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Research Article

Effect of Three Tenderizers; (*Papain, Bromelain* and *Ficin*) on the Tenderization of Beef (Oxtail)

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Abstract

The study on the effect of three tenderizers *Papain* (Treatment II) *Bromelain* (Treatment III) and *Ficin* (Treatment IV) and control (Treatment I) on the tenderization of beef (oxtail) was investigated. The tenderizers efficacy was determined using enzymes individually from the plant vegetables on meat cut from cow oxtail (4 - 5 years of age) at the food science laboratory of Imo state university Owerri. Meat samples were subjected to sensory evaluation of 10 semi-trained panelists for acceptability and physiochemical analysis at the same laboratory in triplicate order. Results obtained from this study showed that all the tenderizing treatments were significant differences ($p < 0.05$) in all the meat samples. However, *Papain* (Treatment II) had the higher tenderizing effect while the control (Treatment I) showed the leash tenderizing effect. In the nutrient composition of tenderized meat, the control (Treatment I) showed the highest moisture content (69 - 58%) and crude protein (26 - 94%) whereas *Bromelain* (Treatment III) showed highest crude fat (6 - 7), ash content (1.12 %) and dry matter (38.35). *Bromelain* was significantly different ($P < 0.05$) among other tenderizers. Significant difference ($P < 0.05$) existed among on all the mineral contents of the meat tenderizers and control (Treatment 1). No significant difference ($P < 0.05$) was observed in the weight change and cost benefit of meat samples before and after cooking with tenderizers, including the control. Phytochemical analysis revealed that all the tenderizers showed positive result in saponin, they showed negative with cyanogenic glucoside except *Ficin.* The sensory evaluation result revealed that all the meat samples were accepted by consumers but consumers, preferred mostly, the *Papain* (Treatment II) meat samples as significant difference ($P < 0.05$) existed among other meat samples, while the control (Treatment I) was the least preferred. Hence, the three tenderizers had positive tenderizer effect on the cow oxtail meat. Therefore, meat from spent cow can be tenderized using these proteolytic enzymes (*Papain, Bromelain and Ficin*) rather than tenderizing with metals, potash, trona, carbonated beverages and salt which may be harmful to the human health.

Keywords: *Tenderizing Treatment; Oxtail; Plant Proteolytic Enzymes; Sensory Evaluation*

Introduction

Meat includes the flesh of animals typically mammals and birds used as food such as muscles and edible organs [1]. Meat is seen as those tissues of animals which are suitable for food use, all proceed and manufactured products processed from these tissues and inclusive. Toughness creates difficulty in the eating of meats; it is therefore, a challenge to cook the meat so that it gets tender and much easier to eat (Born, 2010). Meat can be classified into four (4) broad categories namely: Red meat, poultry meat, sea food and game meat [1].

A meat major constituent includes muscles, fat and bone. Other tissues include nerve and blood vessels. The Usefulness of meat as food depends on its chemical and physical properties associated within the connective tissues [2].

Meat comprises basically of protein, fats, minerals, phosphorous, iron and calcium. Some carbohydrates, nitrogenous and non-nitrogenous extractive pigments, enzymes, vitamins and water (www.meatscience.org/students/meat...J.3/July 2015). There are some miscellaneous soluble non-protein substances, with weight of about 2 - 3%. These nitrogenous substances such as Amino acids, nucleotides and creatinine. Also, inorganic substances and vitamins. However, Meat protein has about three (3) types namely Myofibrillar, Sarcoplasmic protein and Connective tissue.

The principal component of meat is estimated to have about 70 - 75% water and the most variable component in its fresh state and it affects its juiciness. Water holding capacities are the meat ability of retaining its water or add water, during application of external forces such as cutting, grinding or pressing. It influences texture and firmness of raw meat, palatability characteristics, juiciness and tenderness of cooked meat (www.meatscience.org/students/meat...J.3/July 2015).

