties} - \text{Diameter of cooked patties}}{\text{Diameter of raw patties}} \times 100$$

The moisture content of the patties was determined by oven drying, protein by Kjeldahl nitrogen estimation, and Fat by Soxhlet extraction with petroleum ether as described in methods of AOAC (2002). The gross energy of buffalo meat patty samples was determined by Gallenkamp Ballistic Bomb Calorimeter (Haque and Murari Lal, 1999). The deflection on the galvanometer was compared with the deflection caused by 1 g of benzoic acid as standard with a known calorific value (6.318 Kcal/g). The calorific or energy value of the sample was calculated and expressed as Kcal/100g. Cholesterol content was determined using a modified method based on Bohac *et al.*, (1988). The shear force value was measured as per the modified method of Berry and Stiffler (1981). The shear force of buffalo meat patties was estimated in six cores from each sample with the same Warner-Bratzler blade attached to the texture analyzer. The crosshead speed was 200 mm/min. The maximum force required to cut the samples (shear force) was recorded and expressed in Newton (N). The water activity (aW) of buffalo meat patties was measured by a Pawkit water activity meter (Decagon Devices, Pullman, Washington, USA). The distillation method of Tarladgis *et al.*, (1960) was followed to estimate the thiobarbituric acid reactive substances (TBARS) value of the cooked patties. The optical density (OD) was recorded at 538 nm using a spectrophotometer (Scanning mini-SPEC, model SL 177, Elico Ltd, Hyderabad). The OD was multiplied by a factor of 7.8 and the TBARS value was expressed as mg malonaldehyde/kg of the sample as suggested by Koniecko, (1979).

## ii. Microbiological quality

The standard plate count (SPC) of buffalo meat was determined as per the methods described by APHA (2001). The microbial quality was assessed to establish the relevance of meat product pH and aW with SPC. The readymade media from Hi-Media Laboratories (P) Ltd, Mumbai, were used for the enumeration of different microbes. The plate count agar (M091) for SPC, violet red bile agar (M049A) for coliforms, and potato dextrose agar (M096) for yeast and mold count were used for media preparation. The preparation of samples and serial dilution of buffalo meat was done near the flame in a horizontal laminar flow unit (Model YSI-188, Yarco Sales (P) Ltd., New Delhi) which was pre-sterilized by ultraviolet radiation, observing all possible aseptic precautions. The duplicate plates were prepared for each dilution. The plates were incubated at 37±1°C for 48 hrs for enumeration of SPC and coliforms, while, at 25°C±1°C for 7 days for yeast and mold counts. The plates showing 30-300 colonies were counted for SPC, the number of red-purple/pink colonies were counted for coliforms and black, white, yellow, red, or greenish-black colored colonies were counted for yeast and mold count. The number of colonies was multiplied by the reciprocal of the dilution and expressed as log<sub>10</sub> cfu/g.

## iii. Sensory Evaluation

A sensory panel perceived the differences between the cooked buffalo meat patties through descriptive profile

scoring of sensory attributes. The sensory panelists ( $n = 10$ ) consisted of scientists and post-graduate students of the Division of Livestock Products Technology, IVRI, Izatnagar. The panelists were trained according to the guidelines for cookery and sensory analysis of meat products as suggested by the American Meat Science Association (AMSA, 1995). They were well acquainted with the different sensory attributes. They were briefly told about the nature of the experiment without disclosing the identity of the samples. The same panelists attended all the sessions to prevent the variance due to the panelists on sensory scores. The samples were warmed ( $40-45^{\circ}\text{C}$ ) using a microwave oven (LG electronics India (P) Ltd., Mumbai) for 1 min and served to the panelists. Each panelist received two pieces from each sample of cooked buffalo meat patties in a randomized order. There were three sessions of sensory evaluation. Each session included samples from CSF & SFO incorporated buffalo meat patties.

The panelists were provided with filtered water to cleanse their pallets between the samples. The panelists evaluated samples for appearance, flavour, texture, and juiciness using eight-point scales. The scale used for appearance was: 1 = extremely poor, 2 = very poor, 3 = moderately poor, 4 = slightly poor, 5 = fair, 6 = good, 7 = very good, and 8 = excellent. The scale used for flavour was: 1 = extremely bland, 2 = very bland, 3 = moderately bland, 4 = slightly bland, 5 = slightly intense, 6 = moderately intense, 7 = very intense, and 8 = extremely intense. The scale for juiciness was: 1 = extremely dry, 2 = very dry, 3 = moderately dry, 4 = slightly dry, 5 = slightly juicy, 6 = moderately juicy, 7 = very juicy, and 8 = extremely juicy. The scale used for texture was: 1 = extremely tough, 2 = very tough, 3 = moderately tough, 4 = slightly tough, 5 = slightly tender, 6 = moderately tender, 7 = very tender, and 8 = extremely tender. The panelists reported the scores to the nearest half-point. The panelists' scores were averaged for statistical analysis. The tests were conducted under white fluorescent lights in partitioned booths.

## Statistical Analysis

The data were analyzed using SPSS (version 17.0 for Windows; SPSS, Chicago, III., USA) with randomized block design. Three trials were conducted for CSF and SFO-added buffalo meat patties. A total of 30 buffalo meat patties were evaluated for each group with 10 patties from each trial. The data were subjected to analysis and compare means through paired samples t-test to find the difference between the two groups (Snedecor and Cochran, 1995). The paired variables were analyzed with a 95% confidence interval to obtain the mean, standard deviation, standard error, t-value, degree of freedom, and significance (2-tailed) values. The smallest difference (D5%) for the two means to be significantly different was expressed as  $P < 0.05$ .

