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Effect of Processing Method on the Quality Characteristics of Edible Cowhides (*Ponmo*)

[*1]Arisa N. U., [2]Igbokwe C. C. and [1]Muyibi N. A.
[1]Department of Chemical and Food Sciences,
Bells University of Technology, Ota Ogun State, Nigeria
[2]Abia State University, Uturu Abia State, Nigeria
*Corresponding author's email: nuarisa@bellsuniversity.edu.ng

Abstract
Cowhides commonly referred to as *Ponmo* (Yoruba), *Kanda* (Hausa) and *Akpupoanu* (Igbo) are relished in several parts of Africa. Fresh cowhide with fur (9064g) was dipped in 10000 ml hot water (85oC for 30seconds) or placed in a fire made by burning wood until the hair was charred. Hair on the skin was carefully scraped off with a sharp new stainless steel razor blade or charred hair was scrubbed off with an iron sponge under running water. Using standard procedures, *Ponmo* was analyzed for proximate, mineral, amino acid profile and microbiological characteristics. Results showed that the protein content of the edible hides and skin (cow) produced using the different processing methods varied from 5.38% (brown *ponmo*-singed market-bought) to 7.34% (white *ponmo*-lab processed). The crude fibre content of the edible hides and skin (cow) produced using the processing methods varied from 3.5% (brown *ponmo*-singed market-bought) to 3.75% (white *ponmo*-lab processed (control)). The amino acid profile of the *ponmo* samples was lower than beef's. Market-bought *ponmo* (Brown) had a microbial load of $2.5x10^6$ cfu/ml, Lab-Processed *ponmo* (Brown) had 1.7 $x10^6$ cfu/ml and the Market-bought *ponmo* (White) had a microbial load of $2x10^6$ cfu/ml.

Keywords: Cowhides, processing methods, nutritional quality, and microbiological characteristics

Introduction
Dehaired edible cowhides, locally referred to as *Ponmo* (Yoruba), Kanda (Northerners), Akpupoanu (Igbos) and Welle (Southern part of Ghana) are delicacies in several parts of Africa (Tijani and Ajayi, 2016). Consumption of *Ponmo* was associated with poverty, but now both the poor, rich, educated and uneducated find it enjoyable to eat (Adeyeye *et al*., 2015). Removal of furs from cows, goats and sheep hides and other animals in Nigeria is traditionally done by singeing and smoking the hides or softening them with hot water, followed by scrapping off the fur with a sharp knife or razor blade (Okiel *et al*., 2009). Edible cowhides (*ponmo*), are classified based on the mode of processing or colour. The processing method may entail soaking the animal hides in hot water and shaving off the hair with a blade or a very sharp knife (cowhides prepared in this way come out creamy-white) or by burning off the hair on the hide followed by scrubbing off charred hair with a hard scrubbing brush. The hide is then washed and softened by boiling for up to 4 h. In Nigeria and other African countries where *ponmo* is consumed, singeing is preferred because it makes them taste like meat (FAO, 1995).

In Nigeria, most of the hides consumed come from the north so they are usually dried by the processors. The marketers (usually women) procure the dried hides and rehydrate them before selling. It has been said that they add quantities of sodium hydroxide and potash to the

steep water and leave the hides to soften for days, thereby causing a form of fermentation to take place in the hide, resulting in a characteristic odour associated with brown *ponmo*. Again, consumers have different beliefs about the nutritional content of *ponmo*. It is generally believed that they are very low in nutrients or have no nutritional value. Hence, the name "show boy" is given to it. This work, therefore, aimed at determining the effects of processing methods on the nutritional and microbiological compositions of *ponmo*.

Materials and Methods

Dehairing with hot water

Fresh cowhides with fur (9064g) were dipped in 10000ml of water at 85oC in a 20000 ml stainless steel bowl for 30 seconds. Hair on the skin was carefully scraped off with a sharp new razor blade, washed thoroughly with clean water, drained and stored in a Haire thermocool deep freezer for subsequent processes.

