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Effects of various methods of singeing on the heavy metal proximate and sensory properties of singed cowhode (Ponmo)

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ABSTRACT

The effect of methods of singing of cowhide on the concentration of heavy metal, proximate composition and sensory properties of cowhides obtained from four major abattoir in Abia State, Nigeria were studied. The concentration of Copper (Cu); Zinc (Zn); Cadmium (Cd); Lead (Pb), Iron (Fe); Chromium (Cr) and Nickel (Ni) concentration were analyzed using Atomic Absorption Spectrophotometer (AAS). The concentration of the heavy metals varied from 0.32-7.55, 0.00-13.76, 0.00-2.40, 0.00-0.71, 25.59- 68.65mg/kg, for copper, zinc, cadmium, lead and iron respectively. No chromium and nickel were found in all the samples. Lead was also not detected in the control sample (unsinged cowhide) and the sample from Ndoki abattoir. However, boiling significantly (P≤ 0.05) reduced the concentration of heavy metal in all the samples. The unboiled sample from Ogborhill abattoir had the highest concentration of copper (7.55mg/kg) and zinc (13.76mg/kg) and was significantly (P≤0.05) higher than concentration of Cu and Pb in all the samples. Boiling significantly (P≤0.05) reduced the fat and protein content of some of the samples. There was significant different in the texture and general acceptability of the singed cowhide and unsinged cowhide. However, they differed significantly (P≤0.05) in taste, colour, aroma and palatability.

INTRODUCTION

Heavy metals is a term used to describe more than a dozen element that are metals or metalloids. The important toxic heavy metals are cadmium, zinc, chromium, copper and nickel [1]. These heavy metals are the causes of the environmental pollution from a number of sources including lead in petrol, industrial effluent and leaching of metal ions from the soil into lakes and rivers by acid rain [1] [2]. Human activities affects the natural geological and biological redistribution of heavy metals through pollution of the air, water and soil [3] [4] and by altering the chemical form of heavy metals released to the environment. Such alteration affect its (heavy metals) toxicity by allowing it to bio-accumulate in plants and animals, bio-centration in the food chain or attack specific organs of the body [5].

Heavy metals are associated with some adverse health effect including allergic reactions, neurotoxicity, nephrotoxicity and cancer [6]. Humans are often exposed to heavy metals in various ways mainly through the inhalation of metals in the workplace or polluted neighborhoods or through the ingestion of food (particularly meat) that contains high levels of heavy metals [7].

Hides of cow meat popularly called “ponmo” in south western Nigeria and “wele” in southern Ghana are served as food delicacy in several parts of Africa [8]. Traditionally, the hairs from the hides are removed by tendering the hides in hot water, followed by shaving with razor blade to give the finished product “ponmo”. Hides obtained through this traditional method may contain metals from the shavers used [8].

Several methods are used by meat processors in the last few decades in the processing of cowhide to “ponmo”. Such method singing off the hair in flame fuelled by various substances such as wood mixed with spent engine oil, plastic mixed with refuse or tyres [8]. These materials contain toxic substances (Fe, Cr, Pb, Cu, Al, Si, etc.) which can contaminate the hides and make it toxic for human consumption. However, during singing some aromatic compounds are developed which affect the sensory properties of the singed cow-hide.

The aim of this work is to determine the effect of different methods of singing on the proximate composition, level of heavy metal and sensory properties of “ponmo” purchased from different abattoir from Abia State.

Keywords: Singed Cowhides, Heavy metals, Sensory attribute, Proximate, abattoir.

MATERIALS AND METHODS

Sample Collection
Cowhides “ponmo” were obtained from different abattoirs to ascertain the processing method used. A total of 10 samples were collected from three abattoirs; Ogbor hill, Ndoki and Ubakala, on different days between May and July, 2010.

Preparation
Cowhides “ponmo” were prepared by various processing methods and the levels of Lead, Cadium, Chromium, Zinc, Nickel, Copper and Iron in each of the sample.