## Results and discussion

### Comparison Between the Physicochemical Attributes of Patties Made from Spent Female Buffalo Meat with Sunflower Oil and Chicken Skin with Fat as Oil/Fat Source

#### i. Emulsion pH

The physicochemical quality attributes of patties made from spent female buffalo meat patties with sunflower oil (SFO) and chicken skin with fat (CSF) are given in Table 1. The results indicated that the emulsion pH did not differ significantly ( $P > 0.05$ ) between groups. In another research, Biswas *et al.*, (2011) reported an emulsion pH of 6.09 in duck patties incorporated with skin fat and visceral organs. Thus, it is inferred from the current findings that the difference in oil/fat source does not create a significant pH difference in meat emulsion.

#### ii. Product pH

The results have shown that the buffalo meat patties prepared with CSF showed a significantly ( $P < 0.05$ ) higher pH compared to that made with SFO (Table 1). Raut *et al.*, (2011) reported that enrobed chicken patties prepared with vegetable oil resulted in a product pH of 6.24. Alabdulkarim *et al.* (2012) revealed that frozen chicken patties fried in palm and corn oil showed a pH of 6.05-6.25. Biswas *et al.*, (2011) reported a pH of 6.20 in duck patties incorporated with skin fat and visceral organs. While Vieira *et al.*, (2019) indicated that the replacement of chicken fat with canola oil in chicken meatballs non-significantly changed the pH from 5.93 to 5.95. Whereas, in the present study, the replacement of vegetable oil with chicken skin and fat significantly changed the patties' pH. Backes *et al.*, (2013) attributed that the decrease in the pH is associated with the water retention capacity of the proteins, which is affected when the pH of the product approaches the isoelectric point (5.3), leading to dehydration of the product. Hence the results indicate that the denaturation and dehydration of skin protein after cooking might have contributed

to the significant difference in buffalo meat patties prepared with SFO and CSF.

### **iii. Yield**

The buffalo meat patties incorporated with SFO showed a significantly ( $P<0.05$ ) higher yield compared to the patty with CSF (Table 1). The lower weight loss in SFO added group is because less fluid was lost during cooking due to its lower fat content. The higher weight loss in CSF-incorporated patties is due to the higher moisture content in the product. The result of the present study corroborated with the findings of Suman & Sharma (2003) in low-fat buffalo meat patties. Raut *et al.*, (2011) reported that enrobed chicken patties prepared with vegetable oil resulted in a product yield of 110.27%. Biswas *et al.*, (2011) reported a product yield of 83.6% in duck patties incorporated with skin fat and visceral organs. In the current study, when compared to CSF, the addition of SFO contributes to better emulsification and binding of moisture and fat, hence reducing the cooking loss and improving the yield of the product. The result shows that the product pH and moisture content do not influence the product yield as in the case of SFO and CSF-incorporated buffalo meat patties.

### **iv. Emulsion Stability**

The results have indicated that SFO significantly ( $P<0.05$ ) improves the emulsion stability of buffalo meat patty compared to CSF (Table 1). In another study, Biswas *et al.*, (2011) reported emulsion stability or cooking loss of 12% in duck patties incorporated with skin fat and visceral organs. Ramadhan *et al.*, (2011) reported that the weight loss in chicken burger patties ranges from 5-25%. Gujral *et al.*, (2002) reported that the addition of texturized soy protein in goat meat patties lowered the cooking loss to 10.1%. The loss of weight occurred during cooking mainly due to moisture evaporation and the drip of melted fat (Alakali *et al.*, 2010). Hence the present study reveals that higher moisture in CSF compared to SFO contributes to decreased emulsion stability of buffalo meat patties.

### **v. Decrease in Diameter**

The buffalo meat patties showed no significant ( $P>0.05$ ) difference for the decrease in diameter due to the addition of SFO or CSF (Table 1). Ramadhan *et al.*, (2011) stated that the shrinkage of chicken burger patties ranged from about 2-10%. Biswas *et al.*, (2011) reported a diameter shrinkage of 2.94% in duck patties incorporated with skin fat and visceral organs. The degree of shrinkage is a significant attribute since patties are mainly served with burger buns and it should be comparable with the bun size. The patties shrink during cooking due to the meat protein denaturation and moisture and fat loss. The incorporation of fibers and non-meat protein ingredients may reduce the diameter shrinkage and weight loss (Turhan *et al.*, 2009). The results of the current study show that better emulsion formation and good binding negate the difference in patty diameter irrespective of the difference in oil/fat source.

### **vi. Increase in Height**

The results indicated that the height of the buffalo meat patties increased significantly ( $P<0.05$ ) due to the SFO incorporation than CSF (Table 1). The significantly higher fat content in SFO compared to CSF added group has caused the difference in height of buffalo meat patties.

### **vii. Moisture**

The moisture content of the buffalo meat patties differed significantly ( $P<0.05$ ) due to the addition of SFO and CSF, with CSF-added patties showing a significantly higher moisture content than SFO (Table 1). In another research by Bou *et al.*, (2006), sunflower oil incorporation increased the moisture content of the cooked dark chicken meat with skin compared to the addition of beef tallow as the fat source. Vieira *et al.*, (2019) indicated that the replacement of chicken fat with canola oil in roasted chicken meatballs non-significantly changed the moisture from 59.79 to 58.04. Ramadhan *et al.*, (2011) reported that the moisture content in chicken burger patties varies from 46.72-69.37%. Raut *et al.*, (2011) reported that enrobed chicken patties prepared with vegetable oil resulted in a product moisture content of 63.45%. Alabdulkarim *et al.*, (2012) revealed that frozen chicken patties fried in palm and corn oil showed a moisture content of 53.07-64.00%. Biswas *et al.*, (2011) reported a moisture content of 57.60% in duck patties incorporated with skin fat and visceral organs. As evident in the current research findings, better dispersion of CSF in the emulsion and higher protein content in the group is responsible for the more water-binding capacity of the product.

