

Standardization of Processing Technologies for the Preparation of Restructured Buffalo Meat Steaks

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Abstract

Appropriate binding of meat pieces and high water retention are two most important factors in marketing high quality restructured meat products. Here, the processing technologies viz massaging time and cooking time play pivotal role and can improve the appearance, palatability and texture of the finished products. and under this study, the quality of Restructured Buffalo Meat Steaks (RBMS) prepared with three different massaging times viz., 10(7+3), 12(9+3) and 15(12+3) minutes and cooking time viz., 40, 45 and 50 minutes was evaluated. It was found that cooking yield of the steaks prepared with 15 minutes massaging time was significantly higher ($P < 0.05$) than 10 and 12 minutes and sensory scores revealed no significant difference ($P > 0.05$) between different massaging time. However, there was a significant reduction ($P < 0.05$) in the product yield with each increase in cooking time. Based on cooking yield and sensory attributes, 15 minutes massaging time and cooking time of 40 minutes was considered optimum for product preparation.

Keywords: Restructured buffalo meat steaks; Massaging time; Cooking time; Cooking yield; Sensory attributes

Introduction

India with immense livestock wealth claims a remarkable 58 per cent of the world's buffalo population (106.63 millions) produces 1.42 MT of buffalo meat, accounting for 24.4% of total meat production of the country [1]. As per APEDA [2], only 2% of the total meat is processed in India. So, processing of buffalo meat is essential to exploit its undermined potential. In India, buffalo meat is primarily produced from aged/spent animals (about 12–15 years) after their productive/reproductive life is over. Meat from such aged/spent animals is tough, less juicy, and characterized by high amounts of connective tissue. This coarse textured meat needs to be subjected to special processing and cooking methods to improve tenderness [3]. Thus, the abundantly available low-cost buffalo meat from spent animals has vast potential for production of several value added convenience meat products.

Restructuring of meat products enables the use of less valuable meat components to produce high quality meat products at reduced cost [4]. Therefore, the enhanced use of low-priced cuts and/or raw material from mature animals can be achieved using restructured meat technology. Meat to meat binding in restructured meat products may be achieved through the formation of gels that set thermally (hot-set) or chemically (cold-set). Conventional restructured meat products depend on the hot-set binding of myofibrillar proteins that are extracted from the meat with the combined effects of salt, phosphate and mechanical action [5]. Booren et al. [6] found that there was a significant linear increase in binding strengths till 12 min of mixing at 2°C.

In view of the above considerations, it was proposed to develop novel restructured buffalo meat steaks from spent animals and thus, various processing technologies were standardized in order to improve the palatability and texture of the product.

Source of Buffalo meat

Buffalo meat free from external fat was obtained from rounds of spent adult female buffalo carcass within 5-6 hours after slaughter from meat market of Bareilly. All visible fascia and external fat was trimmed off and meat portions were made into cuts of approximately 0.5 kg. The cuts were then packaged separately in Low Density Polyethylene

(LDPE) pouches and kept in refrigerator ($4 \pm 1^\circ\text{C}$) for conditioning for about 24 hours. Thereafter, the samples were shifted to deep freezer (Blue Star, FS345, Denmark) for storage at $-18 \pm 2^\circ\text{C}$ until further use.

Non-meat ingredients

Spice ingredients were purchased from the local market of Bareilly and freed from extraneous matter. These were dried in hot air oven at 50°C for 4 hours and grounded and sieved through a fine mesh. The different spice ingredients used for preparation of spice mix were mixed in suitable proportion (Table 1). For the preparation of condiments, onion was peeled off, cut into small pieces and homogenized in a mixer to obtain a fine paste. Garlic paste was purchased from the local market of Bareilly.

Preparation of restructured buffalo meat steaks

Chunking: Frozen meat in LDPE packages was thawed (approx. 16 h at $4 \pm 1^\circ\text{C}$, reaching between -3 and -5°C) (Figure 1). The partially thawed meat was carefully trimmed off from adhering visible loose connective tissue and fascia was sliced across the grain into 1cm thick slices. The sliced buffalo meat was then cut along and across to chunks of nearly 1 cm^3 . Temperature of the meat chunks was maintained below 2°C by keeping it immediately in a refrigerator at 0°C after chunking, so as to ensure temperature of meat chunks below 10°C throughout the processing.

Curing solution formulation: The processing of the restructured buffalo meat steaks was done using suitable ingredients in curing solution formulation for restructured buffalo meat blocks (Table 2).