Samples collected from Ogbor hill and Ndoki abattoir were processed with tyres as fuel source while samples collected from Ubakala abattoir were processed with firewood and the control sample was processed using the traditional method of boiling for 30 minutes and shaving with razor blade. Half of each samples were boiled in water for a period of 1 hour to determine the effects of boiling on the concentration of heavy metal. All samples were dried in the oven for 3 days at 103^0C.

Determination of the Heavy Metals
The burnt cow hides were scraped to remove ash. The flakes of 5 – 8mm thick processed cow hides weighing between 30g to 103g were oven dried at 50^0C for 2 hours and re-weighed. A known weight (20g) of the dried cowhide lakes were ashed at 500^0C and digested with 2 – $3cm^3$ concentrated HNO_3 and processed for AAS analysis on a Perkin Elmer Atomic Absorption Spectrophotometer, model AA – 200. The blank solution was made from concentrated HNO_3 and distilled water. The heavy metals determined were Copper, Zinc, Cadium, Lead, Iron, Chromium and Nickel. Samples of the same cowhides were boiled for about one hour, ashed and prepared for AAS analysis. All determinations were carried out in triplicates.

PROXIMATE DETERMINATION
The proximate composition of “ponmo” sample evaluated were ash, fat, protein, carbohydrate and crude fibre according to [9].

DETERMINATION OF MOISTURE
The moisture content was determined by the gravimetric methods as described by James [10]. A known weight of 5g of each sample was dried at 105^0C in an oven for about 5 hours. The determination was done using a dish that had been previously dried at above 105^0C and pre-weighed. After drying, the samples were cooled in a desiccator and weighed until a constant weight was obtained. The weight of the moisture loss was determined by difference and expressed as a percentage. The formula below was used for the calculation

$$\% \text{ Moisture} = \frac{W_3 - W_2}{W_2 - W_1} \times 100$$

Where
W_1 = weight of empty moisture dish
W_2 = weight of dish and sample before drying
W_3 = weight of dish and sample after drying

DETERMINATION OF TOTAL ASH
The ash content was determined using the furnace incineration gravimeter method [9].

DETERMINATION OF CRUDE FIBRE
This was determined by Wende methods [10]. A known quantity (2.7g – 3.0g) of each sample was defatted during fat analysis. The defatted sample was boiled in 200ml of 0.225M H_2SO_4 solution under reflux for 30 minutes with constant stirring. The samples were washed with several portion of hot water using a two-fold muslin cloth to trap the particles. The washed sample was transferred back to the flask and 200ml of 0.313M NaOH solution was added to it. Again, the samples were boiled for 30 minutes and washed as before with hot water. They were then carefully transferred to a weighed porcelain crucible and dried in the oven at 100^0C for 3 hours. The sample was cooled in a desiccator, reweighed and ash in a muffle furnace at 550^0C for 2hours. The samples were cooled in a desiccator and re-weighed.

The crude fibre content was calculated using the following formula below

$$\% \text{ Crude fibre} = \frac{W_2 - W_1}{\text{Wet of sample}} \times 100$$

Where
W_2 = weight of flask + sample
W_1 = weight of Crucible + sample ash

DETERMINATION OF CARBOHYDRATE
The carbohydrate content of the sample was calculated by difference.

DETEMINATION OF FAT CONTENT
Fat content of the samples were determined by the continuous solvent extraction methods using Soxhlet apparatus [9].

DETERMINATION OF PROTEIN
The protein content was determined by Kjedahl method as described by James. [10] The total nitrogen was determined and multiplied with the factor 6.25 to obtain the protein.

One gram of each of the sample was mixed with 20ml of concentrartion H_2SO_4 in a Kjedahl digestion flask. A tablet of Selenium catalyst was added to it and the mixture was digested until a clear solution was obtained. A blank solution (i.e. without the sample) was also digested. All the digests were carefully transferred to 100ml volumetric flask using distilled water and made up to a mark (100ml). A 10ml portion of each digest was mixed with equal volume of 45% NaOH solution in kjedahl distilling unit. The mixture were distilled and the distillate collected into 10ml of 10ml of 40% boric acid solution containing about 2 -3 days of indicate (which was a mixture of bromocresolgreen) and titrated against 0.02M H_2SO_4 solution till a change in color of the solution from initial green color to a deep red color at end point.

