

Nutritional composition and sensory properties of raw and roasted “Niri” (*Citrullus vulgaris*) puree extended beef sausages

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ABSTRACT

*The rising demand for quality meat products at competitive prices demands that processors explore less costly local feed resources for incorporation into meat products. This study investigated the effects of raw and roasted “Niri” (*Citrullus vulgaris*) purees (as an extender) on the nutritional and sensory qualities of beef sausages. “Niri” purees (treatments) were randomly assigned to minced beef. That is, raw (RaP) and roasted (RoP) “Niri” purees were separately added to 1kg minced beef at 0% (control), 5%, 15% and 25% inclusion levels. The proximate composition, mineral concentration and sensory attributes were evaluated. The study revealed a significant difference ($P < 0.05$) in all proximate parameters with RaP 25% recording the highest protein, ash and fat content, RoP 25% had the highest carbohydrate content while the control had the highest moisture content in percentage per gram on dry matter basis. There was increasing proximate values as the inclusion levels increased except moisture where there was a reverse. Protein, fat, ash and carbohydrates recorded values that were in the range of 18.14 - 22.02%, 0.42 - 3.07%, 1.31 - 2.16%, and 0.26 - 2.94%, respectively for all samples. pH values ranged from 5.84 - 6.15, with the highest values recorded in high inclusion products. Mineral contents ranged from 2.67 - 3.63mg/g (calcium), 0.20 - 0.34mg/g (iron), 27.33 - 29.92mg/g (potassium), 15.10 - 21.86mg/g (magnesium) and 0.45 - 0.62mg/g (zinc) in all samples. Sausages extended with raw purees generally had significant ($P < 0.05$) mineral levels than the roasted puree products. There were no significant differences ($P > 0.05$) in all sensory parameters evaluated except colour and tenderness ($P < 0.05$). Products extended with raw “Niri” had better colour scores (3.46 - 3.6) than roasted “Niri” puree extended products (1.73 - 2.66). The addition of “Niri” improved the nutritional quality of beef sausages, however, it significantly ($P > 0.05$) affected the colour and tenderness of beef sausages.*

Keywords: *Citrullus vulgaris* (“Niri”), proximate, sausages, puree, raw, roasted

INTRODUCTION

Meat products including sausages are sources of high-quality protein for nourishment and each meat product mostly possesses a unique

and characteristic taste that attracts consumers. According to the European Food Information Council (2008), meats and meat products have high biological value making it easily absorbable by the human body. Meat

and meat products are excellent supplies of minerals, complete proteins and vitamins (Verbeke *et al.*, 2010); and thus contribute to the high demand for meat in human meals.

Consumers of meat and meat products of late demand healthier products that are fresh, low in nitrates, calories, cholesterol and salts, and health-promoting bioactive compounds like carotenoids, unsaturated fatty acids, fibres and sterols (Badpa and Ahmad, 2014; Nsoah *et al.*, 2019). These are usually found in meat and meat products, and due to health complications associated with some of these ingredients much consideration is given to their consumption. These have led processors to produce meat products with more lean meat, and the practice leads to high production cost because boneless meat is high-priced (Teye *et al.*, 2012). This subsequently makes products expensive, limiting patronage to the wealthy and high-income earners (Adjekum, 1997).

To make meat product affordable to all income levels, processors are now finding efficient and competitive ways to produce products at reduced cost (Jochen *et al.*, 2010) by using meat extenders (Teye *et al.*, 2012; Adzitey *et al.*, 2015; Teye *et al.*, 2015; Adzitey *et al.*, 2016; Herman *et al.*, 2019; Ossom *et al.*, 2020a; Ossom *et al.*, 2020b). According to Food and Agricultural Organisation, FAO (2013), extenders are protein additives that increase water binding capacity, yield and nutritional (protein) quality of meat products and reduce cost as they are usually cheaper than lean meat. However, the desire to reduce the cost of meat products must not reduce the nutritional content of the products especially protein which is the main nutrient in meat. Notable extenders are; soy beans, cowpea, milk proteins, flours of cereals and oil seeds (FAO, 2013). These extenders are not readily available in required quantities in northern Ghana all year round due to poor yields as a result of erratic rainfall. This usually leads to

high cost of most feed resources at certain times hence the need to explore other locally available feed resources. Furthermore, some of these extenders are imported at a higher cost compared to using locally available food resources for same.