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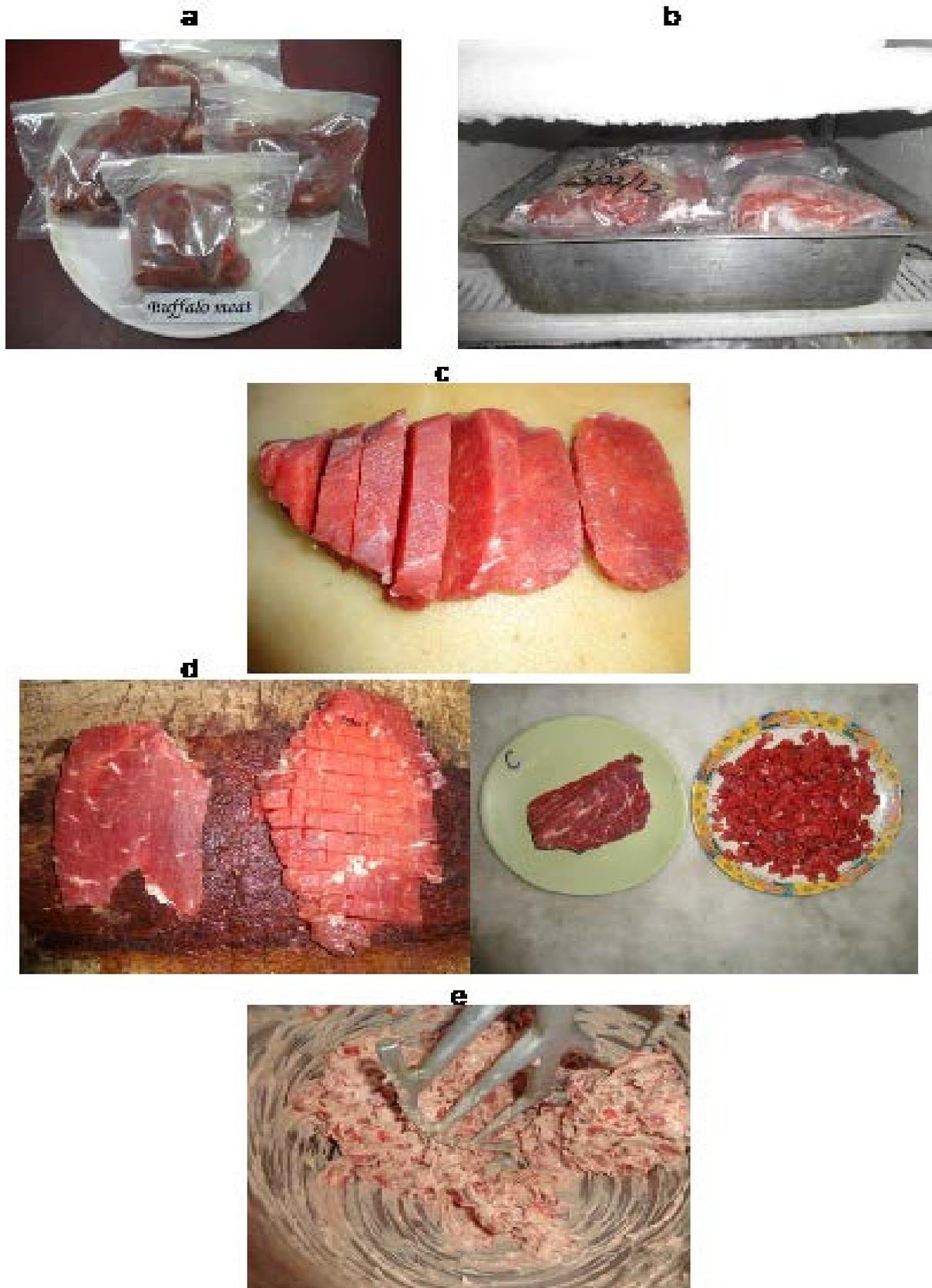


Figure 1: Processing of Buffalo Meat

| Ingredients | Percentage |
|----------------------------|------------|
| Coriander powder (Dhaniya) | 17 |
| Cumin seed (Jeera) | 10 |
| Aniseed (Soanf) | 10 |
| Black pepper (Kalimirch) | 10 |
| Caraway seed (Ajowan) | 10 |
| Turmeric (Haldi) | 10 |
| Dried ginger | 10 |
| Capsicum (Mirch powder) | 8 |
| Cardamom (BadaElaichi) | 5 |
| Cinnamon (Dal chini) | 5 |
| Cloves (Laung) | 3 |
| Nutmeg (Jaibhal) | 1 |
| Lace (Jaipatri) | 1 |
| Total | 100 |

Table 1: Formulation of spice mix used for the preparation of restructured buffalo meat steaks.

| Ingredients | Quantity |
|-------------------------------|----------|
| Sodium chloride(g) | 120.0 g |
| Cane sugar(g) | 60.00 |
| Sodium tripolyphosphate(g) | 25.00 |
| Monosodium glutamate (MSG)(g) | 0.05 |
| Sodium nitrite(g) | 0.75 |
| Water(ml) | 1000.00 |

Table 2: Formulation of curing solution.