SENSORY EVALUATION
The acceptability (sensory) test of the cowhide samples “ponmo” was conducted using 21 member test panelist. The samples were evaluated for texture, taste, palatability and general acceptability.

A descriptive 9 point hedionic sale rating as described by [11] was used. Nine (9) stood for “like extremely” while 1 stood for “dislike extremely”. The score “5” represented neither like or dislike.

STATISTICAL ANALYSIS OF DATA

Complete Randomized Design (CRD) was used and the data were subjected to analysis of variance (ANOVA) at 0.05% level of significance

RESULTS AND DISCUSSION

Heavy Metal Concentration

The concentration of Copper (Cu) in all samples ranged from 0.24 – 7.55mg/kg. Samples (ponmo) processed with tyre from Ogbor hill abattoir had the highest concentration of Cu (7.46 – 7.55mg/kg) which was significantly ($P \leq 0.05$) higher than the concentration of copper in all other samples. The control had the least value (0.32 and 1.90mg/kg) for boiled and unboiled samples respectively.

TABLE 4.1 MEAN VALUES FOR THE HEAVY METAL CONTENTS OF SINGED CATTLE SKIN

S/N	SAMPLE ID	Cu	Zn	Cd	Pb	Fe	Cr	Ni
1	Ogbor hill (un-boiled)	$7.55^{a} \pm 0.00$	$13.75^{a} \pm 0.00$	$0.76^{d} \pm 0.00$	$0.09^{d} \pm 0.00$	$68.65^{a} \pm 0.03$	$0.00^{a} \pm 0.00$	$0.00^{ab} \pm 0.00$
2	Ogbor hill (boiled)	$7.46^{b} \pm 0.00$	$3.84^{c} \pm 0.00$	$0.28^{g} \pm 0.00$	$0.00^{f} \pm 0.00$	$52.61^{b} \pm 0.03$	$0.00^{a} \pm 0.00$	$0.00^{b} \pm 0.00$
3	Ndoki (un-boiled)	$2.94^{f} \pm 0.00$	$6.68^{ab} \pm 0.00$	$1.06^{b} \pm 0.00$	$0.00^{f} \pm 0.00$	$43.13^{d} \pm 0.04$	$0.00^{a} \pm 0.00$	$0.00^{a} \pm 0.10$
4	Ndoki (boiled)	$0.24^{j} \pm 0.00$	$2.24^{d} \pm 0.00$	$0.27^{h} \pm 0.00$	$0.00^{f} \pm 0.00$	$29.86^{b} \pm 0.04$	$0.00^{a} \pm 0.00$	$0.00^{ab} \pm 0.00$
5	Ubakala (un-boiled)	$6.02^{c} \pm 0.00$	$2.14^{e} \pm 0.00$	$2.40^{a} \pm 0.00$	$0.71^{a} \pm 0.00$	$51.18^{c} \pm 0.04$	$0.00^{a} \pm 0.00$	$0.00^{ab} \pm 0.00$
6	Ubakala (boiled)	$5.51^{d} \pm 0.00$	$0.02^{f} \pm 0.00$	$0.90^{c} \pm 0.00$	$0.21^{b} \pm 0.01$	$40.28^{e} \pm 0.04$	$0.00^{a} \pm 0.00$	$0.00^{ab} \pm 0.00$
7	Laboratory Sample (Un-boiled)	$5.28^{e} \pm 0.01$	$0.00^{af} \pm 0.00$	$0.66^{e} \pm 0.00$	$0.19^{c} \pm 0.00$	$35.07^{f} \pm 0.04$	$0.00^{a} \pm 0.00$	$0.00^{b} \pm 0.00$
8	Laboratory Sample (Boiled)	$2.44^{g} \pm 0.00$	$0.00^{f} \pm 0.00$	$0.42^{f} \pm 0.00$	$0.07^{e} \pm 0.00$	$33.18^{g} \pm 0.04$	$0.00^{a} \pm 0.00$	$0.00^{b} \pm 0.00$
9	Control (un-boiled)	$1.90^{h} \pm 0.00$	$0.00^{af} \pm 0.00$	$0.00^{i} \pm 0.00$	$0.00^{f} \pm 0.00$	$28.91^{i} \pm 0.04$	$0.00^{a} \pm 0.00$	$0.00^{b} \pm 0.00$
10	Control (boiled)	$0.32^{i} \pm 0.00$	$0.00^{f} \pm 0.00$	$0.00^{i} \pm 0.00$	$0.00^{f} \pm 0.00$	$25.59^{j} \pm 0.04$	$0.00^{a} \pm 0.00$	$0.00^{b} \pm 0.00$