Meat eating quality including tenderness, juiciness and flavour are considered the most important meat palatability traits by consumers (Lawrie and Ledward, 2006; Warriss, 2000). Meat ageing is a method of tenderizing meat, manufactured products for varying periods under controlled temperature and humidity condition [1]. In recent years, interest is growing in the development of better methods to produce meat with improved tenderness that aids in preserving meat nutritional qualities [3]. The basic methods used in meat tenderization are marination and in/organic acid injections. The physical and chemical methods improve meat tenderness with little effectiveness.

Oxtail is a cut of meat taken from the tail of a cattle. Oxtails are officially classified as offal, along with the assortment of organ meat (www.wisegeek.com/2004). An oxtail typically weighs 2 to 4 lbs (1 - 1.8 kg) and is skinned and cut into small or short length for sale. It is also a gelatin rich meat which is usually slow-cooked as a stew or braised (www.wisegeek.com/2004).

The most common sources of meat or domesticated animal species such as cattle, pigs, poultry and to a lesser extent buffalos, sheep and goats (Russio., *et al.* 2001).

In recent years from all the exogenous proteolytic enzymes used in meat tenderization, the cysteine protease has attracted considerable interest, in particular, vegetable cysteine protease. Some of them have long be used in cooking (Sullivan and Calkin, 2010). Madubike and Ekenyem [1] stated that the animal meat gets tougher or less tender with age. The use of plant enzymes as a method of tenderization. Based on this, there is need to use three (3) organic tenderizers *Papain* (from unripe paw-paw), *Bromelain* (from fresh pineapple) and *Ficin* (from the fig plant) in cooking beef (oxtail) with a view to achieving tenderness and other physical and chemical characteristics of good meat products.

However, most people use potash as tenderizer especially in oxtail and beef preparation. Medically, it has been observed that excess intake of potash may cause miscarriage or abortion in pregnant women and animals. Also, hyperkalemia may arise from excessive intake of potash. Some persons also tenderize meat with carbonated beverages such as cola and soda drinks (Aberdeen, 2017). Medically, it was reported by Naik (2015) that a can of coke contains approximately 10 teaspoons of sugar which spikes your blood sugar giving you an insulation burst as a response to your liver which dumps more sugar into your blood stream. In recent time, some individuals marinate meat in salt solution to achieve tenderness, but medically, excess intake of salt (Sodium Chloride) may lead/result to high blood pressure, leading to cardiovascular disease. Consumption of high amount of salt can also lead to stroke, heart failure and increase in stomach cancer. [4].

Papain is a natural source of proteolytic enzymes (Skelton, 2006), extracted from *Carica papaya* which acts on the structural components of muscle [2]. Cornier., *et al*. (2002) explained that it is unsafe to consume raw *Ficin* in large amounts because it can lead to diarrhea, it is also unsafe to use *Ficin* on skin because it can cause bleeding and allergic reactions (Kayumor, 2017). However, *Bromelain* is a proteolytic enzyme reported to be present in pineapple stem, fruits and waste materials, used as nutritional additive to assist digestive health and anti-inflammatory, antioedematous, absorption facilitator of antibiotic drugs, osteoarthritis and aids in digestion (Fitzhugh., *et al.* 2008).

It has been observed that meat from spent cattle especially female (cow) are tough during consumption posing a problem of rejection by consumers especially the young and the very elderly people that usually prefer tender meat. Therefore, some important questions may come as follows:

- How can meat from spent cow be tenderized to gain acceptability by young and the very elderly people?
- Will the use of tenderizers from plant extracts aid in the tenderization of the beef?
- Which of these tenderizers will best tenderize the beef with adequate health friendliness?
- The phytochemical and the proximate analysis of these three plant enzymes (*Papain, Bromelain, Ficin*).
- To improve the acceptability of beef from spent cow upon slaughter by consumers as an indices of improving meat quality.
- To compare the tenderization effect of *Papain, Bromelain* and *Ficin* on spent cow meat (Oxtail) based on tenderness.
- To ascertain the physical, chemical and organoleptic qualities of the tenderized meat according to consumers preference.
- To determine the economic viability and profitability of using the tenderizers in meat processing.

Therefore, there is every need to examine the use of plant exogenous enzymes extracted from paw-paw (*Papain*), pineapple (*Bromelain*), and fig (*Ficin*) to tenderize beef (oxtail) so as to make it acceptable and palatable to the consumers and also for safety and health reasons [5-11].

