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Effect of Processing on the Quality Characteristics of Meat Products Prepared from Buffalo Veal

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ABSTRACT

Male buffalo calves are not valued as such, but are an excellent source of tender meat suitable for processing into a large variety of products. Buffalo meat is gaining popularity and is becoming acceptable among the consumers mainly because of its good quality proteins, lower cholesterol and fat contents. The major objective of this study was to examine the instrumental texture and microbial quality and safety of these prepared buffalo veal products. Three young buffalo calves were slaughtered in compliance with the relevant institutional guidelines, on three different days, the boneless veal was collected from legs, and used for preparing sausages, meat balls and meat patties. Textural and microbiological quality of raw and prepared products cooked in water, fried in oil and broiled in hot air oven was determined. Sausages cooked in water had the lowest Warner Bratzler shear value (0.8 lb force) and were very tender in texture than all other meat products. The coliforms were found to be absent in cooked meat balls and patties, however, this count ranged from 10 to 20 CFU/g in cooked sausages. The standard plate count and coliforms in cooked products were within the permissible limits of microbiological standards.

Key words: Buffalo veal, coliforms, instrumental texture, microbiological quality, TPC

INTRODUCTION

India has the highest number of buffalo population and contributing 42.2% of the total buffalo meat available in world trade during 2016 (Kaur *et al.*, 2021). Most of the buffalo meat produced in India is frozen and exported to many countries, as it is comparatively much cheaper than beef and mutton, thus a great foreign exchange earner for the country. Processing buffalo meat into various value-added products will also enhance its export earnings. Buffalo meat (also called carabeef) is becoming very popular in many countries of the world, more so in the Gulf Cooperation Council (GCC) countries. Compared with bovine beef, buffalo meat is reported to be low in inter-muscular fat, thus lower calories, lower in cholesterol, but higher in iron, essential amino acids and thus providing with higher biological value proteins to human diet (Li *et al.*, 2018). The younger buffalo meat has lower collagen content, lower cooking loss and shrinkage than the older animals. The presence of a few amino acids which affect the quality of meat and the fat deposition in buffaloes to be under the influence of a set of six genes has been reported by Wang *et al.* (2022), and these important bio-molecules can be exploited to improve the chemical composition and quality of buffalo meat. Interestingly, the buffalo meat is also reported to be healthier than the red meat derived from bovine as the former has more of omega-3 fatty acids those work against carotid atherosclerotic burden and susceptibility to oxidative stress, thus reducing cardiovascular risks (Al-Hassawi *et al.*, 2022). Feeding of *Moringa oleifera* leaf powder has been reported to improve nutrient digestibility, rumen fermentation, ruminal enzyme activities and growth performance of buffalo calves (Abdel-Raheem and Hassan, 2021). A large section of Indian population does not consume beef due to religious reasons, so a few studies have been reported to popularize the consumption of meat products made from buffalo meat, because this source of meat does not attract any religious taboo (Kaur *et al.*, 2021). Addition of 6% *Mosambi* peel powder (MPP) has also been used to produce fiber-enriched buffalo meat sausages and patties as functional foods with

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improved shelf life, microbial quality and the overall consumer acceptability for the health conscious consumers (Younis *et al.*, 2021).

There are about 204 million buffaloes in the world which are mainly reared for milk, but a total of 4.3 million tonnes of buffalo meat was produced in 2019 and the large portion of this buffalo meat came from the older animals, with only a small portion from young animals (Di Stasio and Brugiapaglia, 2021). In a recent study, Turan *et al.* (2021) have reported that the meat from younger female buffalo was equally tender in texture, but lighter in colour than the male buffalo, and can be used for various processed meat products. Kiran *et al.* (2016) have investigated the use of scanning electron microscopy to differentiate the textural and age variability affecting the quality of meat obtained from younger and older buffaloes.

Although, a number of methods have been suggested for the cooking of buffalo meat to obtain more juiciness, higher fat content and ultimately superior sensory quality, however, to achieve the well-done stage, the meat must be cooked rapidly to at least an internal temperature of 82.2°C and boiling in water and microwave cooking methods were found to achieve the best microbial and sensory quality (Abdel-Naeem *et al.*, 2021). The standardization of various processed product recipes, such as, meat balls, meat patties and sausages from buffalo veal has been reported earlier in another publication (Al-Hassawi *et al.*, 2022). As buffalo veal is reported to be lower in collagen, fat content and other connective tissues, it has softer texture when compared with bovine beef from mature animals. The major objective of this study was to examine the instrumental texture and microbial quality and safety of these prepared buffalo veal products.