In this study, massaging technique was used for the preparation of restructured buffalo meat steaks. The ingredients were dissolved, mixed well and then filtered. 200 ml curing solution was used for massaging of 1 kg of buffalo meat chunks.

Forming to restructured steaks: Meat chunks in semi frozen state were placed in paddle mixture (HOBART, Model: N50G) and massaging was done initially at low speed with simultaneous addition of curing solution which facilitated the extraction of muscle proteins from meat and formed a tacky exudate to bind meat pieces. Then, non-meat additives such as refined wheat flour, spices, and condiments were added in order and concurrently mixed/blended for few minutes at medium speed for uniform mixing. Once each mixing time was achieved, the meat was unloaded from the mixer, weighed and stuffed into stainless steel moulds. Moulds were squeezed with wooden press to remove air pockets.

Once ready, the batter prepared was stuffed in stainless steel moulds which were closed tightly and placed in pressure cooker filled with 1/3 boiling hot water and then cooked by steam without pressure. Slow heating rate was ensured by adjusting the flame regulating knob (Code: 637470, Regalia, Sun flame) to low, so that the required internal temperature 85°C of the product was achieved. The formulation of restructured buffalo meat steaks is given in Table 3.

Experimental plan

Standardization of massaging time for processing of restructured buffalo meat steaks: Three batches, each containing 500 g of buffalo meat chunks (1 cm³) were put in paddle mixer along with other ingredients and respectively massaged for three different timings viz., 10 minutes (7 minutes of initial mixing of meat and non-meat ingredients+3 minutes of additional mixing), 12 minutes (9+3) and 15 minutes (12+3). The mix obtained was stuffed in stainless steel moulds

and cooked by steam without pressure for 45 minutes. Based on the sensory attributes and cooking yield, optimum massaging time was selected.

Standardization of cooking time for processing of restructured buffalo meat steaks: For the standardization of cooking time, 1500 g of buffalo meat chunks were put in paddle mixer along with other ingredients and massaged for fixed time (selected as per above experiment). Mix obtained was stuffed into three different stainless steel moulds and cooked in steam without pressure for three different timings viz., 40 minutes, 45 minutes and 50 minutes. Based on the core temperature, sensory attributes and cooking yield, optimum cooking time was used for further experiment.

Sensory analysis: Sensory evaluation method using an 8 point descriptive scale [7] was followed, where 8= like extremely; 1 = dislike extremely. The sensory panel consisted of seven trained scientists and post graduate students of the division. Three digit coded samples were served to the panelists in random order. They were explained

| Ingredients | Control |
|-------------------------------|---------|
| Lean meat (g/100 g) | 75.00 |
| Curing solution(g/100 ml) | 15.00 |
| Refined wheat flour (g/100 g) | 3.00 |
| Spice Mix(g/100 g) | 2.00 |
| Condiments(g/100 g) | 5.00 |

Table 3: General formulation for restructured buffalo meat steaks.

| Parameters | Massaging time | | |
|----------------------------|---------------------------|---------------------------|---------------------------|
| | 10 min | 12 min | 15 min |
| Cooking yield (%) † | 87.75 ± 0.56 ^b | 87.82 ± 0.65 ^b | 90.18 ± 0.46 ^a |
| Sensory attributes‡ | | | |
| General appearance | 6.80 ± 0.12 | 7.00 ± 0.11 | 6.91 ± 0.13 |
| Flavor | 6.85 ± 0.10 | 6.84 ± 0.11 | 6.85 ± 0.13 |
| Juiciness | 6.80 ± 0.10 | 6.71 ± 0.14 | 6.72 ± 0.14 |
| Texture | 6.94 ± 0.10 | 6.79 ± 0.16 | 6.79 ± 0.14 |
| Binding | 6.80 ± 0.11 | 6.85 ± 0.14 | 6.90 ± 0.13 |
| Overall acceptability | 6.92 ± 0.08 | 6.97 ± 0.10 | 6.91 ± 0.12 |

*Mean values are scores on 8-point descriptive scale where 1: extremely undesirable and 8: extremely desirable. Mean ± SE bearing different superscripts in a row differ significantly (P<0.01) †n=6 and ‡n=21 for each treatment

Table 4: Effect of massaging time on cooking yield and sensory attributes of restructured buffalo meat steaks (Mean ± SE)*.