Materials and Methods

Procurement of samples

Freshly slaughtered cow meat (Oxtail) of about 4 - 5 years of age was obtained from modern market abattoir, Egbu Road, Owerri, Imo State for the analysis.

Materials for the experiment

a. *Papain*, b. *Bromelain*, c. *Ficin*, d. Syringe D Scotch tape for labeling, E. Desiccators, crucible and water bath, F. Muffle furnace for ashing, G. Volumetric flask, test tube and baker, h. Pipette, filter paper and funnel, I Covet (Container), J. Multi-parameter photometer, k. Slaughtering knife, pot, Oven (gas cooker), l. Reagents for phytochemical analysis of the three (3) tenderizers (*Papain*, *Bromelain* and *Ficin*) includes Ethanol's 100 ml, Distilled water, H_2SO_4, potassium hydroxide, Fehling solution, ferric chloride (F_3CL_3), Sodium hydroxide solution, $ALCL_3$, Conc H_2SO_4, M. Hand held refractometer (test for sugar content), N. Table salt, pepper, Onion and seasoning to taste, O. Cooking Utensils, P. Weighing balance, Q. Kjeldhal flask, R. Distillation flask, S. Burette and mixed indicators.

Experimental methods

There were altogether four treatments in this study. Treatment 1,0% tenderizer (the control, which is neither *Papain*, *Bromelain* nor *Ficin*), Treatment II (*Papain*), Treatment III (*Bromelain*) and Treatment IV (*Ficin*). They were all replicated three times.

Proximate analysis of the three tenderizers (Enzymes), Papain (Paw-paw), Bromelain (Pineapple) and Ficin (Fig plant)

The proximate analysis of these tenderizers was used to determine or the nutrients present in them and this process of analyzing the sample is known as proximate principles of the three tenderizers. These three samples were analysed into six (6) fractions which includes: water content, ash determination, protein (Crude Protein) Crude fibre determination, ether extract (fat) and nitrogen free extract (Other carbohydrates).

The Moisture content of the *Papain* (paw-paw), *Bromelain* (pineapple) and *Ficin* (fig) samples were determined using oven drying method. These samples were heated under specified condition of about 105°C and the loss in weight were used to calculate the moisture content of the samples (FAO, 2001).

Calculate the Moisture content as described in the equation.

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

Where W_1 = Initial weight of empty dish.

W_2 = Weight of dish plus food samples before drying.

W_3 = Final weight of dish plus food after drying.

The Protein (Crude protein) content was determined using the Kjeldhal method which was based on the wet combustion of the samples; *Papain*, *Bromelain* and *Ficin* by heating with concentrated H_2SO_4 (Hydrogen Tetraoxo sulphate VI) in the presence of Copper sulphate and Sodium Sulphate to effect the reduction of organic nitrogen in the samples to ammonia. Mixed indicator of methyl acid solution of titrate the ammonia direct with 0.1 normal hydrogen chloride (HCL):

% Protein =100% - (% water+ %ash+%fat) (FAO, 2001).

The Ether extract (Crude fat) was determined using the direct solvent extraction method by extracting the dried and ground material with a light petroleum fraction or spirit in a continuous extraction apparatus.

The Ash (Mineral) content was determined by heating the three ground samples in a crucible, in a muffle furnace set at 5500°C for 7hr. The weight of the ash gotten from the incinerated tenderizers (Samples) were then divided by the initial weight of the three tenderizer samples and multiplied by 100 to get the percentage of ash content (FAO, 2001):

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

W_1 = Empty crucible.

W_2 = Crucible with sample.

W_3=Weight after ashing.

Crude fibre determination was done by collecting dry matter sample residue of which biomolecules like proteins have been removed by successive treatment with boiling acid and alkaline, alcohols and ether. Crude fibre is made largely of cellulose together with a little lignin (FAO, 2001):

$$\text{\% of CF} = \frac{W_2 - W_3}{W} \times 100$$

W = Weight of ethanol.

W_2 = Weight of crucible with sample.

W_3 = Weight after ashing.