One local seed resource as a potential extender which is currently untapped is “Niri” (*Citrullus vulgaris*) a member of the melon families. Adua *et al.* (2019) found that “Niri” is a good source of fat (42.27%/g), proteins (20.30%/g) and minerals (calcium, iron, potassium, magnesium and zinc) and a cheap protein resource for most rural families. Adua *et al.* (2019), stated that “Niri” is commonly used in the preparation of soups and stews in rural communities. This study determined the potential of “Niri” purees (raw and roasted) as extenders on the nutritional and sensory characteristics of beef sausages. To the best of our knowledge, this is the first report on the use of “Niri” as an extender in beef sausages.

MATERIALS AND METHODS

Experimental design

All trials were carried out using completely randomised design. Equal amounts of spices were added to minced beef (1kg). The treatments (raw and roasted “Niri” purees) were each randomly assigned to minced beef at 0, 5, 15 and 25% inclusion rate.

Processing of “Niri” seeds

Ten (10) kg of “Niri” seeds were obtained from Aboabo Market in Tamale Metropolis. Each kilogram of seeds was fully immersed in half bucket of water and washed thoroughly. Seeds were then allowed to settle and all debris and empty seeds that floated were removed. Settled seeds were sun-dried (at a temperature of 29°C and relative humidity of 59%; CustomWeather, 2019) for 8 hours, winnowed and bagged for roasting and/or milling. For the roasting of seeds, a

kilogram of seeds was spread on a 50×35cm² steel tray and roasted at 220°C for 30 minutes (manually stirred at 10 minutes' interval) using an electric oven (Turbofan Blue seal, UK). Seeds were then spread on a clean floor for cooling, bagging and milled using corn mill.

Preparation of “Niri” puree

One kilogram of milled “Niri” seeds (raw or roasted) was mixed in 1.5 litres of tap water for a start and sieved with a cheese cloth into a bucket. The semi-sieved sample was mixed with 0.75 litres of water and sieved to obtain the chaff. The chaff was for the third time mixed with 0.75 litres of water and sieved. The filtrate was then kept in a refrigerator (4°C) for 24 hours and decanted to obtain the puree. The puree was then stored in a freezer (-18°C) for further use.

Formulation of “Niri” beef sausages

Thirteen (13) kg of boneless beef was bought from University for Development Studies (UDS) Meats Unit and thawed at 4°C. The meat was chopped into smaller pieces and minced in a 5mm sieve table top mincer (Tallers Ramon, Spain). The purees (raw and roasted) were incorporated at 0, 5, 15 and 25% inclusion per 1 kg minced meat. The incorporation levels were chosen to determine the best level of inclusion without exceeding the 25% inclusion limit for non-meat ingredients in sausages (Ismed, 2016). Spices; 15g curing salt, 0.5g red pepper, 2.0g adobo®, 1g each of black and white pepper and 5g of polyphosphate were added into each treatment. One hundred and fifty grams (150g) of ice cubes were added to each level and then comminuted. The comminuted paste was stuffed into natural casings using hydraulic stuffer (Talleres Rammon, Spain), linked into equal lengths of approximately 10cm manually. The products were then smoked (Laint Smoker, Spain) to a core temperature of 70°C for 15 minutes, scalded

in water to cool the products, packaged and stored in a deep freezer (-18°C) for sensory evaluation and nutritional analysis.