Means of duplicate determination
Means with the same superscript within each column are not significantly different ($P \leq 0.05$)
Means without the same superscript within each column are significantly different ($P \leq 0.05$)

Zinc was not detected in the control samples and in the sample processed with firewood. However, the concentration of zinc in the other samples varied from 0.02 – 13.76. The samples processed with tyre had the highest concentration of zinc (3.76 – 3.84) which was significantly higher ($P<0.05$) than the concentration of zinc in all other samples. Nevertheless, the concentration of zinc in the samples was within the maximum permissible level of 50mg/kg [12] [13]. Boiling reduced the zinc concentration. This reduction may be as a result of leaching of zinc into the water.

The control sample (processed through the traditional method of boiling in water and shaving) had no cadium (Cd). However, it was observed that singing increased the concentration of Cd in all the samples processed with tyre and firewood. The concentration of Cadium varied from 0.27 to 2.40mg/kg. It is important to note that the concentration of Cadium exceeded the maximum permissible level of 0.05mg/kg. No Cadium was detected in a similar work in Nigeria except in samples that were picked randomly in the market [8]. Cadium intake in relatively high amount can over a long period be detrimental to human health [14]. Cadium may accumulate in the kidney and liver and because of its long biological half-life may lead to kidney damage [15].

Lead was not detected in the samples processed with tyre from Ndoki abattoir and the control sample. The concentration of lead (0.09mg/kg) detected in the sample processed with tyre (Ogbor hill abattoir) was within the maximum permissible level [12] [13]. Samples processed with firewood (Ubakala abattoir) had the highest concentration of lead (0.21 – 0.71) for boiled and un-boiled samples respectively which was significantly higher than the concentration of lead in all other samples. This concentration of lead which varied from 0.21 to 0.71mg/kg exceeded the maximum permissible level [16]. However, boiling reduced the concentration of lead in all the samples. High level of Lead in foods can cause Lead encephalopathy in adults [8]. Early symptoms include dullness, headache, muscular tremor, loss of memory and hallucinations. This may develop into delirium convulsion, paralysis, coma and death (Kumar *et al.*, 1985) [17]. Furthermore, exposure to toxic levels of lead can also cause insomnia, nausea, headache, constipation, weight loss, anemia, malfunctioning of the kidney and reproductive organs [18] [19]. The concentration of lead obtained in this week is lower than what was reported [8]. This variation may be as a result of slight difference in the processing of the cowhides. The estimated provisional tolerable weekly intake of Pb for a 60kg adult is 1500µg per body weight.

Boiling reduced the concentration of Iron (Fe) in all the samples. The concentration of Fe measured in this study varied from 25.59 – 68.65mg/kg which is lower than what was detected in fish (S.gahlaeus) [20]. Un-boiled sample processed with tyre (Ogbor hill abattoir) had the highest level of Fe which was significantly higher than concentration of Fe in every other sample.

No Chronium and Nickel was detected in all the samples.

