

# Effect of Banana Peel Ash on Proximate, Mineral and Sensory Properties of Dried Beef

Samuel Muyoma Nato, Symon Maina Mahungu, Alfred Anakalo Shitandi.

**Abstract-** The association between excessive sodium intake and hypertension necessitates reduction of dietary sodium intake. This study investigated the effect of 1%, 2% and 3% of water soluble ash extract (WSA) from banana peels on proximate, mineral and sensory properties of dried beef. Portions of beef loin, each weighing 500g, were treated with one of the three levels of WSA. The positive control used was 1%, 2% and 3% of table salt (TS) while distilled water was used as the negative control. The treated portions were equilibrated with 1L of their respective solutions for 1h. The portions were thereafter cut into strips and dried at 60°C for 15h. Proximate, mineral and sensory analysis was carried out immediately after drying. Data analysis was done using statistical analysis system (SAS) version 9.1 to identify significant differences in treatment means of proximate values, mineral levels and sensory scores. Mean separation was done at  $p < 0.05$ . The results showed that beef treated with WSA had lower sodium than that treated with TS. Sensory evaluation showed that there was no significant difference in preference between beef treated with 1% WSA with 1% TS and 2% TS. There is therefore a potential for 1% WSA to be used in dried beef to enhance sensory properties with the specific intention of reducing dietary sodium intake.

**Key words:** meat, beef, salt, sodium chloride, sensory evaluation, banana ash, health, hypertension.

## Abbreviations and/or nomenclature

WSA- Water soluble ash extract from green banana peels

TS- Table salt

DW- Beef sample treated with distilled water

1S- Beef sample treated with 1% TS solution

2S- Beef sample treated with 2% TS solution

3S- Beef sample treated with 3% TS solution

1W- Beef sample treated with 1% WSA

2W- Beef sample treated with 2% WSA

3W- Beef sample treated with 3% WSA

## 1 INTRODUCTION

There are various strategies for developing healthier meat and meat products. One of the most important of these is to design meat products that have reduced amounts of sodium [8]. Dietary intake of sodium, from all sources, influences blood pressure levels in populations and should be limited in order to reduce the risk of coronary heart disease and stroke. High blood pressure (hypertension) is an important public health challenge worldwide [10], and many studies indicate a high prevalence among populations. It is reported that 25% of the world population were hypertensive in the year 2000, and that this is likely to increase to 29% by the year 2029 [7]. In America, 50 million people are affected [6], while in Ghana, the prevalence is 28.3% [6]. In Seychelles, the prevalence is higher at 40%, and the situation may not be unique in Sub-Saharan Africa because of a high prevalence of cardiovascular risk factors [29]; one of which is a high sodium intake [7],[12],[17]. This association between excessive sodium intake and the development of

hypertension has prompted public health authorities to recommend reducing dietary intake of sodium and increased consumption of foods rich in potassium [20]. Consequently, a new class of foods, the so-called "functional foods" are being developed that either contain components that have beneficial physiological effects or that are void of components that depending on intake amounts may negatively impact consumers health [15]. Accordingly, due to the role of sodium in the development of hypertension in sodium-sensitive individuals, public health authorities have recommended a reduced dietary intake of sodium chloride [22]. The World Health Organization (WHO) recommends no more than 5 g/day/person [3]. Thus, sodium chloride reduction in meat products while maintaining their sensory properties is important in the goal of an overall decrease in dietary sodium intake [22].

Sodium chloride is used in the production of meat products because of its effects on texture, flavour and shelf life. Salt reduction in meat products has adverse effects on

water and fat binding, impairing overall texture and increasing cooking loss, and also on sensory quality especially taste [24]. Sodium reduction requires partially or totally substituting the sodium chloride added to meat derivatives by other compounds that have similar effects on sensory properties [21]. There is however no panacea in terms of a single ingredient that can be used to replace sodium chloride in meat products, therefore a range of functional ingredient combinations must be developed and/or optimised [2]. Studies on the effect of substitution of sodium chloride with potassium chloride, potassium lactate, or glycine (0–40% substitution) on some sensory, microbiological and physicochemical characteristics of fermented sausages indicated that there was no effect on sensory properties [12]. Indeed, it has been found that potassium lactate could reduce the excessive hardening at the surface of salted meat products [9]. Also, phosphates and lactates could be applied successfully to enhance the sensory attributes of beef [19]. There is however no published study on the effect of water soluble ash extract (WSA) from banana peels on proximate, mineral and sensory properties in dried beef in spite of its use to season meat among communities in western Kenya.