### **viii. Protein**

The protein content of the buffalo meat patties with CSF was significantly ( $P<0.05$ ) higher than SFO (Table 1). The finding differed with Vieira *et al.*, (2019) who indicated that the replacement of chicken fat with canola oil in roasted chicken meatballs non-significantly changed the protein from 25.69 to 23.75. The protein content of the chicken burgers ranged from 11.08-18.77% (Ramadhan *et al.*, 2011). Raut *et al.*, (2011) reported that enrobed chicken patties prepared with vegetable oil resulted in a product protein content of 21.04%. Biswas *et al.*, (2011) reported a protein content of 23.1% in duck patties incorporated with skin fat and visceral organs. The Food Safety and Standards Authority of India (FSSAI) regulations require a minimum limit of 18% protein for processed meat products (FSSAI, 2013). Therefore, the patties prepared in the study have adequate protein content and comply with FSSAI regulations. The higher content of protein in CSF than the SFO group is owed to the additional protein contribution by chicken skin to the buffalo meat patties.

### **ix. Fat**

The fat content of the buffalo meat patties showed a significantly ( $P<0.05$ ) higher value in SFO added group compared to CSF (Table 1). Whereas, Bou *et al.*, (2006) reported that sunflower oil incorporation decreases the fat content of cooked dark chicken meat with skin compared to the addition of beef tallow as the fat source. Vieira *et al.*, (2019) indicated that the replacement of chicken fat with canola oil in roasted chicken meatballs non-significantly changed the lipids from 3.57 to 3.28. Raut *et al.*, (2011) reported that enrobed chicken patties prepared with vegetable oil resulted in a product fat content of 10.70%. Ramadhan *et al.*, (2011) reported that the fat content in chicken burgers varies from 9.08-20.54%. Alabdulkarim *et al.*, (2012) revealed that frozen chicken patties fried in palm and corn oil showed a fat content of 10.16-11.93%. Biswas *et al.*, (2011) reported an ether extract content of 13.50% in duck patties incorporated with skin fat and visceral organs. The Food Safety and Standards Authority of India (FSSAI) regulations state that the fat content in processed meat products should not exceed 30% (FSSAI, 2013). The fat in the meat product influences the sensory quality of patties, particularly their flavor. In the present study, the oil/fat source in SFO added buffalo patty group is 100% oil/fat, whereas, in patties added with CSF fat group, the skin (protein) and fat combination decreased the overall fat content of the product.

### **x. Carbohydrate**

The carbohydrate content of the buffalo meat patties showed no significant ( $P>0.05$ ) difference between SFO and CSF-added groups (Table 1). In another study, Vieira *et al.*, (2019) indicated that the replacement of chicken fat with canola oil in roasted chicken meatballs non-significantly changed the carbohydrate value from 7.52 to 11.34%. Ramadhan *et al.*, (2011) showed that the carbohydrate content in chicken burgers ranged from 2.56-21.27%. The carbohydrates in patties are mainly from the use of starches as ingredients. Starches such as maize, tapioca, rice, potato, and wheat have been used in processed meat products as fillers and binders. The same level of extender in CSF and SFO groups caused a non-significant variation in the carbohydrate content of buffalo meat patties.

### **xi. Ash**

The ash content of the buffalo meat patties showed no significant ( $P>0.05$ ) difference between SFO and CSF-added groups (Table 1). Vieira *et al.*, (2019) indicated that the replacement of chicken fat with canola oil in roasted chicken meatballs non-significantly changed the ash value from 3.43 to 3.58%. Biswas *et al.*, (2011) reported an ash content of 1.96% in duck patties incorporated with skin fat and visceral organs. Ramadhan *et al.*, (2011) indicated that the ash content in chicken burgers ranged from 1.50-2.96%. Ash content is the sum of the total minerals present in the patties such as sodium, phosphorous, and iron, that are contributed by the meat, salt, spices, and other food-grade additives added to the product formulation, which was the same in CSF and SFO groups, contributing to a non-significant difference.

### **xii. Energy**

The energy content of the buffalo meat patty was significantly ( $P<0.05$ ) higher in the SFO group than in CSF (Table 1). The energy content is attributed to the proportion of fat, protein, and carbohydrate in the meat product, which was relatively higher in SFO than CSF-incorporated buffalo meat patties.

### **xiii. Cholesterol**

The cholesterol contents of the buffalo meat patties were significantly higher in SFO added group than in the CSF-added group (Table 1). Contrary to the present finding, Das *et al.*, (2008) indicated that goat meat patties with refined mustard oil significantly lowered the cholesterol content more than chicken and goat fat. Alina *et al.*, (2009) reported that palm fat can be used as an animal fat replacer in processed meat products and it can reduce 28-41 mg cholesterol/100 g. Martinez *et al.*, (2009) reported that a mixture of pre-emulsified corn, olive, and deodorized fish oil in a hamburger can reduce cholesterol levels to 16.1 mg/100 g. Ramadhan *et al.*, (2011) indicated that the cholesterol values were ranging from 41.62-82.16 mg/100 g in chicken burger patties. The cholesterol values in low-fat beef burgers were reported as 61.97- 72.13% (Turhan *et al.*, 2009). Health-related organizations' recommendation for cholesterol intake is 300 mg or below per day. The cholesterol contents of meat products are generally less than 75 mg/100 g (Jiménez- Colmenero *et al.*, 2001). The difference in cholesterol content is mainly due to the type of muscle used, and the type, and quantity of fat/oil used in formulation and cooking. Cooking processes particularly roasting and grilling lead to loss of fat due to fat melting and dripping. The significantly higher cholesterol content is owed to the higher fat content in SFO than CSF-added buffalo meat patties. The results of the present research indicate that the replacement of plant-based oil with chicken skin and fat in buffalo meat patties can reduce cholesterol levels by 11.98mg/100g.

