



PHYSICO-CHEMICAL PROPERTIES AND ECONOMICS OF BARBECUED PORK

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ABSTRACT

A study was planned to develop barbecued pork utilizing pork lean meat and further replacing the lean meat with pork head and tongue meat (2:1) at 25% level and to assess their comparative quality. Preliminary trials were conducted to standardize the barbecuing procedure and dry marinade/spice mix for preparation of barbecued pork. The minced meat was restructured into a cylindrical shape and sliced followed by barbecuing in a prestige barbecue oven with basting of the product with barbecue sauce at definite interval. The physico-chemical, sensory attributes and economics for the preparation of the two types of barbecued pork were assessed. There was no significant difference ($P>0.05$) in pH value, TBARS value and sensory scores between barbecued pork prepared from 100% lean meat and by replacing 25% pork lean meat with head and tongue meat @ 2:1, whereas a highly significant difference ($P<0.01$) was observed in cooking yield value between the two. The barbecued pork prepared from lean meat had highly significant difference ($P<0.01$) for lightness value (L^*) when compared with barbecued pork prepared by replacing 25% pork lean meat with head and tongue meat @ 2:1. But no significant difference ($P>0.05$) was observed for redness (a^*), yellowness (b^*), hue and chroma values between the two. The cost of production of barbecued pork prepared by replacing 25% lean meat with head and tongue meat (2:1) was much lower than the barbecued pork prepared from 100% lean meat.

KEY WORDS Barbecued pork, head, tongue, economics

INTRODUCTION

India is an agricultural country with a huge number of livestock populations. The livestock sector alone contributes nearly 25.6% of the total value of output at current prices in agriculture, fishery and forestry sector. The overall contribution of the livestock sector in total GDP was nearly 4.11% during 2012-13. According to the 19th Livestock Census, the total pigs in the country were 10.29 million numbers in 2012 (GOI, 19th Livestock census, 2012).

Pig rearing is an important occupation of rural society especially among the tribal masses of India. Pig production, among other species has a huge potential to contribute to high economic gain because they have advantages like high fecundity, high feed conversion efficiency, early maturity, relatively small space requirement etc. They are providing about 40% of meat consumed in the world market (NRC on Pig, 2011). The products obtained from pig ranges from primary commodities such as pork, to processed foods such as sausage, smoked ham to cooked salted ears, eaten as snack food (Dietze, 2011). Consumption of pork in India is mainly concentrated in North-Eastern states including Nagaland, Assam, Arunachal Pradesh, Manipur, Meghalaya, Mizoram, Sikkim, and Tripura (USDA Gain Report Number: IN6098, 2016).

The present disposal pattern/method in the commercial meat processing is rendering for production of carcass meal and fertilizer whereas in small scale processing, the byproducts are either consumed directly or are disposed of by dumping in water bodies or in free lands, which

ultimately leads to environmental pollution and spread of diseases. Making better use of many of the byproducts arising from meat processing is important from a sustainability perspective and also offers opportunities to the industry to increase the value of their product. Encouraging optimal utilization of raw materials, early in the production chain, can help ameliorate food waste losses (Mullen *et al.*, 2017). The consumption of traditional smoked meat and meat products are very common in North-east region of India. Many restaurant and street vendors use to sell roasted or grilled meat/chunks of meat which are greatly relished by the people of this region. Barbecued pork were prepared by cooking with dry heat indirectly, resulting from the burning of a charcoal or hard wood. Barbecue is a technique of cooking, a party and sometimes the food cooked in this manner itself is known as barbecue. The main difference between grilling and barbecuing is that grilling is done directly over the heat source while barbecuing uses indirect heat (Cumbay and Schneider, 2008). Restructured product helps in preparation of value added products and facilitates marketing of low value meat and has characteristics somewhere between ground meat and intact muscle steaks (Gadekar *et al.*, 2015).

In light of the above facts this study was planned initially to standardize the preparation of barbecued pork using lean meat and then prepare a value added barbecued pork incorporating 25% pork head and tongue meat (Head: Tongue meat @ 2:1) and to compare the differences in their quality, if any.