Proximate Composition

The proximate compostion of the sample "ponmo" are shown in table 4.2

The un-boiled sample prepared with tyre (from Ogbor hill abattoir) had the highest moisture content (200%) which was significantly higher ($P \leq 0.05$) than all other samples. The control (boiled) had the least moisture content. According to Adepoju *et al*., 2006, samples with high moisture content have low shelf life because micro-organisms thrive or grow more in food with high moisture content [21]. High moisture content of some foods reduces its keeping quality and storage value [22]. Un-boiled sample singed with tyre (Ogbor hill abattoir) had the highest ash content which was significantly ($P \leq 0.05$) higher than the ash content of all other samples. There was significant difference ($P \leq 0.05$) between un-boiled and boiled sample processed with firewood (from Ubakala abattoir).

The sample prepared with tyre (boiled) from Ubakala abattoir had the least fat content and were significantly ($P \leq 0.05$) lower than the fat content of the rest of the samples. The difference in the fat content may be attributed to the source of heat and duration of signing of the cow-hides.

There was significant difference ($P \leq 0.05$) in the protein content of the samples. The protein content of samples from Ogbor hill abattoir (un-boiled), samples from Ndoki abattoir (boiled and un-boiled) were significantly higher than the protein content of all samples. The un-boiled sample from Ubakala had the lowest protein content.

The carbohydrate content of the samples varied significantly from 0.14 – 0.71%. The sample from Ubakala (boiled) had the least carbohydrate content and differed significantly ($P \leq 0.05$) from the rest of the sample.

TABLE 4.2 MEAN VALUES FOR THE PROXIMATE COMPOSITION OF SAMPLES

S/N	SAMPLE ID	Moisture	Ash	Fat	Protein	Carbohydrate	Crude oil
1	Ogbor hill (un-boiled)	$20.01^{a} \pm 0.01$	$4.17^{a} \pm 0.03$	$0.35^{de} \pm 0.35$	$8.68^{a} \pm 0.25$	$0.71^{a} \pm 0.01$	$35.86^{cd} \pm 0.08$
2	Ogbor hill (boiled)	$17.37^{b} \pm 0.09$	$2.11^{b} \pm 0.14$	$0.21^{f} \pm 0.01$	$8.12^{b} \pm 0.03$	$0.67^{ab} \pm 0.03$	$34.43^{d} \pm 0.04$
3	Ndoki (un-boiled)	$12.78^{c} \pm 0.13$	$0.15^{d} \pm 0.07$	$0.55^{ab} \pm 0.07$	$8.57^{a} \pm 0.24$	$0.65^{ab} \pm 0.021$	$40.15^{a} \pm 0.07$
4	Ndoki (boiled)	$12.53^{d} \pm 0.18$	$0.13^{d} \pm 0.04$	$0.42^{cd} \pm 0.04$	$8.45^{a} \pm 0.04$	$0.57^{abc} \pm 0.04$	$37.26^{abcd} \pm 0.04$
5	Ubakala (un-boiled)	$11.54^{e} \pm 0.06$	$0.13^{d} \pm 0.04$	$0.51^{bc} \pm 0.04$	$7.16^{c} \pm 0.04$	$0.51^{bc} \pm 0.04$	$40.01^{ab} \pm 4.24$
6	Ubakala (boiled)	$7.35^{f} \pm 0.04$	$0.12^{d} \pm 0.03$	$0.27^{ef} \pm 0.04$	$7.15^{c} \pm 0.04$	$0.44^{c} \pm 0.06$	$36.81^{bcd} \pm 0.06$
7	Laboratory Sample (Un-boiled)	$6.84^{g} \pm 0.06$	$1.02^{c} \pm 0.03$	$0.62^{a} \pm 0.04$	$6.56^{d} \pm 0.57$	$0.49^{bc} \pm 0.06$	$38.86^{abc} \pm 0.04$
8	Laboratory Sample (Boiled)	$3.35^{i} \pm 0.04$	$0.12^{d} \pm 0.03$	$0.31^{e} \pm 0.04$	$6.13^{e} \pm 0.04$	$0.14^{d} \pm 0.04$	$36.92^{abcd} \pm 0.06$
9	Control (un-boiled)	$4.25^{h} \pm 0.06$	$1.01^{c} \pm 0.01$	$0.60^{ab} \pm 0.03$	$7.10^{c} \pm 0.03$	$0.50^{bc} \pm 0.04$	$37.15^{abcd} \pm 0.07$
10	Control (boiled)	$3.12^{j} \pm 0.03$	$0.11^{d} \pm 0.04$	$0.58^{ab} \pm 0.04$	$6.06^{e} \pm 0.06$	$0.25^{d} \pm 0.06$	$35.13^{d} \pm 0.06$