### **xiv. Water Activity**

The water activity of the buffalo meat patties did not differ significantly ( $P>0.05$ ) due to the addition of SFO and CSF in meat emulsion (Table 1). On the other hand, Vieira *et al.*, (2019) indicated that the replacement of chicken fat with canola oil in chicken meatballs significantly decreased the aW from 0.98 to 0.97. As per the present study, the significant difference in moisture content of the CSF and SFO added groups did not cause significant variation in the water activity of the meat product.

### **xv. Thiobarbituric Acid Reactive Substances (TBARS)**

The TBARS value of buffalo meat patties in the present study did not show any significant ( $P>0.05$ ) difference due to the addition of SFO and CSF in meat emulsion (Table 1). While Vieira *et al.*, (2019) indicated that the replacement of chicken fat with canola oil in chicken meatballs non-significantly changed the TBARS value from 1.11 to 0.93 mg/kg. Alabdulkarim *et al.*, (2012) revealed that frozen chicken patties fried in palm and corn oil showed a TBARS value of 0.10-0.18. Biswas *et al.*, (2011) reported a TBA value of 0.14 in duck patties incorporated with skin fat and visceral organs. The unsaturated fatty acids get oxidized resulting in more TBARS (Grau, 2001). Jin *et al.*, (2007) reported that lipid oxidation results in the formation of an array of products such as malonaldehyde which directly or indirectly decreases the sensory quality of meat products such as off-flavor and rancidity (Klose *et al.*, 1959). There are various factors responsible for oxidation, such as temperature, light, availability of oxygen, and the presence of moisture and metals. Price and Schweigert (1970) indicated that rancidity is due to the formation of hydroperoxides (-OOH) during the early stages of autoxidation. They further reported that the hydroperoxides were quite stable at low temperatures. Cross and Overby (1988) also reported that elevated temperatures will speed the chain propagation reactions of rancidity and accelerate the decomposition of peroxides which leads to a higher rate of lipid oxidation. As evident in the results, the significant difference in fat content of the CSF and SFO-added buffalo meat patties did not show a significant effect on TBARS values in cooked products.

### **xvi. Shear Force Value**

The shear force value of the buffalo meat patties was significantly ( $P<0.05$ ) higher in the CSF group compared to SFO (Table 1). While Alvarez *et al.*, (2012) found that the replacement of back fat with canola-olive oils increased the rupture force of pork frankfurters from 55.2 to 74.0N. Vieira *et al.*, (2019) indicated that the replacement of chicken fat with canola oil in chicken meatballs non-significantly changed the texture value from 2.30 to 2.06 kg/mm. Gujral *et al.*, (2002) indicated that an increase in fat increased the shear force from 37.81 to 64.13N in the baked goat meat patties incorporated with hydrogenated vegetable fat and texturized soy protein. The reduced shear force in SFO-added patties indicates the formation of softer and less cohesive meat structures. The SFO decreases the meat protein interaction and gelation and resulting in a softer product texture. Thus, in the present study, the replacement of CSF with SFO decreased the shear force of buffalo meat patties. The results suggest that the type and quantity of fat are highly influential on the textural properties of meat products such as buffalo meat patties.

## Comparison Between the Microbial Quality of Patties Made from Spent Female Buffalo Meat with Sunflower Oil and Chicken Skin with Fat as Oil/Fat Source

### i. Microbial quality

The standard plate count of the buffalo meat patties did not differ significantly ( $P < 0.05$ ) between the SFO and CSF-added groups (Table 2). The study revealed that the coliforms, and yeast and mold counts were absent in both groups. Biswas *et al.*, (2004) revealed a total plate count of 3.05 log cfu/g in pork patties. Biswas *et al.*, (2011) reported a total viable count of 2.94 log cfu/g in duck patties incorporated with skin fat and visceral organs. According to the Bureau of Indian Standards (BIS, 1992), aerobic plate count should not be beyond log 4 log cfu/g in ready-to-eat sausage products. However, the level of total viable counts to the extent of log 5.0 log cfu/g was considered as the maximum limit for the acceptability of the product (Bauemann, 1979). The results indicate that the microbial load was within the permissible limit and the SFO and CSF did not influence the microbial load in buffalo meat patties.

## Comparison Between the Sensorial Attributes of Patties Made from Spent Female Buffalo Meat with Sunflower Oil and Chicken Skin with Fat as Oil/Fat Source

### i. Appearance

The appearance of the cooked buffalo meat patties was significantly ( $P < 0.05$ ) higher in CSF added group than in the SFO-incorporated patties (Table 2). Raut *et al.*, (2011) reported that enrobed chicken patties prepared with vegetable oil resulted in a product appearance score of 6.80 on an 8-point sensory scale. Alabdulkarim *et al.*, (2012) revealed that frozen chicken patties with 5% honey, fried in palm and corn oil showed a color score of 8 on a 9-point sensory scale. Biswas *et al.*, (2011) reported a color value of 7.33 on a 9-point sensory scale in duck patties incorporated with skin fat and visceral organs. The appearance of patties is contributed by the type of meat used and the additives added in the formulation. During patty preparation, color alteration occurs in meat, while heme protein is denatured simultaneously with the oxidation of iron into ferric and the heme pigment remains intact (Ganhao *et al.*, 2010). Color is a quality factor that greatly influences the appearance of the meat and its products and in turn, influences its acceptability to consumers. Various factors such as concentration, chemical state of meat pigment, physical properties of the meat, and presence of non-meat ingredients affect the color of the meat products (Sayago-Ayerdi *et al.*, 2009). The decrease in color scores of patties might be due to lipid oxidation resulting in non-enzymatic browning as in SFO added group.