Singeing

Fresh cowhides with fur (9060g) were placed in a fire made by burning firewood until the hair on it was charred. The charred hair was scrubbed off with an iron sponge under running water. The hide was subsequently washed thoroughly with clean water,drained, weighed and stored in a Haire thermocool deep freezer for further studies.

Proximate analysis

The moisture content of the samples was determined using the procedure described by AOAC, (2000). The routine semi-micro Kjeldahl procedure described by AOAC, (2005) was used to determine the protein content. Ash content was determined using the method described by Pearson, (1976). Crude fat was determined using the method described by AOAC, (2000). The crude fibre was determined using the method of AOAC (1990).

Microbial analysis

Total viable counts of bacteria

The total bacteria counts of the samples were determined using the method of Bergey et al., (1994). Each serially diluted sample (1ml) was inoculated into sterile petri dishes and plate count agar (prepared according to the manufacturer's specification) was poured into the petri dish, then allowed to solidify and incubated (37 ºC for 4 hours)

Lactic acid bacteria counts

The lactic acid bacteria count was determined using the method of Bergey et al., (1994). Each serially diluted sample (1ml) was inoculated into a sterile petri dish and DeMan Rogosa and Sharpe agar (MRS) (prepared according to the manufacturer's specification) was poured on them and allowed to solidify then incubated at 37 ºC for 48 hours.

Yeasts and moulds counts

The yeasts and moulds counts were determined using the method described by Bergey et al., (1994). Each serially diluted sample (1ml) was inoculated into a sterile petri dish and acidified Potato Dextrose Agar (PDA) prepared according to the manufacturer's specification was poured into the petri dish, allowed to solidify and then incubated at 25 ºC for 72 hours.

Total coliform count

The sample (1ml) was inoculated into sterile petri dishes and MacConkey agar (prepared according to the manufacturer's specification) was poured on them and allowed to solidify then incubated at 37 ºC for 48 hours.

Statistical analysis

The data generated were statistically analyzed using SPSS (Statistical Package for Social Sciences) Version 24.0. One-way Analysis of variance (ANOVA) was performed. Means were separated using Duncan's multiple range test.

Results and Discussion

Proximate compositions of edible cowhides (ponmo)

The results of the proximate analysis of the processed cowhide (*ponmo*) samples are presented in Table 1. The results showed that the moisture contents of the various samples were significantly different from one another except for the two brown *ponmos*; brown *ponmo-singed* lab processed (control) (63.11 %) and in brown *ponmo-singed* market (63.15 %) and ranged between 63.15 and 71.23% for brown *ponmo-singed* market and *Ijebu ponmo* respectively ($p < 0.05$). The lower moist ure content of the brown *ponmo-*(*singed*) market and brown *ponmo-singed* lab processed (control) may have been due to the singeing process, which would have resulted in moisture loss. The white *ponmo-market* bought and white *ponmo-lab* processed (control) had higher moisture content might have been because their processing involved the addition of water. It has been reported that a typical meat muscle consists of about 75 % moisture (Briggs and Schweigert, 1990).

The protein content of the edible hides and skin (cow) produced using the different processing methods varied from 5.38 % (in brown *ponmo-singed* market bought) to 7.34 % (in white *ponmo-lab* processed).

White *ponmo-lab* processed (control) had the highest protein content of 7.34 %. The protein content of the singed and Ijebu *ponmo* may have been because protein is easily denatured by heat (Hsien *et al*., 1925). The fat content of the edible hides and skin (cow) varied from 0.46 % (in brown *ponmo-singed* market bought) to 0.88 % (in white *ponmo*-lab processed control). The results showed there was no significant difference between the fat content of white *ponmo-*market bought (0.86 %) and white *ponmo*-lab processed (control) (0.88 %). There was also no significant difference between the brown *ponmo-singed* market bought (0.46 %) and brown *ponmo-singed* lab processed (control) (0.43 %) but there were significant differences between the fat content of the Ijebu *ponmo*, the group of brown *ponmo-singed* lab processed (control), brown *ponmo-singed* market bought and the group of white *ponmo-lab* processed (control), white *ponmo-market* bought.