MATERIALS & METHODS

Pork, head and tongue meat Fresh pork, head and tongue meat were collected in hygienic manner from the pigs slaughtered scientifically in the Department of Livestock Products Technology (Meat Science), Madras Veterinary College, Chennai. The visible connective tissue from the lean meat and head meat was removed manually. The surface epithelium of the tongue was scrapped off thoroughly. The meat was then packed in low-density polyethylene (LDPE) bags separately and stored in the freezer (-18±1°C) till further use.

Dry marinade/Spice mix The ingredients viz. salt, pepper powder, chilli powder, coriander powder, cumin powder, ginger, garlic and onion used for preparing dry marinade were procured from the local market. All the ingredients except ginger, garlic and onion were stored in PET (polyethylene terephthalate) bottle for subsequent use.

Barbecue sauce The barbecue sauce was purchased from online store which contains the following ingredients viz. corn syrup, distilled vinegar, water, tomato paste, molasses, apple cider vinegar, modified corn starch, salt, 2% or less of natural hickory and mesquite smoke flavours, mustard flour, spices (black pepper, ginger, bay

leaf), caramel colour (E 150), dried garlic, dried onions, paprika and potassium sorbate as a preservative.

Product preparation Preliminary trials were conducted to standardize the barbecuing procedure and dry marinade/spice mix for preparing restructured barbecued pork. Restructuring of the meat was done as per the method described by Sudheer *et al.*, (2011) with slight modification. Meat was minced in a meat mincer after thawing overnight in a refrigerator, using 4.5 mm plate (Model No. TS 12, Omas Food Machinery, Italy). The standardized dry marinade along with binder (refined wheat flour) and water were added based on the raw weight of the meat and massaged manually for 15 to 20 minutes. It was filled in a cylindrical mould with a diameter of 6.5 cm and covered with a food grade aluminium foil and pressure cooked for 30 minutes and kept overnight in a refrigerator (4±1°C) for setting followed by slicing into a cylindrical shape with average height of 0.6 cm and diameter of 6.3 cm respectively. The resultant product was barbecued by using charcoal barbecue oven (Prestige) indirectly. During the barbecuing process the product was basted with barbecue sauce twice in between. The standardized procedure and dry marinade were presented in Table 1 and 2 respectively.

TABLE 1: Standardised dry marinade for preparing barbecued pork

S. No	Ingredients	Percentage based on the raw weight of meat (w/w)
1.	Salt	2
2.	Pepper	0.5
3.	Chilli powder	0.5
4.	Coriander powder	0.5
5.	Cumin powder	0.5
6.	Ginger	1.5
7.	Garlic	3
8.	Onion	2
9.	Refined flour (Maida)	4
10.	Water	4

TABLE 2: Standardised barbecuing procedure

Distance between meat and charcoal grill rack	5.8 cm
Distance of meat away from the charcoal	5.0 cm
Time for barbecuing	1 hour and 30 minutes
Turning of the product	In between every 10 minutes
Basting with barbecue sauce	Twice
Product dimension	Height= 0.6 cm Diameter= 6.3 cm

Similar procedure was followed for preparing value added barbecued pork by replacing pork lean meat with a combination of pork head and tongue meat (2:1) at 25% level.

pH The pH of barbecued pork was determined by adopting the method of AOAC (1995). About 5g of sample was homogenised with 45 ml of distilled water in a Waring

laboratory blender (Waring Laboratory Science, Connecticut, USA) for 1 minute. Then pH of the homogenate was recorded by immersing combined glass electrode of the pH meter (Cyberscan pH 510, Merck).