Proximate, pH and mineral analyses of “Niri” beef sausages

Crude protein, moisture, crude fat, ash, carbohydrates and mineral contents were analyzed to ascertain the nutritional values of extended products by following the procedures in the International Association of Official Analytical Chemist (2005). Briefly, crude protein and crude fat were determined using the Kjeldhal and soxhlet extraction methods, respectively. Moisture was determined by oven drying samples (5g) at 105°C for 5 hours. The ash content was determined by completely burning 5g of sample in a muffle furnace at 600°C for 2 hours. The amount of carbohydrate was then determined by difference [100% - (%ash + % crude protein + % crude fat + % moisture)]. Mineral (calcium, zinc, iron, potassium and magnesium) content was analysed by digesting a gram of sample in 5.0ml of doubled distilled water, followed by addition of 4.0ml of NHO₃-HClO₄. Five (5) milliliters of concentrated H₂SO₄ was added after which the sample mixture was heated at 200°C until solution was clear. The solution was cooled and topped with distilled water to 50 ml mark. The samples were then ran with ASPECT LS software using Atomic Absorption Spectrometer (AAS). The pH of products was determined by grinding 10g of sample using laboratory pestle and mortar and, homogenising with 10ml of deionized water for 30 minutes before taking readings using pH meter (CpH METER BASIC 20, Spain).

Sensory analysis of “Niri” beef sausages

Samples were removed from freezer and allowed to thaw for 4 hours at room temperature. Thawed samples were grilled to a core temperature of 70°C for 15 minutes,

sliced to about 2cm³ and wrapped with aluminium foil to keep warm and packed into transparent containers with lids before analysis. Sliced bread and sachet water were provided to taste panelists after each treatment to serve as pallet neutralizer during the tasting. Fifteen (15) students from the Faculty of Agriculture of University for Development Studies, Tamale were selected randomly and trained according to the British Standard Institution (1993) guidelines to constitute the taste panel. Products were evaluated for aroma, flavour liking, juiciness, tenderness, texture, taste, colour and over-all acceptability using a five-point hedonic scale (Colour : 1 = very dark, 2 = dark, 3 = intermediate, 4 = pale, 5 = very pale, Aroma : 1 = very offensive, 2 = offensive, 3 = intermediate, 4 = pleasant, 5 = very pleasant, Flavour Intensity : 1 = very weak, 2 = weak, 3 = intermediate, 4 = strong, 5 = very strong, Flavour Liking : 1 = dislike very much, 2 = dislike, 3 = intermediate, 4 = like, 5 = like very much, Texture: 1 = very rough, 2 = rough, 3 = intermediate, 4 smooth, 5 = very smooth, Tenderness: 1 = very tough, 2 =tough, 3 = intermediate, 4 = tender, 5 = very tender Juiciness: 1 = very dry, 2 = dry, 3 intermediate, 4 = juicy, 5 very juicy, Taste: 1 = very bitter, 2 = bitter, 3 = intermediate, 4 =

sweet, 5 = very sweet, Overall acceptance: 1 = dislike very much, 2 = dislike, 3 = intermediate, 4 = like, 5 = liked very much). Panelists independently evaluated each treatment in an appropriately lit room at the UDS Meats Unit.

Statistical analysis

Data were analysed by One-way Analysis of Variance (ANOVA) in Genstat Discovery 4th edition. Where there were significant differences ($P < 0.05$), means were separated using Tukey studentised range test at 5% significant level.

RESULTS AND DISCUSSIONS

Proximate composition of raw and roasted “Niri” puree beef sausages

Table 1 shows the proximate contents of beef sausages prepared from either raw, roasted ‘Niri’ or no ‘Niri’ (control). There were significant differences ($P < 0.05$) in all parameters except carbohydrate ($P > 0.05$). Although there was no significant difference ($P > 0.05$) in carbohydrate content, the extended products (raw and roasted “Niri” puree beef sausages) were higher than the control and increased as the inclusion level increases.