## 2 MATERIALS AND METHODS

### 2.1 Source of beef and green banana peels for preparation of the WSA

Lean beef (15kg) was obtained from a retail outlet in Egerton while green bananas (Uganda green) were sourced from a farmer in Webuye, Kenya. The bananas were washed and peeled, and the peels dried in the sun for four days then transported to Egerton University.

### 2.2 Preparation of water soluble ash extract (WSA)

The dry green banana peels were incinerated in a furnace till there was no visible organic matter. Solvent extraction using distilled water was done to obtain a filtrate. The filtrate was then evaporated in an open pan to obtain the WSA.

### 2.3 Meat treatment and experimental layout

The levels of WSA and table salt applied were 1%, 2% and 3%. Each level was made into a solution of 50 ml per 500g meat using distilled water and injected evenly (using a single-needle hand-held injector) into the meat [14]. The negative control samples were injected with 50ml distilled water per 500g meat. The injected cuts were then immersed in 1L of their respective solutions to equilibrate for 1hour. The treated samples were then cut into strips of approximately 5cm by 2cm by 2cm and dried at 60 °C for 15 h, and continually turned after every 2h for uniform drying. The experiment was laid out in completely randomized design and replicated three times.

### 2.4 Determination of pH of WSA

The pH of the WSA was determined using a pH meter (PHS-3B, Nanjing T-Bota Sciotech Instruments & Equipments co. Ltd, China) calibrated with pH buffers at pH 7.0 and 9.0 [27]. A concentration of 1%, 2% and 3% (w/v) of the sample solution was prepared by dissolving 1g, 2g and 3g respectively of WSA in distilled water to make 100ml of solution. The pH of the meat was determined on 2g of meat homogenised in distilled water (10/1 water/sample) [3].

### 2.5 Determination of minerals in WSA and meat

Sodium, potassium, magnesium and calcium were determined. A sample weighing 1g was wet ashed using 10ml concentrated nitric acid and 5ml concentrated sulphuric acid in a digester (2012 digester Foss Tecator, Burlandegen Germany). The samples were carefully heated at 250°C until vigorous reaction stopped. Heating continued to 450°C for 3h. The digested samples were cooled then filtered (Whatmans filter paper no. 4) into a 100 ml flat-bottomed flask and contents topped to the mark with distilled water. Approximately 1mL of 10% w/v of lanthanum chloride was added to each sample [1]. An Atomic Absorption Spectrophotometer (AA-6300 Shimadzu Co-operation, Tokyo) was used for the analysis.

### 2.6 Determination of Phosphorous and Chloride in WSA and meat

Phosphorous and chloride were analyzed. A sample weighing 2g was ashed at 600°C for 4h for determination of phosphorous. Hydrochloric acid with 6M concentration and several drops of nitric acid were added to dissolve the ash completely. The sample was cooled, put into 100ml volumetric flask and topped to the mark with distilled water. An aliquote containing about 0.5-1.5mg (about 10ml) of phosphorous was pipetted into a 100ml volumetric flask and 20ml of molybdovanadate reagent added, and brought to the mark using distilled water. The colour was allowed to develop in 10min and the absorbance read at 400nm [27] using a UV visible spectrophotometer (UV-1700 Shimadzu Co-operation, Tokyo). A phosphorous standard curve was used for calibration. Chloride level was determined by Volhard titration using 0.1M silver nitrate (excess). The titrate was filtered using a retentive filter paper and the residue washed thoroughly. Nitric acid measuring 3ml was added and excess silver titrated with 0.1M potassium thiocyanate using ferric ion as an indicator. The net volume of silver nitrate used was determined and mg/Kg of chloride in the sample calculated. All the reagents used were of analytical grade. Glassware was acid washed and thoroughly rinsed with distilled water.