The Nitrogen Free extract (carbohydrates) was determined by adding up that which were from crude fibre, ash, moisture content and ether extract and subtracting from the dry matter of each of the three samples. Therefore, percentage of NFE (carbohydrate) is 100 - (1% moisture content + % Crude protein +% ether extract +% Crude Fibre +% ash) (FAO, 2001).

At the end of the experiment, the tenderized samples were tested and the result were subjected to statistical analysis using ANOVA (Analysis of variance) for completely randomizing design (CRD). Means of the various treatments were compared at 5% (0.05) level of probability using the Duncan's multiple Range test.

Sensory evaluation

The meat (Oxtail) from spent cow were washed after hairs must have been scraped off and cut into parts or bits. 5 ml of *Papain* was injected and applied evenly on the meat cuts and allowed to penetrate the cut for 2 hr, the same method was used for treatment III (*Bromelain*) and treatment IV (*Ficin*). The experiment was also carried out for treatment I (Control sample) which has neither *Papain*, *Bromelain* nor *Ficin*.

Meat samples were cooked using microwave set at 60^{o}C to reach tenderness. cooking, the cuts (Meats) were served to the taste panel of judges. Ten Judges selected from Academic staff of Faculty of Agriculture and Veterinary medicine, Departments of Food Science and Technology and the department of Nutrition and Dietetics, Imo State University, Owerri to assess the level of tenderness using 9 point hedonic scale.

Results and Discussion

Proximate analysis of the three tenderizers (Enzymes), Papain (Paw-paw), Bromelain (Pineapple) and Ficin (Fig plant)

Table 1 presents the proximate analysis of the three enzymes, *Papain* (Paw-paw), *Bromelain* (Pineapple) And *Ficin* (Fig Plant). Mean results in all the parameters in the showed differences P < 0.05. T II (*Bromelain* showed significant difference (P < 0.05) along the column, having all other parameters with highest value crude fibre (70.38), followed by Moisture value (12.39), however there was no value in the ash content (0.82).

Parameter	T1 Papain	TII Bromelain	TIII Ficin	SEM
Moisture	31.20^a	12.39^c	15.93^b	0.84
Crude Fat	1.46^a	2.81^b	4.79^a	0.48
Ash content	0.05^b	0.82^b	2.85^a	0.34
Crude Fibre	56.89^b	70.38^a	68.80^a	0.72
Crude Protein	2.13^a	2.63^{ab}	3.63^a	0.30
Nitrogen free Extract CHO	8.27^b	10.97^a	4.00^a	0.48

***Table 1:** Proximate analysis of the three tenderizers (Enzymes), papain (Paw-paw), bromelain (Pineapple) and ficin (Fig plant).*
SEM: Standard Error of Mean; Abed: Means on the same horizontal row with different superscript are significantly different @ (P < 0.05).

TIII (*Ficin*) showed no significant difference (P > 0.05) along the column except moisture content with the value (15.93). However, highest value was found in crude fibre (68.80), having Ash content with the least value (2.85).

TI (*Papain*) showed significant differences (P < 0.05) along the column with crude fibre having the highest value (56.89) and the least with Ash content (0.05).

Proximate analysis of tenderized meat samples

The data presented in table 2 revealed that the ANOVA results of the proximate analysis of the tenderized meat samples significantly differed (P < 0.05) in all the parameters. The results from the table of mean showed that TIII which is meat sample treated with *Bromelain* has significant difference highest in crude fats (6.77), Ash content (1.12), Crude fibre (0.43) and dry matter (38.35) to TI (Control), TII (*Papain*) and TIV (*Ficin*). TI (Control) which had neither *Papain, Bromelain* and *Ficin* had differed significantly (P < 0.05) highest in crude protein (26.44) and moisture content (69.58) to other treatments respectively. The least count was obtained in TI (Control) sample which shows significant difference (P < 0.05) in crude fat (0.39), NFE (2.09) and dry matter content (30.42) but varied significantly in crude fibre (0.24) with TIV (*Ficin*). TIV (*Ficin*) has significant difference (P < 0.05) least in crude protein (24.94) and ash content (0.53).