TABLE 1. Proximate composition of raw and roasted “Niri” puree beef sausages

Parameter	Contr ol	RaP 5%	RoP 5%	RaP 15%	RoP 15 %	RaP 25%	RoP 25%	S.e.d	P-value
Ash	1.39 ^c	1.88 ^{ab}	1.31 ^c	2.00 ^{ab}	1.59 ^{bc}	2.16 ^a	1.87 ^{ab}	0.1782	0.014
Carbohy-drate	0.26	0.65	0.49	2.00	1.58	2.94	2.03	0.769	0.072
Fat	0.42 ^f	1.13 ^e	1.08 ^e	1.87 ^c	1.37 ^d	2.19 ^b	3.07 ^a	0.0805	<.001
Moisture	78.73 ^a	76.51 ^d	77.03 ^b	75.65 ^e	76.84 ^c	70.8	71.43 ^f	0.116	<.001
Protein	19.19 b ^c	18.14 ^c	18.53 ^c	19.08 ^{bc}	19.70 ^b	21.8	22.02 ^a	0.466	<.001

RaP - Raw Puree, RoP - Roasted Puree, , S.e.d.- Standard error of difference, Means in a row with the same superscripts are not significantly different ($P > 0.05$)

Moisture values ranged from 70.88-78.73%, with values decreasing as inclusion levels increased. Moisture in products has the ability to improve the juiciness and tenderness of meat products which enhances sensory qualities. The results however, disagrees with Haluk *et al.* (2014) who reported increasing moisture content as the inclusion level of potato puree was increased (66.8 - 67.6%) in meat balls from 10 - 20%. The moisture contents in this study were higher than that of Ossom *et al.* (2020b) who reported 56.15 - 66.45% moisture in sweet potato puree extended frankfurter sausages. The high moisture content, therefore, tends to improve the eating quality of products.

The fat content of the “Niri” puree extended products was significantly higher ($P < 0.05$) than the control. The high fat content of extended products is as a result of the high-fat content of raw (13.79%) and roasted (13.00%) “Niri” purees as reported by Adua *et al.* (2019). Despite the health concerns (cholesterol and its association with hypertension and cardiovascular diseases), dietary fat has a positive impact on juiciness, flavour and texture of processed meat products (Crehan *et al.*, 2000) and gives more energy than carbohydrate per kilogram dry matter. The increasing fat content as inclusion increased agrees with Hegazy (2011) who reported increase fat content with increasing inclusion level of fenugreek in beef sausages.

A significant difference ($P < 0.014$) was observed in the ash contents of the products. Ash content gives an idea of the presence of minerals. The treatments recorded 0.2 - 0.77% higher than the control except 5% roasted puree which was lower. Raw puree products had higher ash content than roasted products implying that, roasting is detrimental to ash content hence consuming raw” Niri” puree product has the potential of providing consumers more minerals than roasted “Niri” puree products. The scores

increased as the inclusion levels of each treatment increased. The results were lower than sweet potato puree extended frankfurter sausages (5.15 - 6.92%) reported by Ossom *et al.* (2020b).

This study showed a high protein content as the inclusion level of roasted “Niri” puree increased in products. The results of this study disagree with Haluk *et al.* (2014) who found no significance ($P > 0.05$) in protein content as inclusion level of potato puree increased from 10% (17.7% protein) - 20% (17.0% protein) in meatballs. The outcome of this study also disagrees with Ossom *et al.*, (2020b) who recorded a decline in protein content as the percentage inclusion level (10-15%) of sweet potato puree in frankfurter sausage (6.8 - 5.15% in white flesh sweet potato puree and 6.78-5.84% in purple flesh sweet potato puree) increased. The high protein results of this study (18.14 - 22.02%) will satisfy the contemporary global Recommended Dietary Allowance (RDA) of 0.8g per kg body weight irrespective of age (Food and Nutrition Board, 2005) since a gram of “niri” puree extended sausages will give consumers more than the 0.8g as recommended.