**Table 1:** Composition of spice mix for buffalo meat patties

Ingredients	% in the mix
Coriander powder (Dhania)	20
Cumin seeds (Zeera)	10
Turmeric (Haldi)	10
Dried ginger (Sont)	10
Aniseed (Soanf)	10
Black pepper (Kali mirch)	10
Capsicum (Mirch powder)	10
Caraway seed (Ajowain)	05
Cardamom (Bada elaichi)	05
Cloves (Laung)	05
Cinnamom (Dal chini)	04
Mace (Javithri)	01
<b>Total</b>	<b>100</b>

### ii. Binding

The results have indicated that the binding of the cooked buffalo meat patties did not differ significantly ( $P < 0.05$ ) between CSF and SFO incorporated groups (Table 2). In another research, Soni *et al.*, (2018) reported a binding score of 7.5 in chicken patties with refined mustard oil. The results of the present study reveal that the effect of a difference in fat/oil source gets nullified if the emulsion formation is properly leading to equally better binding

scores.

### iii. Flavor

The flavor of the cooked buffalo meat patties was significantly ( $P<0.05$ ) higher for the CSF-incorporated group than the SFO-added patties (Table 2). Similarly, Das *et al.*, (2008) indicated that goat meat patties prepared with chicken fat improved the flavor of refined mustard oil. Biswas *et al.*, (2011) reported a flavor value of 7.67 on a 9-point sensory scale in duck patties incorporated with skin fat and visceral organs. Raut *et al.*, (2011) reported that enrobed chicken patties prepared with vegetable oil resulted in a product flavor score of 6.00 on an 8-point sensory scale. Alabdulkarim *et al.*, (2012) revealed that frozen chicken patties with 10% honey, fried in palm oil showed a flavor score of 8 on a 9-point sensory scale. The flavor is the result of the interaction of taste, odor, and texture feelings after consumption of food which in turn is due to compounds responsible for taste and aroma. The lower flavor score sometimes is related to increased malonaldehyde formation due to the oxidation of fat, which has a detrimental effect on the flavor and firmness of the product (Miller *et al.*, 1980). The significantly higher flavor scores in CSF than SFO-added buffalo meat patties are attributed to the highly perceivable meat flavor emanating from the CSF group.

**Table 2:** Formulation for buffalo meat patties with sunflower oil (SFO) and chicken skin with fat (CSF) added groups

Ingredients	SFO group (%)	CSF group (%)
Minced buffalo meat	66.000	66.000
Sunflower oil (SFO)	12.000	00.000
Chicken skin with fat (CSF)	00.000	12.000
Chilled water/ ice flakes	10.000	10.000
Condiment paste (onion:garlic, 3:1)	5.000	5.000
Maida	2.900	2.900
Salt	1.800	1.800
Spice mix	1.800	1.800
Sodium tripolyphosphate (STPP)	0.485	0.485
Sodium nitrite	0.015	0.015
<b>Total</b>	<b>100.000</b>	<b>100.000</b>

**Table 3:** Comparison between the physicochemical attributes of patties made from spent female buffalo meat with sunflower oil and chicken skin with fat as oil/fat source

Quality attribute	Patty with sunflower oil	Patty with chicken skin and fat
Emulsion pH	5.99±0.02	5.97±0.02
Product pH	6.01±0.10 <sup>b</sup>	6.63±0.01 <sup>a</sup>
Yield (%)	89.64±0.14 <sup>a</sup>	88.95±0.22 <sup>b</sup>
Emulsion stability (%)	93.11±1.11 <sup>a</sup>	90.62±1.70 <sup>b</sup>
Decrease in diameter (%)	4.99±0.30	5.33±0.16
Increase in height (%)	16.28±5.20 <sup>a</sup>	11.96±3.75 <sup>b</sup>
Moisture (%)	59.07±0.11 <sup>b</sup>	61.00±0.09 <sup>a</sup>
Protein (%)	18.15±0.18 <sup>b</sup>	19.88±0.01 <sup>a</sup>
Fat (%)	17.24±0.01 <sup>a</sup>	14.40±0.02 <sup>b</sup>
Carbohydrate (%)	2.99±0.05	2.62±0.01
Ash (%)	2.54±0.01	2.11±0.03
Cholesterol (mg/100g)	72.73±0.01 <sup>a</sup>	60.75±0.01 <sup>b</sup>
Energy (Kcal)	243.03±0.02 <sup>a</sup>	222.90±0.01 <sup>b</sup>
Shear force value (N)	17.81±0.30 <sup>b</sup>	19.93±0.22 <sup>a</sup>
aW	0.96±0.01	0.96±0.01
TBARS (mgMDA/kg)	0.11±0.02	0.11±0.02

*n*=30; Means with different superscripts in the same row differ significantly ( $P<0.05$ )

**Table 4:** Comparison between the microbial and sensorial attributes of patties made from spent female buffalo meat with sunflower oil and chicken skin with fat as oil/fat source

Quality attribute	Patty with sunflower oil	Patty with chicken skin and fat
<b>Microbial quality</b>		
Standard plate count (log cfu/g)	1.00±0.11	1.30±0.12
Coliform count (log cfu/g)	NF	NF
Yeast and mold count (log cfu/g)	NF	NF
<b>Sensorial quality</b>		
Appearance	7.00±0.15 <sup>b</sup>	7.50±0.12 <sup>a</sup>
Binding	7.50±0.14	7.50±0.11
Flavour	7.00±0.11 <sup>b</sup>	7.50±0.10 <sup>a</sup>
Texture	7.00±0.13 <sup>b</sup>	7.50±0.12 <sup>a</sup>
Juiciness	7.00±0.11 <sup>b</sup>	7.50±0.10 <sup>a</sup>

*n*=30; Means with different superscripts in the same row differ significantly ( $P<0.05$ ), NF= none found

#### iv. Texture

The texture scores for the cooked buffalo meat patties were significantly ( $P<0.05$ ) higher in CSF added group than the SFO-added patty group (Table 2). Raut *et al.*, (2011) reported that enrobed chicken patties prepared with vegetable oil resulted in a product appearance score of 6.60 on an 8-point sensory scale. Biswas *et al.*, (2011) reported a texture value of 7.33 on a 9-point sensory scale in duck patties incorporated with skin fat and visceral organs. Backes *et al.*, (2013) described that the amount of water in the product is one of the main factors responsible for the texture. This relation is found in the present study, wherein, buffalo patties prepared with CSF showed significantly higher moisture compare to the SFO group. The increased texture scores in CSF added group may be due to relatively lower moisture loss during cooking.

