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The Quality of Beef Cold Cuts Made of Buffalo Meat

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Abstract

The purpose of study was to evaluate the suitability of buffalo meat for production of different cold meat cuts and to compare its quality with beef. Three value added cold meat cuts products, luncheon, meat loaf and cooked roast beef were produced from beef and buffalo following the Good Manufacturing practices and examined for different quality attributes. The results indicated the presence of slight differences in sensory quality between the products produced with beef and buffalo meat. The main difference was in color and tenderness where beef products were slightly superior to those of buffalo. Results of chemical examination showed that beef products had significantly higher moisture and protein but lower fat, connective tissue and connective tissue solubility than buffalo meat products. The results also showed significant difference in Hunter measurements of color and shear force between the products of both types of meat.

(Keywords: Buffalo, cold cuts, emulsion sausage, beef ham, roast beef)

Introduction

Buffalo meat production is rapidly growing in buffalo producing countries. The world water buffalo (*Bubalus bubalis*) population is 195 million spread worldwide in 129 countries. About 189 million of them found in Asia (97.9%), more than 50% of these buffaloes are found in India. 3.80 million are in Africa, almost entirely in Egypt (3 million), 1.28 million in South America, and 0.39 million in Europe (FAO, 2013). Although buffalo is a potential source of meat, and recently gained importance due to domestic needs (Ziauddin et al., 1994) it is seldom used primarily as meat animal and only slaughtered when reached the end of their useful working life, which resulted in poor meat quality characteristics (Robertson et al., 1983; Naveena et al., 2004).

Although buffalo meat is rated superior to beef (Rao et al., 1986), the meat from aged buffalo is not preferred as table meat because of its toughness and darker colour (Modi et al., 2004). Moreover, rapid increase in price of beef which is the basic raw material in producing further processed meat products as well as higher content of lean meat and lower fat of buffalo meat as well as its good binding properties (Kandeepan et al., 2009) directed meat processors to use of buffalo meat in processed meat.

The increasing costs of beef resulted in a consequent increase of meat products to a level makes many consumers unable to purchase such products especially in under developed and developing countries; a matter which forced many meat processors to replace beef with the lower price buffalo meat. Buffalo meat is used in production of different value-added products such as sausages (Sachindra et al., 2005), loaves (Suresh et al., 2004, Anjaneyulu et al., 2007), burgers (Modi et al., 2004), patties (Suman and Sharma, 2003), salted and cured meat (Paleari et al., 2000, Anjaneyulu et al., 2007) and buffalo corned beef (Karvir, 1985). Studies indicated that production of corned beef from either beef or buffalo resulted in products of nearly the same organoleptic characteristics, however colour of products produced from buffalo have a better appearance due to the white colour of the fat (Karvir, 1985).

The Egyptian market for processed meat products is expanding due to changing the behavior of the consumers. To develop successful value-added products such as luncheon, meatloaf and roasts it is important to understand how type of meat affects the processing characteristics of the finished product. Furthermore, now-a-days most imported meat for processing is from Indian buffalo and at the same time few researches are available on quality of buffalo meat cold cuts, therefore, the present study was performed to develop an acceptable buffalo meat cold cuts and at the same time to compare its quality with those of beef.

Material and Methods

Experimental design

The present study was designed to produce luncheon, corned meatloaf and cooked roast beef from both beef and buffalo. Three independent batches from the three buffalo meat products were produced to follow up the different quality attributes in comparison with those of beef. At each sampling time, three pieces from each product were sampled and each test was performed three times from each piece.

Meat and additives

Imported deep frozen chuck (for luncheon) and topside (for meatloaf and cooked roast) were purchased from a local store within the first third of its shelf life. Sodium chloride, sodium tripolyphosphate, spices oleoresins, starch, soy isolate and sodium nitrite were purchased from local distributers.