Parameter	TI (Control)	TII Papain	TIII Bromelain	TIV Ficin	SEM
Crude Protein Moisture	26.94^{a}	26.36^{a} 66.71^{b}	26.25^{a}	24.94^{a}	0.71
Crude Fat	69.58^{a}		61.65^{c}	66.71^{b}	0.59
Ash content	0.39^{b}	0.72^{b}	6.77a	0.92^{b}	0.29
Crude Fibre	0.76^{a}	0.63^{a}	1.12^{a}	0.53^{a}	0.30
	0.24^{b}	0.27^{b}	0.43^{a}	0.24^{b}	0.03
Nitrogen free Extract CHO	2.09^{c}	5.31^{ab}	3.78^{ab}	6.66^{a}	0.70
Dry Matter	30.42^{b}	33.29^{b}	38.35^{a}	33.29^{b}	1.08

Table 2: *Nutrient composition of tenderized meat samples.*

SEM: Standard Error of Mean; Abed: Means on the same horizontal row with different superscript are significantly different (P < 0.05).

Mineral determination of the tenderized meat samples

Anova results obtained from the mineral assay of the tenderized meat sample showed significant difference (P < 0.05) in table 3.

Parameter	TI (Control)	TII Papain	TIII Bromelain	TIV Ficin	SEM
Sodium Calcium	0.047^{b} 0.063^{b}	0.082^{a} 0.102^{a}	0.049^{a} 0.050^{c}	0.048^{b} 0.037^{d}	0.003 0.003
Phosphorous	0.029^{b}	0.056^{b}	0.031^{b}	0.029^{b}	0.004
Potassium	0.002^{c}	0.019^{a}	0.004^{b}	0.003^{bc}	0.001
Magnesium	0.017^{ab}	0.024^{a}	0.013^{bc}	0.009^{c}	0.005

Table 3: *Mineral determination of the tenderized meat samples.*

SEM: Standard Error of mean; Abc: Means on the same horizontal row with different superscript are significantly different (P < 0.05).

The result of the experiment TII (*Papain*) had highest significant difference (P < 0.05) among all the parameters; Sodium (0.082) Calcium (0.102), Phosphorous (0.056), Potassium (0.019) and magnesium (0.024). TI and T4 varied significantly (0.029) in phosphorous content. TI (Control) differ significantly (P < 0.05) having least value in Sodium (0.047) and Potassium (0.002) respectively to other treatments.

Weight of meat samples before and after cooking

Anova results of the data presented on the weight of the meat samples before and after cooking showed some similarities and had significant difference (P < 0.05) in table 4.

Parameter (g)	TI (Control)	TII Papain	TIII Bromelain	TIV Ficin	SEM
Before cooking	403.33^a	426.00^a	420.33^a	424.00^a	8.35
After cooking	279.33^a	280.00^a	294.33^a	281.33^a	14.20
Weight change (Loss)	124.00^a	146.00^a	126.00^a	142.67^a	6.86

Table 4: *Weight of meat samples before and after cooking.*

SEM: Standard Error of Mean; Abcd: Means on the same horizontal row with different superscript are significantly different (P < 0.05).

Weight before cooking had significant difference with highest value in TII which was meat sample treated with *Papain* (426.00) followed by TIV, TIII and TI respectively. Weight after cooking had significant difference with highest value in TIII which was meat sample treated with *bromelain* (294.33) among other treatments. Weight loss during cooking was observed in all treatments leaving TI (Control) which had neither of the tenderizers with the least (124.00).

Cost benefits and implication

The data presented in table 5 shows similarities and significant differences (P < 0.05) in the mean on the same horizontal row. Cost of the meat before cooking and after cooking showed the highest value (1.45) with the control (Sample TI) and after cooking also it showed the least value (2.20) in cost with the control Meat sample (TI) which had neither *Papain*/*Bromelain* nor *Ficin*.