Cooking yield The weights of the product were recorded before and after cooking. The cooking yield was calculated and expressed in percentage as follows.

$$\text{Cooking yield (\%)} = \frac{\text{Weight of the product before barbecuing}}{\text{Weight of the product after barbecuing}} \times 100$$

Instrumental colour analysis Colour of barbecued pork was measured using Hunter lab Mini scan XE plus Spectro-colorimeter (Model No. 45/O-L, Reston Virginia,

USA) with geometry of diffuse/80 (sphere - 8mm view) and an illuminant of D65/10 deg (Bindu *et al.*, 2007). The instrument was calibrated with black and white tile (L* =

94, $a^* = 1.10$ and $b^* = 0.6$) every time before the colour measurement was taken. The colour was expressed as L^* (brightness), a^* (redness) and b^* (yellowness). The hue (relative position of colour between redness and yellowness) and chroma (colour intensity) was calculated as follows.

$$\text{Hue} = \tan^{-1} (b^*/a^*)$$

$$\text{Chroma} = \frac{1}{\sqrt{(a^*)^2 + (b^*)^2}}$$

TBARS value Thiobarbituric Acid Reactive Substances (TBARS) of barbecued pork was determined following the method of Tarladgis *et al.* (1960) and the value obtained were reported as mg of malonaldehyde/ kg of sample.

Sensory evaluation Sensory panel consisting of the Faculty and Post graduate students of the Department of Livestock Products Technology (Meat Science) evaluated the barbecued pork for its sensory characteristics. Barbecued pork were evaluated for appearance, flavour, texture, juiciness and overall acceptability by a semi-

trained taste panel using a nine point hedonic scale as given in the score card. Sensory analysis was conducted in morning session every time and plain water was provided to all panelists to rinse the mouth in between the samples.

Economics The economics of barbecued pork was calculated out by taking into account of the cost of pork lean meat, pork head meat, ingredients used in marinade preparation and labour charge for processing of meat after slaughter.

Statistical analysis Six trials were conducted and data obtained were analyzed statistically using Independent Sample t-test (Snedecor and Cochran, 1967) to see the effect of raw materials on quality of restructured barbecued pork.

RESULTS

The results of physico-chemical analysis, sensory evaluation and cost economics of barbecued pork were presented in Table 3 and 4 respectively.

TABLE 3: Quality of barbecued pork

Parameter	Barbecue pork prepared from 100% lean meat	Barbecued pork prepared by replacing 25% pork lean meat with head and tongue meat @ 2:1
Physico-chemical		
pH	6.04 ± 0.10	6.12 ± 0.07
Cooking yield	68.20 ± 0.15 ^a	67.52 ± 0.06 ^b
Instrumental colour analysis		
L^*	37.18 ± 0.16 ^a	35.53 ± 0.18 ^b
a^*	14.05 ± 0.49	13.90 ± 0.63
b^*	16.17 ± 0.86	14.42 ± 0.56
Hue	53.85 ± 1.40	50.92 ± 1.23
Chroma	21.52 ± 0.86	20.09 ± 0.55
TBARS value	0.36 ± 0.01	0.41 ± 0.02
Sensory attributes		
Appearance	7.46 ± 0.10	7.33 ± 0.08
Flavour	7.40 ± 0.09	7.33 ± 0.08
Texture	7.43 ± 0.10	7.36 ± 0.08
Juiciness	7.10 ± 0.10	6.93 ± 0.10
Overall acceptability	7.43 ± 0.09	7.26 ± 0.08

n= 6, Means bearing different superscripts (a and b) along the row differ significantly (P<0.01)

TABLE 4: Cost of production of barbecued pork (calculated out for 1kg)

S. No	Barbecued pork prepared from 100% lean meat	Cost (in Rs)	Barbecued pork prepared by replacing 25% pork lean meat with head and tongue meat @ 2:1	Cost (in Rs)
1.	Pork lean meat	300	Pork lean meat	225
2.	-	-	Low value meat	50
3.	Salt	0.36	Salt	0.36
4.	Cumin powder	3.2	Cumin powder	3.2
5.	Pepper powder	8.5	Pepper powder	8.5
6.	Coriander powder	1.9	Coriander powder	1.9
7.	Chilli powder	1.8	Chilli powder	1.8
8.	Binder (Maida)	2	Binder (Maida)	2
9.	Onion	0.4	Onion	0.4
10.	Ginger	0.9	Ginger	0.9
11.	Garlic	2.4	Garlic	2.4
12.	Labour charge (Rs 313/day)	40	Labour charge (Rs 313/day)	40
13.	Total	361.10	Total	336.46