A report on the nutrient composition of a typical muscle of meat shows that a typical muscle contains about 3 % fat (Gerber, 2007). Several factors may affect the level of fat in a meat sample. In the case of cowhide, one of these factors is the processing method. Cowhide processing in the study area involves extensive heat treatment, which can burn up the fat during the processing period (Essumang *et al*., 2011). The quantity of intermuscular and depot fat present in a meat cut differs and is subject to the fat excretion of the animal and how the cut has been trimmed (Seuss *et al*., 1988).

The crude fibre content of the edible hides and skin (cow) produced using the different processing methods varied from 3.5 % in brown *ponmo-singed* market bought to 3.75 % in white *ponmo-lab* processed (control). The values showed that white *ponmo-lab* processed (control) had the highest crude fiber content: 3.75 % when compared to other samples.

The ash content of the edible hides varied from 0.48 % in brown *ponmo-singed* market bought to 0.63 % in white *ponmo-lab* processed (control). The results showed that there was a significant difference between the *Ijebu ponmo* (0.33 %) and the white *ponmo-lab* processed *ponmo* (control) (0.63%), white *ponmo-market* (0.45 %) but no significant difference between it and brown *ponmo-singed* laboratory (control) (0.45 %) and the brown *ponmo-singed* market (0.48 %) ($p < 0.05$). The ash content of the cowhides was slightly different from 1 % ash content reported by Gerber, (2007) for a typical meat Muscle.

The carbohydrate content of the edible hides and skin (cow) produced using the different processing methods varied from 26.94 % in the brown *ponmo-singed* market and 30.59 % for white *ponmo-lab* processed (control). The results showed there was no significant difference between the carbohydrate content of white *ponmo-market* bought (30.53 %) and white *ponmo-lab* processed (control) (30.59 %). There was also no significant difference between the brown *ponmo-singed* market bought (26.94 %) and brown *ponmo-singed* lab processed (control) (27 %). There was a significant difference between the carbohydrate content of the Ijebu *ponmo*, the group of brown *ponmo-singed* lab processed (control), brown *ponmo-singed* market bought and the group of white *ponmo-lab* processed (control), white *ponmo-market* bought ($p < 0.05$).

Amino acid profile of edible cowhides (ponmo)

The results (Table 2) showed that white *ponmo*-lab processed (control) had the highest amino acid profile content, then white *ponmo-market* bought, followed by brown *ponmo-singed* lab processed (control), brown *ponmo*-(singed) market bought and lastly, Ijebu *ponmo*. The alanine content of the samples ranged between 1.14 and 2.91 (for Ijebu *ponmo* and white *ponmo* lab processed). The aspartic acid content of the *ponmo* samples ranged between 3.05 and 4.29 (for Ijebu *ponmo* and white *ponmo* lab processed). The lysine content of the *ponmo* samples ranged between 0.69 and 1.25 (respectively for Ijebu *ponmo* and white *ponmo* lab processed). That is lower than the lysine content (8.11) of beef (Elliot *et al*., 2008). The methionine content of the *ponmo* samples ranged between 0.92 and 1.52 (for Ijebu *ponmo* and white *ponmo* lab processed). That is lower than the methionine content (6.28) of beef (Elliot *et al.*, 2008). The cysteine content of the *ponmo* samples ranged between 1.35 and 1.98 (respectively for Ijebu *ponmo* and white *ponmo* lab processed). That is lower than the cysteine content (2.23) of beef (Elliot *et al*., 2008). The tryptophan content of the *ponmo* samples ranged between 1.14 and 1.81 (for Ijebu *ponmo* and white *ponmo* lab processed). That is lower than tryptophan content (4.28) of beef (Elliot *et al*., 2008). The valine content of the *ponmo* samples ranged between 0.81 and 1.37 (for Ijebu *ponmo* and white *ponmo* lab processed). The leucine content of the *ponmo* samples ranged between 3.54 and 4.78 (for Ijebu *ponmo* and white *ponmo* lab processed). The isoleucine content of the *ponmo* samples ranged between 2.79 and 3.52 (respectively for Ijebu *ponmo* and white *ponmo* lab processed). The arginine content of the *ponmo* samples ranged between 2.36 and 3.38 (Ijebu *ponmo* and white *ponmo* lab