Production of luncheon batter

Both beef and buffalo luncheon were produced following the Good Manufacturing Practice guidelines established by the Egyptian Standard Specifications No. 1114/2005. Immediately before luncheon production, frozen chucks were firstly flaked, and then minced with Seydelmann meat grinder (Germany) using 5 mm plates. Minced meat was firstly chopped using Seydelmann bowel cutter (Germany) for short time with sodium chloride, sodium tripolyphosphate, spices and sodium nitrite before cold water was added and finally the starch was added at 1°C. After that, meat batter was mixed to a final batter temperature of 8°C. All prepared batters were filled into polyamide casing using piston filler and cooked using humid cooking program of 90°C room temperature to 72°C core temperatures. Cooked luncheon was then cooled and kept at refrigerator at 4°C till investigation.

Production of corned meatloaf

Both beef and buffalo corned meatloaf was formulated and processed following the procedure described by Koch (1986). Frozen meat blocks were completely thawed at 10°C and then trimmed from all visible fat and connective tissue, then chopped into small chunks. Chunked meat was divided into two portions chopping about ¼ in the bowl cutter with water, ice, all spices for short time. After that, the rest of meat was added and only mixed with the first part to not more than zero °C. Prepared batters were tumbled separately for 6 hours, then filled in vacuum bag casing and pressed in rectangular former to form its shape, and cooked using humid cooking program at 90°C room temperature to 73°C core temperature followed by dry cooking for 3 min. The product was finally cooled and smoked then kept at refrigerator at 4°C till investigation.

Production of cooked roast beef

Thawed silverside meat blocks were injected with the previously prepared brine following the Good Manufacturing Practices Guidelines established by Koch (1986) using multi needle brine injector machine. Each meat block was injected four times with the brine solution. Injected meat blocks were tumbled for 8 hours, and finally cooked. Cooking program started with dry cooking for 45 minutes at 65°C, smoking for 15 minutes at 65°C, dry cooking for 3 minutes at 70°C, steam cooking till 73°C core temperature, and finally dry cooking for 15 minutes at 80°C. After that the product was cooled and kept at refrigerator at 4°C till investigation.

Investigations

Sensory evaluation

Sensory panel analysis was performed by 9 panelists from the members of Food Hygiene and Control Department, Faculty of Veterinary medicine, Cairo University using a 8-point scale (where 8 denote extremely acceptable and 1 denotes extremely unacceptable). Prior to the analysis panelists were trained in the definition and intensities of all investigated sensory parameters. All samples were randomly coded and the panelists were asked to score the samples according to the protocol of the American Meat Science Association (AMSA, 1995). Both luncheon and meatloaf samples were evaluated for binding, emulsion, color, flavor, juiciness, tenderness and overall acceptability, while cooked roast beef samples were evaluated for cured color, color uniformity, juiciness, tenderness, flavor and overall acceptability.

Proximate chemical analysis

Each Sample was rendered into uniform mass by passing three times through a meat mincer and mixed thoroughly after each mincing time. Proximate chemical composition of each replicate was determined according to (AOAC, 1995). For determination of moisture content, 10 g of sample were dried at 100°C until a constant weight was obtained. Protein content was determined according to the Kjeldahl method of analysis. Fat was determined by six-cycle extraction with petroleum ether in a Soxhlet apparatus and calculating the weight loss. Ash was determined by ignition at 500°C for 5 hours.

Physicochemical examination

pH value

Five grams from each replicate were homogenized with 20 ml distilled water for 10-15 second, and the pH of the slurry was measured using digital pH meter (Lovibond Senso Direct) with a probe type electrode (Senso Direct Type 330) where three reading for each sample were obtained and the average was calculated. The meter was calibrated every two samples using two buffers 7.0 and 4.0.

Instrumental texture evaluation

For each replicate, nine portions measured 2×2×2 cm were used for analyzing the shear force, where six scores of 0.5 inch diameter were removed parallel with the sliced surface. Sample cubes were hooked to the testing machine and shear force was estimated as the shear force machine was adjusted at crosshead speed of 200 mm/minutes using an Instron model 2519-105 (USA) according to the procedure outlined by Honikel (1998).

Color evaluation

Color measurement of each replicate was assessed using a Cromameter (Konica Minolta, model CR 410, Japan). The chromameter was calibrated for light source index setting before color measurements using a white plate and light trap supplied by the manufacturer. The average score for each sample was recorded in Hunter L* value (lightness) and chromaticity coordinates a* (redness) and b* (yellowness).