Means of duplicate determination

Means with the same superscript within each column are not significantly different ($P \leq 0.05$)

Means without the same superscript within each column are significantly different ($P \leq 0.05$)

Sensory Evaluation

Results of the sensory evaluation of samples are shown in table 4.3

The samples were used for the sensory evaluation. The samples used were cow hide (ponmo) prepared with tyre, firewood and cowhide prepared using the traditional method of boiling water and shaving (control).

There was no significant difference ($P \leq 0.05$) in the texture of all the samples. The sensory scores varied from 7.00 – 7.61 which means that all the samples were liked moderately.

TABLE 4.3 MEAN VALUE FOR THE SENSORY SCORES OF PONMO SAMPLES

SAMPLE	Texture	Taste	Color	Aroma	Palatability	Acceptability
Ponmo prepared with tyre	7.61^a ± 0.69	7.52^a ± 1.12	7.28^{ab} ± 1.01	7.09^a ± 1.18	7.33^a ± 0.79	7.61^a ± 1.02
Ponmo prepared with firewood	7.33^a ± 1.35	7.57^a ± 1.08	7.57^a ± 1.03	7.38^a ± 1.32	7.52^a ± 0.87	7.85^a ± 0.91
Ponmo prepared with the traditional method of boiling in water (control)	7.00^a ± 1.26	6.47^b ± 0.07	6.52^b ± 1.63	6.47^b ± 1.12	6.61^b ± 1.24	7.23^a ± 1.14

Means of duplicate determination
Means with the same superscript within each column are not significantly different (P≤0.05)
Means without the same superscript within each column are significantly different (P≤0.05)

No significant difference (P≤0.05) was observed in the taste of ponmo prepared with tyre and firewood but differed significant (P≤0.05) from the control. The sensory scores for the three samples were 7.52, 7.57 and 6.47 for ponmo prepared with tyre, firewood and the control respectively. This means that ponmo prepared with firewood and tyre were moderately liked while the control was liked slightly. The preference in taste may be due to the fact that consumers are conversant with the taste of ponmo prepared with firewood and tyre. It is also possible that the wood and tyre may have deposited some aromatic compounds on the samples. The color of ponmo prepared with firewood was preferred to the colors of the rest of the samples. It was scored 7.57von the hedonic scale which was prepared with tyre (7.28) and the control (6.52). The color difference may be attributed to the material used in the singing of the cowhides and the non-enzymatic browning between the carbohydrate and protein molecules of the cow hide.

At 5% level of confidence, the aroma of ponmo prepared with firewood differed significantly to the control but there was no significant difference exist between the sample prepared with firewood and tyre. The sensory scores are 7.09, 7.38 and 6.47 for cowhide prepared with tyre, firewood and the control respectively. This means that the control was liked slightly while the ponmo prepared with tyre and firewood were like moderately. This could be attributed to the fact that consumers and familiar with palatability of ponmo prepared with tyre and firewood.

In general acceptability, there was no significant difference (P≤0.05) among the samples though the ponmo singed with firewood was rated best (7.85). The sensory scores of the sample which ranged from 7.23 – 7.85 shows that they were moderately accepted.

The sensory test was conducted to evaluate the level of acceptability (i.e. degree of likeness of traditionally prepare sample over the singed cowhides. In general acceptability and texture, there was no significant difference (P≤0.05) but the control differed from the singed cowhide in taste, color, aroma and palatability.

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