MATERIALS AND METHODS

Various products, such as, buffalo veal sausages, meat balls and meat patties, were prepared as per the procedure of Al-Hassawi *et al.* (2022). Three young buffalo calves were slaughtered in compliance with the relevant institutional guidelines, on three different days, the boneless veal was collected from legs, and kept in frozen storage (-18 °C) till further use. The raw buffalo veal and the products were prepared, in duplicates, on three different days. The sausages were cooked in boiling water (100°C) and fried in oil (190°C), whereas meat balls and meat patties were cooked in hot air oven (100°C). Written informed consent was obtained from the sensory panelists. All these products were tested for instrumental texture, standard plate counts and coliforms as per the methods discussed below.

The objective texture evaluation (in terms of tenderness) of raw meat and processed meat products was studied using Warner-Bratzler shear press. A meat core of 1.35 cm diameter and 6 cm length was cut parallel to muscle fibers. The sausages were also measured for diameter and length. These pieces and sausages of constant diameter were tested for shearing across the muscle fibre with Warner-Bratzler shear press. The machine recorded the force required for cutting through the sample and results were expressed in pounds (lb) force. These observations were repeated ten times and average values were reported.

The microbiological quality of processed buffalo veal products was evaluated in terms of standard plate counts (SPC) and coliforms (CFU/g) as per the APHA Manual, as reported by Al-Hassawi *et al.* (2022).

The standard plate count of raw and processed meat products was taken by pour plate method as per the APHA Manual, as reported by Al-Hassawi *et al.* (2022). One g of sample was taken and dilution up to 10^5 was made using water blanks. From each dilution 0.5 ml was poured in triplicates. Nutrient agar was poured into Petri plates and allowed to solidify. After incubating the plates at 37°C for two days the colonies were counted, and standard plate count was reported as CFU/g.

Coliforms count of buffalo veal and the prepared meat products was also taken by pour plate method as per the APHA Manual, as reported by Al-Hassawi *et al.* (2022). One g of sample was taken in different dilution till 10^2 dilutions were reached. The media was poured into plates to cover the test sample having different dilutions (0.5 ml sample in each plate). The plates were stirred to mix the sample and the poured media, incubated at 37°C for two days and counts for coliform were reported as CFU/g. The composition of media employed during the standard plate count and coliforms is given in Tables 1 and 2.

The research data were statistically analyzed

Table 1. Composition of medium for standard plate counts (SPC)

Composition of culture media ingredient (Nutrient agar)	Quantity (g)
Beef extract	3
Tryptone (Bacteriological)	5
Distilled water	1000 ml
Agar (for solid medium)	15

Table 2. Composition of medium for coliform counts

Composition of culture medium (Glucose tryptone agar)	Quantity (g)
Glucose	1
Tryptone	5
Beef extract	3
Agar	20
Distilled water	1000 ml
pH	7.4 to 7.6

to know the level of significance, using one-way analysis of variance. The Duncan's multiple range test was employed to determine the statistical significance (P = 0.05) among the mean values of samples. The statistical techniques used were particularly useful for comparing the quality characteristics of the raw buffalo veal as well as the buffalo veal processed products.

RESULTS AND DISCUSSION

The consumers usually accept any food product based on a number of sensory attributes, such as, appearance, colour, odour, taste and texture. Keeping these requirements in view, the processed food products prepared from buffalo veal were evaluated for instrumental texture and microbiological quality.

The textural quality of raw meat, uncooked and cooked sausages was measured by Warner-Bratzler shear press (Table 3). Attempt was made to take the meat samples of uniform diameter for texture measurement. There was a significant difference in the amount of force

Table 3. Texture measurement of raw buffalo veal and sausages by Warner Bratzler-Shear press

S. No.	Sample	Dia. (cm) of meat piece	Texture (lb force)
1.	Raw buffalo veal	1.35	8.60
2.	Sausage (fresh)	1.69	2.62
3.	Sausage (cooked in water)	1.69	0.80
4.	Sausage (fried in oil)	1.69	2.53
	C. D. (P=0.05)	0.398	

required to cut through different samples. Raw meat had the toughest texture (8.6 lb force) in comparison with prepared products. The force required cutting through a uniform size of raw meat, fresh sausages, sausages cooked in water and oil was 8.6, 2.62, 0.8 and 2.53 lb, respectively. The sausage cooked in water had the tenderest texture among all the products. During frying of sausages in oil, case hardening took place, which resulted in slightly tougher texture. A significant difference in textural properties of fresh sausages was observed when compared with those fried in oil.

From the food safety point of view, presence of certain coliforms is indicative of the possible presence of pathogenic microorganisms which could harm human health. Hasan *et al.* (2018) have investigated the SPC, and Salmonella counts on the buffalo meat being sold in Bangladesh. According to them, Salmonella species were found on a number of samples collected from different districts of the country which could pose a serious public health problem to the consumers. The raw buffalo veal, uncooked as well as cooked sausages, meat balls and patties were evaluated for microbiological quality, particularly for the standard plate count (SPC) and for the presence of coliforms (Tables 4, 5 and 6).