Measurement of collagen content

Soluble and insoluble collagen content of samples was determined according to the procedure of (Nueman and Logan, 1950) and *(Mahendrakar et al., 1988)*. Two from each replicate were hydrolyzed with 40 ml of 6 N HCL in a hot air oven at 105°C for 18 hours, and then filtered, adjusted to 50 ml with distilled water. pH of aliquot was adjusted to 7.0. One ml from the obtained aliquot was mixed with one ml each of 0.001 M copper sulfate, 2.5 N NaOH and 6% H_2So_4. After mixing, the tubes were kept at room temperature for 5 minutes, heated at 80°C for 5 minutes in water bath, then cooled in ice, and 4ml of 3N H_2So_4 and 2 ml of 5% 4-Dimethylaminobenzaldehyde in n-propanol were added. Tubes were then heated again at 70°C for 16 minutes in water bath. Absorbance of the test sample was measured at 540 nm against blank. Hydroxyproline (g/100 g) was estimated using the equation outlined by (Woessner, 1961).

Collagen solubility%

Five grams of each replicate were heated to boiling temperature and held for 30 minutes. Sample was then cut into small pieces and homogenized with 50 ml distilled water at 4±1 °C in a blender for 2 minutes. The extract was then centrifuged at 1500 rpm. for 30 minutes. Aliquots of cooked out juice were hydrolyzed for 18 hours and soluble hydroxyproline was calculated (Mahendrakar et al., 1989) as in collagen content. Collagen solubility percentage was expressed as percent of collagen solubility to collagen content.

Statistical analysis

Each analysis was run in three replicates, and collected data were analyzed using SPSS statistics 17.0 for windows. Results were recorded as mean ± SE. Analysis of variance was performed by T-test procedure to compare results among the different species by the least significant (LSD) and significance was defined at $P> 0.05$.

Results and Discussion

As established by many authors buffalo meat is comparable to beef in many of its physicochemical, nutritional and functional properties and sensory attributes (Robertson et al., 1983; Kandeepan et al., 2009). Furthermore, its use in meat processing is increasing because of its higher content of lean meat and lower fat. This dark meat possesses good binding properties and is useful in product manufacture (Kandeepan et al., 2009). Therefore, it is a matter of interest to explore its use on quality characteristics of cold meat cuts.

Luncheon is widely accepted product by Egyptian consumers because of its characteristic sensory properties specially texture and flavor. Both the raw material and the technological process used in making luncheon influence the sensory quality of the end product. The sensory quality of luncheon is judged based on its texture, flavour and appearance. The sensory panel analysis (Table 1) clearly indicated that beef luncheon generally rated higher but non-significant scores for all sensory attributes. However, color and overall acceptability were the only sensory parameters, which were significantly differing between both types.

Sensory panel analysis indicated that corned meatloaf produced from buffalo meat and from beef were indistinguishable in their organoleptic characteristics except for color, tenderness and overall acceptability which were significantly lower in buffalo meatloaf a matter which was also substantiated by the results of color evaluation (Table 2). However, Karvir (1985) rated corned beef produced from buffalo meat a better appearance and attributed this to the white color of the fat.

Moreover, sensory examination of cooked roast beef produced with both beef and buffalo meat revealed non-significant differences between both types in all sensory attributes except for cured color with slight better quality of the former. Since, the desirable quality of roast beef depends upon the interior bright red color, juiciness and tenderness (Food Safety and Inspection Service, USDA, 1983), therefore the obtained results can safely established the use of buffalo meat in production of cooked roast beef without adverse effect in its characteristic sensory quality.

Data of pH analysis in table (2) revealed the presence of significance difference ($P<0.05$) between luncheon and cooked roast produced with beef and buffalo meat, however, no significant difference was reported in corned meat loaf, such differences could be attributed to the difference in pH between beef and buffalo meat. pH value is the most important physicochemical characteristic to decide the quality and shelf life of cooked buffalo meat products (Khan and Ahmad, 2015). Froning and Neelakantan (1971) found that pH of meat was significantly correlated with the ability of a raw material to emulsify fat and moisture. Moreover, Hwang and Carpenter (1975) established that increasing the pH of a meat could reduce shrinkage loss and shear force.