#### v. Juiciness

The juiciness score of the cooked buffalo meat patties was significantly ( $P<0.05$ ) higher in CSF added group than the SFO-incorporated patties (Table 2). This finding is different from another study in that low-fat burger patties are less acceptable for juiciness compared to patties with higher fat content (Turhan *et al.*, 2009). Gomez *et al.*, (2018) indicated that the sensory properties of cooked low-fat beef patties were not affected by the olive and linseed oils mixture. Raut *et al.*, (2011) reported that enrobed chicken patties prepared with vegetable oil resulted in a product appearance score of 6.40 on an 8-point sensory scale. Biswas *et al.*, (2011) reported a color value of 7.67 on a 9-point sensory scale in duck patties incorporated with skin fat and visceral organs. Alabdulkarim *et al.*, (2012) revealed that frozen chicken patties fried in corn oil showed a juiciness score of 8 on a 9-point sensory scale. The lower fat content in patties with CSF contributed to the lower scores of juiciness. The lower juiciness of buffalo meat patties with CSF is also related to the lower moisture released during chewing and the interaction with salivary moisture.

## Conclusion

The replacement of sunflower oil (SFO) with chicken skin and fat (CSF) in buffalo meat patties is a worthwhile substitute to produce a healthier product since it produced a lower fat, cholesterol, and energy meat product with improved sensory attributes such as appearance, flavor, texture, and juiciness.

## Conflict of Interests

There is no conflict of interest.

## Publisher Disclaimer

IJLR remains neutral concerning jurisdictional claims in published institutional affiliation.

## References

1. Aberle, ED., Forrest, J.C., & Gerrard, D.E., Mills, E.W., Hedrick, H.B., Judge, M.D., Markel, R.A. (2001). *Principles of Meat Science* (4<sup>th</sup> ed.). Kendall Hunt Pub. Co., USA.p.376.
2. Alabdulkarim B., Bakeet Z.A.N., and Arzoo S. (2012). Effect of frying oils on quality characteristics of frozen chicken patties incorporated with honey. *African Journal of Biotechnology*, 11(12): 2985-2992.
3. Alakali, J. S., Irtwange, S. V. and Mzer, M. T. 2010. Quality evaluation of beef patties formulated with Bambara groundnut (*Vigna subterranean L.*) seed flour. *Meat Science* 85(2): 215-223.
4. Alina, A. R., Babji, A.S. and Affandi, S. 2009. Nutritional quality of palm fat substituted chicken nuggets. *Nutrition and Food Science* 39(2): 181-188.
5. Alvarez D., Xiong Y.L., Castillo M., Payne F.A., Garrido M.D. (2012). Textural and viscoelastic properties of pork frankfurters containing canola-olive oils, rice bran, and walnut *Meat Science*, 92: 8-15.
6. AMSA. (1995). *Research guidelines for cookery, sensory evaluation, and instrumental tenderness measurements of fresh meat*. Chicago, IL: American Meat Science Association.
7. Anjaneyulu, A.S.R. and Sharma, N. (1991). Effect of fat and phosphate on the quality of raw and precooked buffalo meat patties. *Journal of Food Science and Technology, India*, 28(3): 157-160.
8. Anjaneyulu, A.S.R., Sharma, N. and Kondaiah, N. (1990). Specific effect of phosphate on the functional properties and yield of buffalo meat patties. *Food Chemistry*, 36(2): 149-154.
9. Anjaneyulu, A.S.R., Sharma, N. and Kondaiah, N.(1994). Effect of salt and its blend with polyphosphates on the quality of buffalo meat and patties under hot, chilled and frozen conditions. *Journal of Food Science and Technology, India*, 31(5): 404-408.
10. Anjaneyulu, A.S.R., Sharma, N., and Kondaiah, N. (1989). Evaluation of salt, polyphosphates and their blends at different levels on physicochemical properties of buffalo meat and patties. *Meat Science*, 25(4): 293-306.
11. AOAC. (2002). *Official Method of Analysis. Revision 1* (17<sup>th</sup> ed.). Association of Official Analytical Chemists, Inc, Arlington, VA.
12. APHA. (2001). *Compendium of Method of Microbiological Examination of Foods*. (4<sup>th</sup> ed.). American Public Health Association. Inc., Washington DC.
13. Backes AM, Terra NN, Guidolin LI, Rezer APS, Lüdtkke FL, Cavalheiro CP, *et al.*, . (2013). Características físico-químicas e aceitação sensorial de salame tipo italiano com adição de óleo de canola. *Semina Ciências Agrárias*, 34:3709-3720.
14. Baumann JF (1979). Processing of poultry products with and without sodium nitrite. *Food Technol.*, 33: 42-43.
15. Bawa, A.S. and Sekhon, K.S. (2000). Effect of level of nutrition and stage of maturity on the quality of patties from meat of male buffalo veal during frozen storage. *Journal of Food Science and Technology*, 37(2):116-120.
16. Berry, B.W., & Stiffler, D.M. (1981). Effects of electrical stimulation, boning temperature, formulation, and rate of freezing on sensory, cooking, and physical properties of ground beef patties. *Journal of Food Science*, 46, 1103-1106.
17. BIS (1992). Year Book, Bureau of Indian Standards, Manak Bhawan, Bahadur Shah Zafar Marg, New Delhi, India.
18. Biswas AK, Keshri RC, Bisht GS. (2004). Effect of enrobing and antioxidants on quality characteristics of precooked pork patties under chilled and frozen storage conditions. *Meat Sci.* 2004 Mar;66(3):733-41. doi: 10.1016/j.meatsci.2003.07.006. PMID: 22060884.
19. Biswas S., Chakraborty A., Patra G. and Dhargupta A. (2011). Quality and acceptability of duck patties stored at ambient and refrigeration temperature. *International Journal of Livestock Production*. 1(1): 1-6.
20. Bohac, C.E., Rhee, K.S., Cross, H.R. and Ono, K. (1988), "Assessment of methodologies for colorimetric cholesterol assay of meats", *Journal of Food Science*, Vol. 53 No. 6, pp. 1642-44.
21. Bou R., Grimpa S., Guardiola F., Barroeta A. C., and Codony R. (2006). Effects of Various Fat Sources,  $\alpha$ -Tocopheryl Acetate, and Ascorbic Acid Supplements on Fatty Acid Composition and  $\alpha$ -Tocopherol Content in Raw and Vacuum-Packed, Cooked Dark Chicken Meat. *Poultry Science* 85:1472-1481.
22. Bruinsma, J. (2003). *World Agriculture: Towards 2015/2030. An FAO Perspective*. Earthscan Publications Ltd. London.p.85.
23. Cliche S, Amiot J, Avezard C, Gariépy C (2003). Extraction and characterization of collagen with or without telopeptides from chicken skin. *Poult Sci.* 2003 Mar;82(3):503-9. doi: 10.1093/ps/82.3.503.
24. Cross HR, Overby AJ (1988). *Meat Science, Milk Science and Technology*, 1st Ed., Elsevier Science