| Parameter | Cooking time | | |
|----------------------------|---------------------------|---------------------------|---------------------------|
| | 40 min | 45 min | 50 min |
| Cooking yield (%) † | 87.08 ± 0.93 ^a | 83.15 ± 0.90 ^b | 78.53 ± 0.67 ^c |
| Sensory attributes‡ | | | |
| Appearance | 7.05 ± 0.11 | 7.00 ± 0.12 | 7.05 ± 0.11 |
| Flavor | 7.12 ± 0.10 | 7.02 ± 0.10 | 7.15 ± 0.12 |
| Juiciness | 7.22 ± 0.09 ^a | 6.88 ± 0.09 ^b | 6.65 ± 0.10 ^b |
| Texture | 7.00 ± 0.06 ^a | 6.66 ± 0.09 ^b | 6.60 ± 0.09 ^b |
| Binding | 7.04 ± 0.07 | 6.91 ± 0.16 | 6.91 ± 0.19 |
| Overall acceptability | 7.06 ± 0.09 | 7.01 ± 0.11 | 6.92 ± 0.10 |

*Mean values are scores on 8-point descriptive scale where 1: extremely undesirable and 8: extremely desirable. Mean ± SE bearing different superscripts in a row differ significantly (P<0.01) †n=6 and ‡n=21 for each treatment *Mean values are scores on 8-point descriptive scale where 1: extremely undesirable and 8: extremely desirable. Mean ± SE bearing different superscripts in a row differ significantly (P<0.01) †n=6 and ‡n=21 for each treatment

Table 5: Effect of cooking time on cooking yield and sensory attributes of restructured buffalo meat steaks (Mean ± S.E.)*.

about the nature of experiment without disclosing the identity of the samples. Taste panel were organized around 3.30-4.00 pm every time. The sensory panelists were asked to rate their preference on 8 point descriptive scale on the sensory evaluation proforma for general appearance, flavour, juiciness, texture, binding and overall palatability. Potable water was provided to rinse the mouth in between the samples.

Statistical analysis: The statistical design of the study was 4 (treatments) *3 (replications) randomized block design. All physical and chemical determinations were done in triplicate. There were seven sensory determinations for each treatment-replication combination. The data generated from various trials under experiment were pooled, processed and analyzed by statistical method of one way-ANOVA and Mean \pm S.E using SPSS software package developed as per the procedure of Snedecor and Cochran [8]. Duncan's multiple range test [9] and critical difference were determined at the 5% significance level.

Results and Discussion

Massaging

Cooking yield at 15 min (12+3) massaging time was significantly higher ($P<0.01$) than at 10 (7+3) and 12 (9+3) min; however, no significant difference was observed between 10 (7+3) and 12 (9+3) min (Table 4). The result was in agreement with the findings of Lachowicz et al.; Pietrasik et al.; Gurikar et al.; and Moon et al. [10-13] who reported that the products tumbled for a longer time had a lower cooking loss due to increased amount of extractable salt soluble proteins, as compared to those tumbled for a short time. Sensory scores revealed no significant difference ($P>0.05$) between 10 (7+3), 12 (9+3) and 15 (12+3) min massaging time on quality attributes of RBMS; however, the binding scores increased marginally with increased massaging time. It appeared that longer massaging time was required for buffalo meat due to stronger collagen connections and differences in the muscle structure to incorporate brine into the muscle cells and to provide more favorable conditions for protein solubilization, extraction and binding which formed the base of restructuring technology. Booren et al.; Durland et al.; Coon et al. and Noble et al. [14-17] reported that optimal mixing times for restructured meat products varied from experiment to experiment. Thus, on the basis of cooking yield and above considerations, 15 min was taken as optimum for preparation of RBMS and used for further studies.

Cooking time

Mean values of cooking yield with different cooking times viz. 40, 45 and 50 min showed that there was a significant reduction ($P<0.01$) in the product yield with each increase in cooking time (Table 5). The result was in agreement with the findings of Gurikar et al., in restructured pork blocks. The reason for this reduction could be due to a greater degree of shrinkage of the muscle fibers and protein coagulation [18]. The core temperature was recorded at 40, 45 and 50 minutes with the help of probe thermometer. It was found that RBMS attained the core temperature of $83 \pm 2^\circ\text{C}$ within 40 minutes. Sensory scores revealed that there was no significant difference ($P>0.05$) in the scores of general appearance, flavor, binding and overall acceptability between different cooking times. However, there was a significant reduction ($P<0.01$) in juiciness and texture scores at higher time-temperature combinations. The reason for such reduction may be due to increased toughness caused by increased cooking loss and collagen shrinkage at high temperatures. Barbut and Findlay [19] reported that binding of meat chunks in restructured meat products during cooking involved a balance of protein-protein interactions and protein-water

interactions as a result of heat denaturation of proteins. At high time-temperature combinations, balance of these interactions might be affected and influenced the scores of juiciness, texture and structural binding. Hence, optimum cooking time of 40 minutes was selected for further studies in view of higher product yield and sensory attributes including juiciness and texture.

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