### 2.7 Determination of proximate composition of meat

Proximate analysis was done according to AOAC methods [1]. The moisture content was determined by oven drying approximately 2.00g of the sample at 105 °C for 8h to constant weight in a cabinet drier (Electrolax, Sweden), cooled in a dessicator and weighed. The results were recorded as percentage moisture loss. Fat content was determined with 2.00g of sample by the Soxhlet method

- Samuel Nato holds a MSc. Food Science, Egerton University Kenya.  
E-mail: [muyomanato@gmail.com](mailto:muyomanato@gmail.com)
- Symon Mahungu is a professor of Food Chemistry, Egerton University.  
E-mail: [smahungu@yahoo.com](mailto:smahungu@yahoo.com)
- Alfred Shitandi is a professor of Food Biotechnology, Egerton University.  
E-mail: [anakalos@gmail.com](mailto:anakalos@gmail.com)

(M-tops extraction mantle, Indonesia) using petroleum ether as a solvent, for 16h. Crude protein was determined by micro-Kjeldahl method using 0.2g of sample. Concentrated sulphuric acid was used for digestion (DK Heating digester-VELP Scientifica, Italy) at 430°C for 1h with Selenium as a catalyst. After distillation using a UDK 127 distillation unit (VELP Scientifica, Italy), the gas was received in 20ml of 0.1M hydrochloric acid with mixed indicator (0.1% methyl red, 0.2% bromocresol green, 0.5% phenolphthalein). The resultant distillate was titrated against 0.1M sodium hydroxide. Carbohydrate content was obtained by subtracting moisture content, protein content, fat content, and ash content from 100%.

**2.8 Sensory evaluation of treated meat**

Sensory evaluation was carried out immediately after drying. Approximately 200g of each treated sample was immersed in 1L of distilled water at ambient temperatures to imbibe water for 1h [14]. The pieces were then boiled at 100 °C till all the water evaporated. A five member trained sensory panel was then used to evaluate the cooked meat for colour, tenderness, juiciness, saltiness and flavour [11], [22]. A preparatory session was held to discuss and clarify each attribute to be evaluated. Testing was initiated after the panelists agreed on the specifications. Attribute intensities were rated on graphical intensity scales, which were anchored from both their ends as shown in the table 1.

Table 1: Graphical intensity scales

Property	1	9
Colour	Red	Brown
Tenderness	Tough	Tender
Juiciness	Dry	Juicy
Saltiness	Not at all	Extremely salty
Flavour (odour and taste)	Weak	Strong

One piece of cooked meat from each treatment was randomly chosen. The pieces with three-digit codes were presented to the panelists in random order. Warm water was provided for rinsing the mouth between samples.

An untrained panel (consumer panel) of 16 members then evaluated the cooked meat pieces for overall acceptability (preference) on a 9-point hedonic scale (1 = dislike extremely, 9 = like extremely) [11]. Panel members were selected from students and staff of the Department of Dairy, Food Science and Technology of Egerton University. The panelists were instructed to express their evaluation for overall acceptability of cooked meat after considering the colour, tenderness, juiciness, saltiness and flavour of the product. Samples were prepared and offered randomly to the panelists as described for trained panel evaluation.

**2.9 Data analysis**

The data on proximate composition, mineral composition and sensory evaluation of the meat was subjected to analysis of variance followed by multiple comparisons between means by Duncan’s Multiple Range Test to

identify any significant differences in mean proximate values, mineral composition and sensory properties at p<0.05. The general linear model of SAS (Statistical Analysis System) version 9.1 was used for all the computations.

**3 RESULTS AND DISCUSSION**

**3.1 Proximate composition**

Proximate analysis was carried out on all the treatments immediately after drying and the results recorded in table 2.

Table 2: Proximate composition of treatments

Treatment	Mean Proximate Property (percent composition) ± SDa				
	Moisture content	Protein	Crude fat	Ash	Carbohydrates
DW	20.95 ± 0.71d	65.03 ±0.54a	5.36 ± 0.15b	3.88 ± 0.46e	4.80 ±1.86a
1S	18.57 ±0.32 e	65.52 ±0.46a	5.26 ±0.15b	5.50 ±0.35d	5.17 ±0.36a
2S	17.27 ±0.30 e	66.38 ±0.49a	5.43 ±0.09b	6.43 ±0.32bc	4.51 ±0.59a
3S	14.34 ± 0.57f	66.45 ±0.23a	5.84 ±0.20a	7.50 ±0.15a	5.88 ±0.45a
1W	23.25 ±0.29c	62.24 ±0.24b	5.20 ±0.27b	6.00 ±0.21cd	3.32 ±0.98a
2W	26.27 ±0.89b	59.29 ±0.30c	4.31 ±0.16c	6.25 ±0.14bcd	3.89 ±1.83a
3W	29.29 ±0.59a	55.43 ±0.81d	3.94 ±0.06c	6.95 ±0.42ab	4.40 ±1.77a