- Publishers, B.V. Oxford, New York.
25. Das A.K., Anjaneyulu A.S.R., Thomas R., Kondaiah, N. (2008). Effect of different fats on the quality of goat meat patties incorporated with full-fat soy paste. *Journal of Muscle Foods*. 20 (1): 37-53.
  26. FAOSTAT. (2013). FAOSTAT. Data. Food Supply-Livestock and Fish Primary Equivalent. Retrieved from <http://www.fao.org/faostat/en/#data/CL>. Accessed on June 2, 2021.
  27. FAOSTAT. (2013). *FAOSTAT. Data. Food Supply-Livestock and Fish Primary Equivalent*. Retrieved from <http://www.fao.org/faostat/en/#data/CL>. Accessed on June 2, 2021.
  28. FAOSTAT. (2017). FAOSTAT statistics database. FAO, Rome, Italy.
  29. FAOSTAT. (2017). *FAOSTAT statistics database*. FAO, Rome, Italy.
  30. FAOSTAT. (2019). FAOSTAT. Data. Production. Livestock Primary. Retrieved from <http://www.fao.org/faostat/en/#data/QL/visualize>. Accessed on June 2, 2021.
  31. FAOSTAT. (2019a). *FAOSTAT. Data. Production. Live Animals*. Retrieved from <http://www.fao.org/faostat/en/#data/QA/visualize>. Accessed on June 2, 2021.
  32. FAOSTAT. (2019b). *FAOSTAT. Data. Production. Livestock Primary*. Retrieved from <http://www.fao.org/faostat/en/#data/QL/visualize>. Accessed on June 2, 2021.
  33. FSSAI (2013). Food Product Standards and Food Additives – FSSAI. <https://www.fssai.gov.in>
  34. Ganhao, R., Morcuende, D. and Estévez, M. 2010. Protein oxidation in emulsified cooked burger patties with added fruit extracts: Influence on colour and texture deterioration during chill storage. *Meat Science* 85(3): 402-409.
  35. Glitsch K (2000). Consumer Perceptions of Fresh Meat Quality: Crossnational comparison. *Br. Food J.* 102: 177-194.
  36. Gomez I, Sarriés MV, Ibañez FC, José M. (2018). Beriain Quality Characteristics of a Low-Fat Beef Patty Enriched by Polyunsaturated Fatty Acids and Vitamin D3 *Journal of Food Science*. 83(2): 454-463
  37. Grau A, Guardiola F, Grimpa S, Barroeta C, Codony R (2001). Oxidative stability of dark chicken meat through frozen storage: Influence of dietary fat and  $\alpha$ -tocopherol and ascorbic acid supplementation. *Poult. Sci.* 80: 1630-1642.
  38. Gujral, H.S., Kaur, A., Singh, N., Sodhi, N.S. (2002). Effect of liquid whole egg, fat and textured soy protein on the textural and cooking properties of raw and baked patties from goat meat. *Journal of Food Engineering*, 53: 377–385.
  39. Haque, N., & Murari Lal. (1999). Gross energy estimation. In *Laboratory Manual of Animal Nutrition* (pp.71-76). Centre of Advanced Studies, Division of Animal Nutrition, Indian Veterinary Research Institute, Izatnagar, U.P, India.
  40. Hoda, I., Ahmad, S. and Srivastava, P.K. (2002). Effect of microwave oven processing, hot air oven cooking, curing and polyphosphate treatment on physico-chemical, sensory and textural characteristics of buffalo meat products. *Journal of Food Science and Technology*, 39(3): 240-245.
  41. Jiménez-Colmenero, F., Carballo, J. and Cofrades, S. 2001. Healthier meat and meat products: their role as functional foods. *Meat Science* 59(1): 5-13.
  42. Jin SK, Kim IS, Jung HJ, Kim DH, Choi YJ, Hur SJ (2007). The development of sausage including meat from spent laying hen surimi. *Poult Sci.* 86: 2676-2684.
  43. Kandeepan G, Anjaneyulu ASR, Kondaiah N, Mendiratta SK, Suresh R .(2009). Comparison of quality and shelf life of buffalo meat patties stored at refrigeration temperature. *International Journal of Food Science and Technology*. 44(11): 2176-2182
  44. Kandeepan, G., Anjaneyulu, A.S.R., Kondaiah, N., Mendiratta, S.K., Lakshmanan, V. (2009). Effect of age and gender on the processing characteristics of buffalo meat. *Meat Science*, 83 (1), 10-14.
  45. Kandeepan, G., Mendiratta, S.K., Shukla, V., & Vishnuraj, M.R. (2013). Processing characteristics of buffalo meat- a review. *Journal of Meat Science and Technology*, 1(1), 1-11.
  46. Klose AA, Pool MF, Campbell AA, Hanson HL (1959). Time temperature tolerance of frozen food. *Food Technol.* 13: p. 477.
  47. Kondaiah, N., Anjaneyulu, A.S.R., Rao, V.K., Sharma, N. and Joshi, H.B. (1985). Effect of salt and phosphate on the quality of buffalo and goat meat. *Meat Science*, 15: 183-192.
  48. Koniecko, E.K. (1979). In: *Handbook for meat chemists*. Ch. 6, Avery Publishing group Inc., Wayne, New Jersey, U.S.A. pp. 68-69.
  49. Martínez, B, Miranda, J., Vazquez, B., Fente, C., Franco, C., Rodríguez, J., Cepeda, A. (2009). Development of a Hamburger Patty with Healthier Lipid Formulation and Study of its Nutritional, Sensory, and Stability Properties. *Food Bioprocess Tech.* 5. 200-208. 10.1007/s11947-009-0268-x.
  50. Martínez, B., Miranda, J., Vázquez, B., Fente, C., Franco, C., Rodríguez, J. and Cepeda, A. 2009. Development