processed). That is lower than the Arginine content (6.91) of beef (Elliot *et al*., 2008). The threonine content of the *ponmo* samples ranged between 1.65 and 2.05 (for Ijebu *ponmo* and white *ponmo* lab processed). The phenylalanine content of the *ponmo* samples ranged between 3.24 and 4.82 (Ijebu *ponmo* and white *ponmo* lab processed). That is lower than the phenylalanine content (7.31) of beef (Elliot *et al*., 2008). Treatment of meat with high temperatures has damaging effects on proteins, especially as it denatures essential amino acids and renders them unavailable (Mayfield *et al*., 1949). This has been observed in lysine at temperatures around 100 °C, cystine and methionine at temperatures around 120 °C, and other amino acids after prolonged heating (Bender *et al*., 2019). According to their study, among all the meat samples they investigated, cowhide was subjected to the highest level of heat processing, hence, in addition to being deficient in essential amino acids like lysine, the high-temperature treatment may have further reduced the protein quality of the cowhides.

Microbiological characteristics of the edible cowhides (ponmo)

The total bacteria counts isolated from ponmo samples are represented in Table 3. The highest microbial load of 3.2x106 cfu/ml was obtained from unprocessed ponmo with fur while the lowest count of 1.5x106 cfu/ml was obtained from lab-processed ponmo (White). Market-bought ponmo (Brown) had a microbial load of 2.5x106 cfu/ml, Lab Processed ponmo (Brown) 1.7 x 106 cfu/ml and the Market-bought ponmo (White) had a microbial load of 2x106 cfu/ml.

Identification of possible microorganisms present in the edible hides (ponmo)

The microorganisms isolated were *Bacillus subtilis, Staphylococcus aureus, Streptococcus mitis, Staphylococcus sp.* and *Escherichia coli*. The occurrence of the microorganisms showed that Bacillus subtilis, Staphylococcus aureus, Streptococcus mitis, *Escherichia coli* and *Staphylococcus spps*. were observed to occur in all the samples assessed. Staphylococcus aureus showed the highest percentage occurrence of at 44%, while *Shigella dysenteriae* showed the lowest percentage of occurrence at 4 %.

The microbial load of the unprocessed ponmo with fur (3.2x106 cfu/ml) and market-bought brown ponmo samples (2.5x106 cfu/ml) might be due to contamination from the environment at the point of sale, during transportation, storage, processing, packaging materials, poor handling by the processor. The occurrence of Staphylococcus spps., Bacillus subtilis and Escherichia coli from the unprocessed cowhide with fur was observed. The presence of Micrococcus spps. could be the natural microflora in the samples. Salmonella spps., Escherichia coli in the ponmo would have been a result of faecal contamination. Clarence et al. (2013) reported the predominance of gram-negative organisms such as *Salmonella typhimorium*, *Shigella dysenteriae* and Escherichia coli, Staphylococcus aureus, Bacillus subtilis, *Enterobacter spps, Pseudomonas aureginosa and Klebsiella pneumonia* in meat pie.

Conclusion

This study showed that the nutrient quality of edible hides and skin (cow) is greatly affected by the processing method employed. Removal of fur with hot water method (white *Ponmo)* should be encouraged because it is environmentally friendly and its products have higher protein, amino acid profile and carbohydrate contents.