Chemical composition of luncheon, meat loaf and cooked roast beef produced from both beef and buffalo meat were reported in Table (2). Moisture and protein contents were significantly ($P< 0.05$) higher, whereas, fat content were lower in all the three products produced with beef than those produced with buffalo meat. However, ash was not significantly differing between the products of the types of meat. These results are satisfactory for good quality products in term of composition and comply with the Good Manufacturing Practices. The results also showed that buffalo products had significantly ($P<0.05$) higher connective tissue content and lower connective tissue solubility percent than that of beef an matter which may explain the lower tenderness sensory panel scores and higher shear force of buffalo meat products.

The pH before cooking significantly affected Hunter L, and b values of all products, where buffalo meat with higher pH had significantly lower L and b values than the lower pH beef, however, redness values were higher in the buffalo meat which could be due to higher total pigments and myoglobin content (Valin et al., 1984; Spanghero et al., 2004). The obtained results were correlated with data of sensory analysis which declared that buffalo meat products had significantly lower color score and consequently lower overall acceptability than beef products because quality of meat products depends basically on colour, appearance and texture, which colour is the most important attributes for product preference.

Shear force differences among products produced with beef and buffalo meat are evaluated in Table 2. Results clearly showed that beef luncheon, beef meat loaf and cooked roast beef had significantly higher shear force values in comparison with those produced with buffalo meat. Such data were substantiated with sensory panel scores (table 1) which showed that panelists rated buffalo meat as tougher than beef. The lower sensory tenderness scores, higher shear force and lower tenderness of buffalo meat products could be attributed to its higher connective tissue content (Spanghero et al., 2004).

Table (1): Sensory analysis of beef and buffalo meat cold cuts

	Luncheon		Corned meat loaf		Cooked roast beef	
	Beef	Buffalo	Beef	Buffalo	Beef	Buffalo
Cured Color	ND	ND	ND		6.33±0.33ᵃ	5.67±0.33 ᵇ
Color Uniformity	ND	ND	ND		6.67±0.33ᵃ	6.33±0.33ᵃ
Binding	6.00±0.01 ᵃ	5.33±0.33ᵃ	6.00±0.58ᵃ	6.00±0.06ᵃ	ND	ND
Emulsion	6.33±0.33ᵃ	5.33±0.33ᵇ	6.00±0.3ᵃ	5.33±0.33ᵃ	ND	ND
Color	6.67±0.33ᵃ	5.33±0.33ᵇ	6.00±0.3ᵃ	5.17±0.58ᵇ	ND	ND
Flavor	7.00±0.02ᵃ	6.67±0.33ᵃ	6.00±0.03ᵃ	6.00±0.58ᵃ	7.00±0.10ᵃ	6.67±0.33ᵃ
Juiciness	6.33±0.30ᵃ	6.00±0.58ᵃ	5.67±0.05ᵃ	5.33±0.58ᵃ	7.00±0.20ᵃ	6.33±0.33ᵃ
Tenderness	7.00±0.03 ᵃ	6.00±0.58ᵇ	6.67±0.3ᵃ	5.33±0.67ᵇ	7.00±0.22ᵃ	7.00±0.33ᵃ
Overall Acceptability	6.56±0.05 ᵃ	5.61±0.34ᵇ	5.95±0.15 ᵃ	5.11±0.43ᵇ	6.80±0.12ᵃ	6.40±0.12ᵃ

*a-b= Means with different letters for each product are significantly different at p value ≤ 0.05.