- of a hamburger patty with healthier lipid formulation and study of its nutritional, sensory, and stability properties. *Food and Bioprocess Technology* doi:10.1007/s11947-009-0268-x.
51. Miller AJ, Ockerman SA, Palumbe SA (1980). Effect of frozen storage on functionality of meat for processing. *J. Food Sci.*, 50: 531-534.
  52. Pati, P.K., Anjaneyulu, A.S.R. and Kondaiah, N. (1993). Effect of chilled and frozen buffalo fat on the quality of patties. *Journal of Applied Animal Research*, 3: 67-72.
  53. Price JF, Schweigert BS (1970). By-products. In: *The science of meat and meat products*, 2nd Ed., p. 559-561, Chapter -13, W.H. Freeman and Company, Sanfransisco.
  54. Ramadhan, K., Huda, N. and Ahmad, R. (2011). Physicochemical characteristics and sensory properties of selected Malaysian commercial chicken burgers. *International Food Research Journal* 18(4): 1349-1357.
  55. Raut K.A., Raziuddin M. and Zanjad P.N. (2011). Effect of batter consistency as enrobing on quality of chicken patties. *Tamilnadu J. Veterinary & Animal Sciences*, 7(3):176-179.
  56. Sayago-Ayerdi SG, Brenes A, Goni I (2009). Effect of grape antioxidant dietary fiber on the lipid oxidation of raw and cooked chicken hamburgers. *LWT. Food Sci. Technol.* 42: 971-976.
  57. Serdaroglu M., Nacak B., and Karabiyikoğlu M. (2017). Effects of Beef Fat Replacement with Gelled Emulsion Prepared with Olive Oil on Quality Parameters of Chicken Patties. *Korean J Food Sci Anim Resour*, 37(3): 376–384.
  58. Snedecor, G.W., & Cochran, W.G. (1995). *Statistical Methods* (8<sup>th</sup> edn.). Oxford and IBH Publishing Co., New Delhi.
  59. Soni A, Gurunathan K, Mendiratta SK, Talukder S, Jaiswal RK, Sharma H. (2018). Effect of essential oils incorporated edible film on quality and storage stability of chicken patties at refrigeration temperature ( $4 \pm 1$  °C). *J Food Sci Technol.* 55(9):3538-3546. doi: 10.1007/s13197-018-3279-7.
  60. Suman, S. P. and Sharma, B. D. (2003). Effect of grind size and fat levels on the physico-chemical and sensory characteristics of low-fat ground buffalo meat patties. *Meat Science*, 65(3): 973-976.
  61. Suman, S. P. and Sharma, B. D. 2003. Effect of grind size and fat levels on the physico-chemical and sensory characteristics of low-fat ground buffalo meat patties. *Meat Science* 65(3): 973-976.
  62. Tarladgis, B.G., Watts, B.M., Younathan, M.T. and Dugan, L.R. (1960). A distillation method for the quantitative determination of malonaldehyde in rancid foods. *Journal of American Oil Chemists Society*, 37: 403-406.
  63. Trout, E.S., Hunt, M.C., Johnson, D.E., Clauss, J.R., Kastner, C.L., Kropf, D.H., & Stroda, S. (1992). Chemical, physical and sensory characterization of ground beef containing 5 to 10 percent fat. *Journal of Food Science*, 57(1), 25-29.
  64. Turhan, S., Temiz, H. and Sagir, I. 2009. Characteristic of beef patties using okara powder. *Journal of Muscle Foods* 20(1): 89-100.
  65. USDA (2021). <https://data.nal.usda.gov/dataset/usda-national-nutrient-database-standard-reference-legacy-release>
  66. Vieira ASP, Souza XR, Rodrigues EC, Sousa DC. (2019). Replacement of Animal Fat by Canola Oil in Chicken Meatball. *Brazilian Journal of Poultry Science*, 21(3): 001-010.
  67. Wertz PW, Stover PM, Abraham W, Downing DT (1986). Lipids of chicken epidermis. *J Lipid Res.* 1986 Apr;27(4):427-35.
  68. Younis, K & Ahmad, S. (2018). Quality evaluation of buffalo meat patties incorporated with apple pomace powder. *Buffalo Bulletin.* 37. 389-401.

\*\*\*\*\*