Parameter (g/N)	TI (Control)	TII Papain	TIII Bromelain	TIV Ficin	SEM
Cost of Meat before cooking (g)	1.45^a	1.36^a	1.37^a	1.39^a	0.05
Cost of Meat after cooking (g)	2.20^a	2.42^a	2.96^a	2.78^a	0.29

Table 5: *Cost benefits and implication*

SEM: Standard Error of mean; Abcd: Means on the same horizontal row with different superscript are significantly different (P < 0.05).

Anova result obtained from the sensory evaluation acceptance test in table 6 showed significant difference (P < 0.05) in all the sensory attributes of the spent meat samples (Appearance, taste, aroma, texture and over all acceptability). TII (*Papain*) showed highest values in all sensory attributed of meat samples following Texture (9), Taste (8), Aroma (9) and Overall acceptability (8) except TIII (*Bromelain*) which had the highest in appearance (8). TI (Control) decreased significantly (P < 0.05) in Aroma (3), Overall acceptability (4), Texture (6) but have similarities in appearance (6) and taste (7) with treatment with *Ficin* (4).

Parameters	TI (Control)	TII (Papain)	TIII (Bromelain)	TIV (Ficin)	SEM
Appearance	6^b	7^b	8^a	6^b	0.37
Texture	6^c	9^a	8^{ab}	7^{bc}	0.41
Taste	7^{ab}	8^a	6^a	7^{ab}	0.33
Aroma	3^c	9^a	7^a	6^a	0.37
Overall acceptability	4^b	8^a	5^{ab}	6^{ab}	0.69

Table 6: *Sensory evaluation/organoleptic assessment.*

SEM: Standard Error of mean; Abcd: Means on the same horizontal row with different superscript are significantly different (P < 0.05).

From the results of the experiment based on the judges observation in table 7 had significantly analyzed statistically at probability level 0.05.

Parameters	TI (Control)	TII (Papain)	TIII (Bromelain)	TIV (Ficin)	SEM
Judge1	6^{b}	9^{a}	6^{b}	7^{b}	0.37
Judge2	6^{c}	9^{a}	8^{ab}	7^{bc}	0.41
Judge3	7^{ab}	8^{a}	7^{ab}	6^{b}	0.33
Judge4	4^{c}	9^{a}	6^{b}	8^{a}	0.37
Judge5	3^{c}	9^{a}	7^{b}	6^{b}	0.37
Judge6	8^{a}	7^{a}	4^{b}	8^{a}	0.48
Judge7	5^{b}	7^{a}	6^{ab}	6^{ab}	0.44
Judge8	5^{ab}	8^{a}	4^{b}	5^{ab}	0.90
Judge9	4^{b}	8^{a}	7^{a}	7^{a}	0.29
Judge 10	4^{a}	8^{a}	5^{ab}	6^{ab}	0.069

Table 7: *Sensory evaluation judges overall acceptability.*

SEM: Standard Error of Mean; Abcd: Means on the same horizontal row with different superscript are significantly different (P < 0.05).

TII (*Papain*) treated meat sample had significant difference in all the judges (Judge I-X) at P < 0.05.

TI (Control) which has neither *Papain*, *Bromelain* nor *Ficin* had significant difference (P < 0.05) least in the Judges findings followed by *bromelain* (TIII) and *Ficin* (TIV).

	Papain	Bromelain	Ficin		Bromelain	Papain	Ficin
Sugar	3%	11.2%	5.2%	Tannin	-ve	-ve	-ve
				Saponin	+ve	+ve	+ve
	Brix	Brix	Brix	Cyanogenic glucoside	-ve	-ve	+ve
Alcohol	1%	1%	1%	Flavonoid	+ve	+ve	-ve

Table 8: *Sugar and phytochemical analysis of papain, bromelain and ficin.*

The sugar was determined using handled refractometer.

Discussion

From the result of the experiment based on the proximate analysis of the three enzymes (*Papain*) differs significantly (P < 0.05) much in moisture content to other treatment.