Table (2): Chemical and physicochemical parameters of beef and buffalo meat cold cuts

	Luncheon		Corned meat loaf		Cooked roast beef	
	Beef	Buffalo	Beef	Buffalo	Beef	Buffalo
pH	6.33±0.003 ᵃ	6.61±0.01ᵇ	6.57±0.03ᵃ	6.62±0.01ᵃ	6.20±0.01ᵃ	6.40±0.01ᵇ
Moisture%	65.02±0.22 ᵃ	64.04±0.03 ᵇ	70.70±0.06 ᵃ	69.61±0.69 ᵇ	72.56±1.70ᵃ	71.81±1.41ᵇ
Protein%	13.51±0.62 ᵃ	13.22±0.42 ᵃ	16.22±0.08ᵃ	15.72±0.28ᵃ	18.75±0.58ᵃ	16.98±0.56ᵃ
Fat%	14.19±1.57 ᵃ	14.27±0.08 ᵇ	5.45±0.10ᵃ	6.26±0.78ᵇ	3.30±1.38ᵃ	3.88±1.38ᵃ
Ash%	3.65±0.26 ᵃ	3.79±0.16 ᵃ	3.18±0.04ᵃ	3.16±0.20ᵃ	3.70±0.04ᵃ	3.66±0.17ᵃ
Collagen content%	0.76±0.14ᵃ	0.92±0.01ᵃ	0.55±0.33ᵃ	0.76±0.07ᵃ	2.06±0.02 ᵃ	2.17±0.06ᵃ
Collagen solubility	0.24±0.02ᵃ	0.02±0.04ᵇ	0.46±0.28ᵃ	0.29±0.09ᵃ	1.52±0.01ᵃ	0.06±0.03ᵇ
Collagen solubility %	35.95±9.91ᵃ	1.99±0.40ᵇ	82.32±6.80ᵃ	37.95±12.83ᵇ	73.77±0.18 ᵇ	2.71±1.25 ᵃ
Lightness L*	56.74±0.05ᵃ	49.43±0.01ᵇ	43.08±0.01ᵃ	42.90±0.35ᵃ	45.26±4.84ᵃ	46.38±1.73ᵃ
Redness a*	14.65±0.01ᵃ	15.83±0.03ᵇ	20.77±0.02ᵃ	23.64±1.05ᵇ	15.02±0.15ᵃ	16.30±0.07ᵇ
Yellowness b*	14.76±0.01ᵃ	14.53±0.001ᵇ	11.77±0.01ᵃ	10.91±0.081ᵇ	16.21±2.09ᵃ	15.63±2.72ᵃ
Shear force	3.00±0.000ᵃ	4.12±0.001ᵇ	6.25±0.000ᵃ	7.25±0.375ᵇ	7.07±0.061 ᵃ	9.29±0.01ᵇ

*a-b= Means with different letters for each product are significantly different at p value ≤ 0.05.

Conclusion

From the obtained results it could be concluded that buffalo meat can be used for production of different value added meat products as luncheon, meat loaf and cooked roasts without detrimental impact in its quality attributes and the slight decrease in its tenderness and color as well as its higher connective tissue content does not make a serious problem for the overall quality of such products.

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الملخص العربي

جوده اللحوم البارده المصنعه من لحم جاموسي

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إن الهدف من الدراسة تقييم مدي ملائمه اللحم الجاموسي لإنتاج انواع مختلفه من اللحوم البارده ومقارنه جودتها باللحوم البقري. تم تصنيع ثلاثه منتجات من اللحوم البارده (اللانشون ولحم بقر جاهز مدخن و بيف بيكون) طبقا للممارسات التصنيعيه الجيده وإختبارهم لمقاييس الجودة المختلفه. اشارت النتائج إلي وجود اختلافات طفيفه في الخواص الحسيه بين المنتجات المصنعه من لحم جاموسي ومثيلتها المصنعه من اللحم البقري. وكان الإختلاف الرئيسي في ارتفاع درجه اللون ودرجه الطراوة للمنتجات البقري عن الجاموسي . واظهرت نتائج الفحص الكيميائي ارتفاع نسبه الرطوبة والبروتين وانخفاض نسبه الدهن والألياف الضامه ودرجه ذوبان الألياف الضامه للحم البقري عن اللحم الجاموسي. وكذلك اظهرت النتائج اختلاف واضح في قياسات جهاز هانتر لدرجه اللون و قوة الشد بين المنتجات من كلا النوعين من اللحوم.