Statistical analysis revealed no significant difference (P>0.05) in pH value, TBARS value and sensory scores

between barbecued pork prepared from 100% lean meat and by replacing 25% pork lean meat with head and

tongue meat @ 2:1 whereas a highly significant difference ($P < 0.01$) was observed in cooking yield value between the two. The barbecued pork prepared from lean meat had highly significant difference ($P < 0.01$) for lightness value (L^*) when compared with barbecued pork prepared by replacing 25% pork lean meat with head and tongue meat @ 2:1. But no significant difference ($P > 0.05$) was observed for redness (a^*), yellowness (b^*), hue and chroma values between the two. The cost of production of barbecued pork prepared by replacing 25% lean meat with head and tongue meat (2:1) was much lower than the barbecued pork prepared from 100% lean meat.

DISCUSSION

The results obtained for pH were in agreement with Sudheer *et al.* (2011) who reported that there was no significant increase in pH of restructured chicken block when the level of gizzard increased from 0 to 40% in the product formulation. Akharaiyi and Isunu (2015) also reported a pH value of 6.2 for self prepared barbecued goat meat, while for purchased ready to eat barbecued goat meat; they reported a higher pH value (6.5).

The barbecued pork prepared by replacing 25% lean meat with head and tongue meat had lower cooking yield. Similarly Sudheer *et al.* (2011) reported that increasing the level of gizzard in the product formulation decreased the cooking yield and Choi *et al.* (2016b) also reported that cooking yield decreased (90.35% to 83.74%) as the level of pork head meat increased from 0% to 20% in pork hamburger patties.

The lightness value (L^*) decreased except redness (a^*), yellowness (b^*), hue and chroma values when the pork barbecue was prepared by replacing 25% lean meat with head and tongue meat. Similar findings for lightness (L^*), redness (a^*) and yellowness (b^*) has been reported by Choi *et al.* (2016a) and Choi *et al.* (2016b) for pork frankfurters and hamburger patties that was prepared by replacing pork meat at the level of 0, 5, 10, 15 and 20% with pork head meat. The non significant difference observed for redness (a^*), yellowness (b^*), hue and chroma except for lightness (L^*) might be due to basting of the product with barbecue sauce during the barbecuing process.

The TBARS value of barbecued pork prepared from 100% lean meat and by replacing 25% pork lean meat with head and tongue meat @ 2:1 were 0.36 ± 0.1 and 0.41 ± 0.2 mg of malonaldehyde/kg of barbecued pork respectively. Similar findings were reported by Sudheer *et al.* (2011) for restructured chicken block incorporated with 40% gizzard on 0th day and Cheng *et al.* (2007) for salted pork patties on 0th day. While Tokur, (2007), Turhan *et al.* (2011) and Lorenzo *et al.* (2015) reported higher TBARS value of barbecued rainbow trout, grilled anchovy (*Engraulis encrasicolus*) fillets and grilled foal meat and attributed the increase in TBARS value due to higher polyunsaturated fatty acids (PUFA) present in the meat. The lower TBARS value obtained for barbecued pork might be due to the indirect way of cooking, slow heating process and basting with barbecue sauce might have acted as a hurdle for lipid oxidation process.

Sensory scores showed no difference between the two groups of barbecued pork. Comparable findings had been reported by Sudheer *et al.* (2011), while Choi *et al.*

(2016a) and Choi *et al.* (2016b) reported that the best result was obtained for their product when 10% pork head meat was used to replace pork meat. The higher score for all the sensory attributes of barbecued pork obtained might be due to removal of visible connective tissue.

The formulation cost of barbecued pork can be further reduced if the product is prepared in a larger quantity.

The result of this study indicates that barbecued pork can be prepared by replacing 25% lean meat with head and tongue meat without affecting the sensory characteristics, TBARS value, pH of the product; it also reduces the cost of product and helps in better utilization of slaughterhouse byproducts.

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