TII (Bromelain) had significantly different (P < 0.05) more in crude fibre (70.38), Nitrogen free extract (10.97) and dry matter contents (87.61) to other treatments. More so, TIII (*Ficin*) had the highest values in crude protein (3.63), crude fat (4.79) and ash content (2.85). TI (*Papain*) had the least values in crude fat (1.46), Ash (0.05), Crude fibre (56.89), Crude protein (2.13) and dry matter content (68.8) to other treatments. TIII (*Ficin*) has also significant difference highest in crude protein content (3.63), Crude fat (4.79) and ash content (2.85). TI (*Papain*) had lowest value in Crude fat (1.46), Ash (0.05), Crude fibre (56.89), Crude Protein (2.13) and dry matter content (68.8) which was significantly different (P < 0.05) to other treatments.

The data obtained from the proximate analysis of the tenderized meat samples significantly differed (P < 0.05). TIII (Bromelain) differed significantly (P < 0.05) with highest values in crude fibre (0.43), crude fat (6.77), Ash (1.12) and dry matter content (38.35) to other treatments. TIV (*Ficin*) had significant different (P < 0.05) with least values in Crude protein (24.94) and Ash content (0.53) to other treatments. TIII (*Bromelain*) differed significantly (P < 0.05) with least values in Moisture content (61.65) to TI, TII and TIV respectively. TIII which is the meat sample treated with *Bromelain* differs and had significant higher cost after meat has been cooked to other treatments with (2.94).

TIII (*Bromelain*) differed significantly (P < 0.05) in Appearance with the highest score (8) to other treatments but decreased significantly (P < 0.05) in taste to other due to sugary or sweet taste of the pineapple which affected the meat sample. The tenderness observed in treatments with TII, TIII and TIV were as a result of the change caused by the proteolytic enzymes which is in line with Madubike and Ekenyem [1] who stated that *Papain* from paw-paw, *bromelain* from pineapple and *Ficin* from fig are all vegetable enzymes capable of regarding or dissolving collagen and elastin.

Conclusion

It can be concluded from the results obtained that *Papain* differs significantly (P < 0.05) from the other tenderizers with the highest Tenderizing effect, followed by *bromelain* and *Ficin*, Leaving the TI (Control) with no tenderizing effect.

The Effect of Tenderizer on sensory acceptability showed that *Papain* differed significantly (P < 0.05) with the highest score for taste (8), Texture (9), Aroma (9) and Overall acceptability (8) followed by *bromelain* and *Ficin*, leaving the control with least acceptability option.

However, *Papain* also differed significantly (P < 0.05) with the highest mineral composition content followed by *bromelain* and then the *Ficin* leaving the control with no treatment effect.

Bromelain on the other showed significant difference (P < 0.05) with the highest nutrient composition of the tenderized meat samples followed by *Papain* and then *Ficin* leaving the control the worst tenderizer.

In the nutrient composition of the three enzymes (Tenderizer) samples (*Papain*, *bromelain* and *Ficin*) differs significantly (P < 0.05) in all the parameters analysed.

In the cost benefits and Implications, meat treated with *Papain* can be considered the best followed by *bromelain* and *Ficin* in the term of price of tenderizers (enzymes) but significantly showed some similarities in all the parameters when analysed.

Therefore, meat from spent cattle (cow) can be tenderized using these proteolytic enzymes (*Papain*, bromelain and *Ficin*) rather than tenderizing with metals, potash, carbonated beverages (Coca-cola and soda drinks) salts which may be harmful to the human health.

Papain stands to be the most effective in meat tenderization followed by *bromelain* and *Ficin*. However, all the tenderizing treatments stand better chance than the control as there is enhancement in nutrient composition of treated samples.

Recommendations

Based on the above findings, I recommend that the level of meat wastage from cow can be reduced by imposing its level of tenderness through the use of vegetable/plant enzymes such as *Papain*, *bromelain* and *Ficin* to cook or tenderized tough meat. This tenderization should also be accepted and adopted in the meat industry by injecting small standardized quantity of this proteolytic enzyme into animal muscles before slaughter for easy tenderization when cooking.

I also recommend the use of these enzymes to be adopted by livestock research institutes, students of Animal sciences, Nutrition and dietetics, food science and technology, Hospitality and management technology, Economics and Animal product processing industries.

Livestock research institutes and students of animal science should conduct more research works on the use of plant tenderizing agents to improve the quality of cow meat based on its tenderness and nutritional benefits to human health.

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