Mean proximate value ± SDa: For each proximate property, mean values with different superscripts in the same column are significantly different (p<0.05). Carbohydrate content was calculated by difference.

Moisture content was significantly different for all the treatments with 3W having the highest moisture retained followed by 2W and 1W respectively. Moisture content reduced significantly from 18.57% to 14.34% with increase in sodium chloride concentration from 1% to 3% respectively. Treatment 3W had significantly lower protein content, followed by 2W then 1W. The protein contents of the rest of the treatments were not significantly different. This trend was similar to the crude fat content. DW had the lowest ash content while the ash content in 3W was not significantly different from 3S. Though the level of total carbohydrates was higher in 3S than the rest of the treatments, it was not significantly different.

**3.2 Mineral composition and pH of treatments.**

Mineral analysis was carried out on all treatments and the results recorded in Table 3. Sodium and chloride levels were significantly high in 3S, 2S and 1S respectively compared to the rest of treatments which, for sodium, were not significantly different when compared amongst themselves. For chloride, DW, 1W and 2W were not significantly different from one another. Potassium levels were significantly different in all the treatments while the



phosphorous level was highest in 3W but not significantly different in DW, 1S, 2S and 3S. Magnesium was highest in 3W but not significantly different in the rest of the treatments.

Table 3: Mineral composition and pH of treatments

Treatment	Mean mineral composition (ppm) /pH ± SDα						
	Na	K	P	Ca	Mg	Cl	pH
DW	775 ±92.5d	5505 ±220.2g	3524 ±118.1d	113 ±2.8c	440 ±28.7b	508 ±24.8e	5.7 ±0.04de
1S	1295 ±48.8c	6293 ±131.6f	3572 ±126.7d	125 ±3.4c	436 ±16.7b	1508 ±49.6c	5.8 ±0.31de
2S	1780 ±69.2b	7068 ±83.0e	3582 ±53.9d	132 ±2.1bc	445 ±44.2b	2417 ±95.5b	5.4 ±0.06e
3S	2361 ±171.0a	7569 ±71.6d	3535 ±81.8d	136 ±5.4bc	463 ±32.4b	2980 ±49.6a	5.9 ±0.03d
1W	790 ±90.3d	9374 ±85.6c	4298 ±96.9c	142 ±27.7bc	471 27.8b	561 ±0.0de	6.8 ±0.19c
2W	881 ±13.4d	12847 ±159.3b	4538 ±80.4b	171 ±14.8ab	513 ±66.7ab	596 ±49.6de	7.2 ±0.03b
3W	903 ±5.6d	15566 ±219.1a	4858 ±26.3a	204 ±21.8a	590 ±9.7a	649 ±24.8d	8.2 ±0.02a

Mean mineral composition and pH ± SDα: For each value, mean values with different superscripts in the same column are significantly different (p<0.05).

### 3.3 Sensory scores

Five trained panelists were used to evaluate the sensory attributes of the treatments. The evaluation was based on colour, tenderness, juiciness, saltiness and flavour of the cooked samples and the scores recorded in Table 4.