The mean values of standard plate count for the raw buffalo meat varied from 2.25×10^2 to 3×10^2 CFU/g (Table 4). Fresh sausages prepared from raw meat showed an increase in standard plate count. It is suspected that these might have come from grinder, chopper,

Table 4. Microbiological quality of raw buffalo veal and prepared sausages (CFU/g)

S. No.	Sample	Standard plate count (SPC)	Coliforms
1.	Raw buffalo veal	3.02×10^2	4.5×10^1
2.	Sausages (fresh)	5×10^4	3.05×10^2
3.	Sausage (cooked in water)	1.5×10^2	10
4.	Sausages (fried in oil)	1.8×10^2	20
5.	Sausages (stored for 2 months at refrigeration temp. (-5°C)	2.05×10^5	2.25×10^3
	C. D. (P=0.05)	159.2	12.5

Table 5. Microbiological quality of raw buffalo veal and prepared meat balls (CFU/g)

S. No.	Sample	Standard plate count	Coliforms
1.	Raw buffalo veal	2.05×10^2	1.05×10^1
2.	Meat balls (uncooked)	2.25×10^5	3.89×10^2
3.	Meat balls (cooked)	Nil	Nil
4.	Meat balls (stored at refrigeration temp. (-5°C) for 15 days)	1.12×10^2	1.00×10^1
	C. D. (P=0.05)	168.4	3.24

Table 6. Microbiological quality of raw buffalo veal and prepared patties (CFU/g)

S. No.	Sample	Standard plate count	Coliforms
1	Raw buffalo veal	2.25×10^2	2.35×10^1
2	Meat patties (uncooked)	3.8×10^5	1.5×10^3
3	Meat patties (cooked)	Nil	Nil
4	Meat patties (stored at refrigeration temp. (-5°C) for 15 days)	2.2×10^2	Nil
	C. D. (P=0.05)	26864	2.18

mixer, stuffer, casing and spices/condiments. Cooking decreased the standard plate count. The fresh sausages contained a standard plate count of 5×10^4 CFU/g, whereas this sausage is cooked in water and fried in oil had the standard plate count of 1.5×10^2 and 4.8×10^2 CFU/g, respectively. It has been observed that the coliforms on buffalo meat varied from 2.25×10^1 to 9×10^1 CFU/g in the present study. In the present study, a significant difference was found in the coliform counts between sausages and fresh meat. The sausages cooked in boiling water and those fried in oil showed negligible count of coliforms. Sausage cooked in boiling water showed slightly low count of coliforms as compared to sausages fried in oil. When sausages were stored for two months at refrigeration temperature (-5°C) showed an increase in coliforms.

The average standard plate count (SPC) for prepared products showed an increase during the preparation of meat balls (Table 5). The cooking process resulted in almost total sterilization of the product. The microorganisms originally present in the raw material were destroyed at the end of the precooking operation. This could be due to two reasons: (1) a very low count of spore formers in the raw material and (2) comparatively high degree of heating applied in the cooking process. The meat balls stored at refrigeration temperature (-5°C) for 15 days showed a bacterial count of 1.05×10^2 CFU/g. The coliform content increased from 2.25×10^1 to 1.5×10^3 CFU/g during preparation of meat balls. After cooking at 100°C for 75 min, no coliform survived in the product. After storage of meat balls at refrigeration temperature (-5°C) for 15 days, the coliform count became almost negligible. The earlier workers have also reported reduction in SPC and spore counts as a result of heat treatments. According to them, pomegranate peel extract (PPE) has an excellent source of phenolic compounds having strong antioxidant and antimicrobial activities. When added at 1.0 to 1.5% to processed buffalo meat products, the shelf life was extended by 20 days under refrigerated temperatures.

Average standard plate counts for meat patties showed an increase during its preparation (Table 6). It has been found that broiling at 100°C for 75 min almost sterilized the finished product. However, storage of meat patties at refrigeration temperature (-5°C) for 15 days showed an increase in the standard plate count. The coliform counts of meat patties increased from 2.25×10^1 to 1.5×10^3CFU/g during the preparation of patties, whereas coliforms were not found in cooked patties as well as after storage for 15 days at refrigeration temperature (-5°C). The cooking methods employed for buffalo meat processed products showed lower SPC and coliforms, depending upon the heat treatment given to these products, especially the pressure cooked buffalo meat patties had the lowest SPC and coliforms. Spray of lactic acid solution has been reported to significantly improve the microbial and other quality parameters of the buffalo meat (Manzoor *et al.*, 2020).

CONCLUSION AND RECOMMENDATIONS

There is possibility of producing soft texture processed products from buffalo veal obtained from 3 to 4 months old calves. Raw meat had the toughest texture (8.6 lb force) in comparison with prepared products. The force required cutting through a uniform size of raw meat, fresh sausages, sausages cooked in water and oil was 8.6, 2.62, 0.8 and 2.53 lb force, respectively. Broiling at 100°C for 75 min almost sterilized the finished product. All the cooked buffalo meat products had standard plate counts (SPC) and coliforms well below the safe limits for human consumption.

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