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Table 1: Proximate composition of the edible cowhides (*ponmo*)

Samples	Moisture	Protein	Ash	Fibre	Fat	CHO
I P	71.23d	4.79a	0.33a	3.47a	0.36a	23.29a
BPMB	63.15a	5.38b	0.48ab	3.5a	0.46b	26.94b
W PMB	64.25c	7.27c	0.62b	3.7a	0.86c	30.59c
BPLP(Control)	63.11a	5.42b	0.45ab	3.53a	0.43b	27.00b
W PLP(Control)	63.15b	7.34c	0.63b	3.75a	0.88c	30.53c

Means in the same column with different superscripts are significantly different (P<0.05)
CHO: Carbohydrate, I P- Ijebu Ponmo, B P M B - Brown Ponmo Market Bought, W P M B - White Ponmo Market-Bought, B P L P - Brown Ponmo Lab Processed (Control), W P L P - White Ponmo- Lab Processed (Control)

Table 2: Amino acid profile of the edible cowhides (*ponmo*)

Samples	BPMB	I P	W PMB	BPLP(Control)	W PLP(Control)
Alanine	1.67	1.14	2.87	1.78	2.91
Asparticacid	3.28	3.05	4.11	3.49	4.29
Lysine	0.87	0.69	1.13	1.02	1.25
Methionine	1.05	0.92	1.24	1.25	1.52
Cysteine	1.46	1.35	1.89	1.72	1.98
Tryptophan	1.27	1.14	1.65	1.51	1.81
Cysteine	2.66	2.43	2.86	2.72	2.95
Valine	0.92	0.81	1.08	0.99	1.37
Leucine	3.78	3.54	4.63	3.94	4.78
Isoleucine	2.94	2.79	3.26	3.17	3.52
Arginine	2.53	2.36	3.18	2.66	3.38
Threonine	1.79	1.65	1.94	1.92	2.05
Phenylalanine	3.43	3.24	4.49	3.82	4.82
Serine	3.95	3.83	4.36	4.05	4.85
Glutamine	2.25	2.17	3.44	2.72	3.78

IP-IjebuPonmo, BPM B-Brown Ponmo Market Bought, BPLP- Brown Ponmo Lab Processed(Control), WPM B-WhitePonmoMarket Bought, WPLP-White Ponmo Lab Processed (Control)

Table 3: Total bacterial count of the edible cowhides (*ponmo)*

Samples	Microbial load (x 106cfu/ml)
Lab Processed *ponmo* boiled (White)	1.5
Unprocessed *ponmo* with fur	3.2
Market bought *ponmo* (Brown)	2.5
Lab Processed *ponmo* (Brown)	1.7
Market bought *ponmo* (White)	2

Table 4: Biochemical characterization to determine the microorganisms present in the edible cowhides (*ponmo*)

	Colony				
Parameter	**1**	**3**	**7**	**10**	**11**
Methylred	-	-	-	+	-
Vogesprokaeur	+	-	+	-	-
Urease	+	+	+	+	+
Catalase	+	+	-	+	+
Citrate	+	+	+	+	+
Sulphide	-	-	-	-	-
Indole	+	+	-	+	+
Motility	-	-	+	-	-
Starch	+	+	+	-	+
Glucose	A	A	A	NC	A
Sorbitol	NC	A	NC	AG	A
Lactose	NC	A	NC	AG	A
Mannitol	A	A	AG	AG	A
Galactose	NC	A	AG	AG	NC
Sucrose	A	A	AG	AG	AG
Fructose	A	A	A	AG	A

Table 5: Physical characterization to determine microorganisms present in the edible cowhides (*ponmo)*

Characteristics	Colony				
	1	**3**	**7**	**10**	**11**
Shape	Circular	Circular	Circular	Irregular	Circular
Margin	Entire	Entire	Entire	Lobate	Entire
Elevation	Raised	Raised	Flat	Flat	Raised
Surface	Glistering	Glistering	Glistering	Glistering	Glistering
Colour	Cream	Cream	Cream	Cream	Cream
Opacity	Opaque	Opaque	Opaque	Translucent	Opaque
Texture	Butyrous	Butyrous	Butyrous	Butyrous	Butyrous
Colony size (mm)	1.5	1	3	4	1.5
Cell shape	Curved	Rod	Short Rod	Rod	Rod
Gram reaction	+	[+]	-	+	+

Table 6: Microorganisms present in the edible cowhides (*ponmo)*

Colony	Organism
1	*Staphylococcus aureus*
3	*Bacillus subtilis*
3	*Staphylococcus spps.*
10	*Staphylococcus mitis*
11	*Escherichia coli*