Table 4: Sensory properties of treatments

Treatment	Sensory property					
	Colour	Tenderness	Juiciness	Saltiness	Flavour	Preference
DW	0.72 ±0.07a	0.66 ±0.08bc	0.54 ±0.07cd	0.19 ±0.12c	0.45 ±0.05e	5.44 ±1.09c
1S	0.72 ±0.05a	0.68 ±0.07abc	0.51 ±0.06d	0.29 ±0.16c	0.52 ±0.05de	6.19 ±0.98abc
2S	0.74 ±0.06a	0.65 ±0.06c	0.50 ±0.06d	0.506 ±0.13b	0.65 ±0.09bc	6.31 ±1.01ab
3S	0.74 ±0.06a	0.76 ±0.07a	0.50 ±0.06d	0.70 ±0.78a	0.71 ±0.09b	6.81 ±1.28a
1W	0.60 ±0.05b	0.74 ±0.05abc	0.61 ±0.07c	0.18 ±0.06c	0.60 ±0.07cd	5.75 ±1.13bc
2W	0.45 ±0.06c	0.75 ±0.06ab	0.74 ±0.06b	0.24 ±0.11c	0.73 ±0.06ab	3.86 ±0.96d
3W	0.35 ±0.07d	0.77 ±0.08a	0.83 ±0.06a	0.26 ±0.11c	0.82 ±0.08a	2.69 ±1.30e

Mean sensory score ± SDα: For each sensory property, mean values with different superscripts in the same column are significantly different (p<0.05).

Scores for colour captured the transition from red meat colour of fresh beef to the brown colour of cooked beef. Treatment 3W had the least score due to the fact that it retained red colour more, followed by 2W then 1W. The rest of the treatments changed colour significantly to the cooked brown meat colour. Treatment 3S and 3W were the most tender of all the treatments. Treatment 2S was found to be the least tender though not significantly different from DW, 1S and 1W while 3W was found to be the juiciest with 1S, 2S and 3S the least. Assessment of saltiness indicated that 3S tasted significantly more salty than the rest of the treatments. This was followed by 2S while the rest of the treatments were not significantly different. Flavour (odour and taste) profiling was not specific on meat flavour but the strength of the flavor with 3W and DW recording the strongest and weakest flavor respectively.

A sixteen member consumer panel was used to rank the meat pieces for preference on a graphical intensity scale. The results of the evaluation are similarly recorded in Table 4. The panel ranked 3S as the most preferred treatment but was however not significantly different from 1S and 2S. This was followed by 1W which was not scored significantly different from 1S with 3W being the least preferred. Most of the panel members commented that 3W had a soapy taste.

The consumer panel ranked 3S as the most preferred treatment. It was however not significantly different from 1S and 2S. This confirmed the role of sodium chloride in enhancing typical meat flavor in processed meat [15]. Preference rank was followed by 1W which was not scored significantly different from 1S while 3W was the least preferred. Most of the Red meat colour retention was highest in 3W followed by 2W then 1W. The reason for colour retention in 1W, 2W and 3W were not known. This could however be attributed to the presence of phosphates which increase meat pH and slow discoloration by stabilizing vitamin C [23] and also sequester metals responsible for oxidation of lipids [16]. The tenderness of 3S and 3W can be ascribed to high sodium chloride level and high phosphate level respectively which are known to improve tenderness[18],[25]. Invariably, 2S was found to be the least tender though it was not significantly different from DW, 1S, and 1W. Treatment 3W was found to be the juiciest while 1W the least. This can also be ascribed to the role of phosphates and sodium in all the treatments [18],[25]. Assessment of saltiness indicated that 3S tasted significantly more salty than the rest of the treatments. This was followed by 2S while the rest of the treatments were not significantly different though DW was the least salty. Flavour (odour and taste) profiling was not specific on meat flavour but the strength of the flavour. Treatment 3W had the strongest flavor which was soapy and thus undesirable. The soapy flavour could be due to saponification of free fatty acids by cations of potassium in the WSA [13]. Treatment DW recorded the least strength of flavour.

#### 4 CONCLUSION AND RECOMMENDATIONS

Protein, crude fat, ash and carbohydrate content were affected mostly by the moisture levels of the treatments. In addition, the ash level was also influenced by the mineral concentrations of WSA and TS solutions. The quality of ash, indicated by the mineral composition, was an important aspect of the research. Sodium content of samples treated with WSA was significantly lower than those treated with TS. This is an important milestone considering the benefits attributed to lower sodium content in foods and the added advantage of higher phosphorous for bone calcification.

Sensory scores for the consumer panel showed that samples treated with 1% TS were not significantly different compared to 1% WSA. This was an important finding and indicated the possibility of use of 1% WSA to replace 1% TS in dried beef. Similarly, 1% WSA was not significantly different from 2% TS. It is however important not to overlook the fact that most consumers are accustomed to higher sodium chloride in beef products and other muscle foods and will need to adjust to the new product if good

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