Mineral compositions of raw and roasted “Niri” puree beef sausages

Calcium, iron, potassium, magnesium and zinc contents of the beef sausages are presented in Table 2. There was significant difference ($P < 0.05$) for all parameters. Extended products (raw and roasted “Niri” puree beef sausages) recorded high values in calcium, iron and magnesium than the control at high inclusion levels.

Raw puree products generally had higher (2.83 - 3.63mg/g) calcium values than roasted puree samples (2.77 - 3.49mg/g). This means roasting reduced the calcium content of purees. Nonetheless, “Niri” could serve as a source of calcium when consumed.

Iron is an essential component of blood haem in promoting respiration. Iron content increased in roasted products as the inclusion level increased, this agrees with Ossom *et al.* (2020b) who found 0.2379 and 0.3019mg/g in 10 and 15% white flesh sweet potato puree frankfurter sausages, respectively. They also

detected a rise in iron content from 10 - 15% orange flesh sweet potato puree frankfurter sausages from 0.2112 - 0.2889mg/g. This implies consuming these extended sausages could serve as a good source of iron for consumers.

TABLE 2. Mineral composition of raw and roasted “Niri” puree beef sausages (mg/g)

Parameter	control	RaP 5%	RoP 5%	RaP 15%	RoP 15 %	RaP 25%	RoP 25%	S.e.d	P-value
Calcium	2.67 ^f	2.83 ^{de}	2.77 ^e	3.29 ^c	2.91 ^d	3.63 ^a	3.49 ^b	0.1782	<0.001
Iron	0.25 ^d	0.20 ^f	0.23 ^e	0.27 ^c	0.22 ^e	0.34 ^a	0.32 ^b	0.7690	<0.001
Potassium	29.91 ^a	28.96 ^c	29.23 ^b	29.85 ^a	29.33 ^b	29.40 ^b	27.33 ^d	0.0805	<0.001
Magnesium	1510 ^e	15.88 ^d	17.01 ^c	19.96 ^b	20.17 ^b	21.61 ^a	21.86 ^a	0.1160	<0.001
Zinc	0.62 ^a	0.56 ^b	0.55 ^b	0.50 ^c	0.53 ^b	0.45 ^d	0.47 ^d	0.4660	<0.001

RaP - Raw Puree, RoP - Roasted Puree, , S.e.d.- Standard error of difference, Means in a row with the same superscripts are not significantly different ($P>0.05$).

Dietary magnesium deficiencies cause hyperactivity, depression, low-stress tolerance and poor athletic performance (Grober *et al.*, 2015). Magnesium content increased as inclusion levels of raw and roasted “Niri” puree increased in extended products. This means the temperature at which “Niri” seeds were roasted did not destroy the magnesium content of the treatment. The results from extended sausages suggest that consuming these products on 100g bases for a day will far exceed (1,508 - 1,766mg/day) the 80 - 420mg/day recommended by the Institute of Medicine (1997) for all categories of persons. Control sausages had the highest zinc content (0.62 mg/g) due to the fact that beef contains 4.6 mg of zinc (William *et al.*, 2007) than the 0.18 - 0.4 mg for “Niri” purees (Adua *et al.*, 2019). Raw and roasted “Niri” samples however, contained 0.45 - 0.56 mg/g and 0.47 - 0.55 mg/g, respectively. Zinc content decreased with increasing inclusion level of raw and roasted “Niri” puree. Consuming

“Niri” extended products will however meet the 1.0 and 1.4 mg/day, respectively for females and males (World Health Organization, 1996) since a 10 gram serving of “Niri” puree extended sausages a day will provide a consumer between 4.5 - 5.6mg of zinc. The zinc value of the control agrees with the findings that zinc is a common source in meat, fish and cereals (Desphande *et al.*, 2013). Consuming “Niri” puree based products could contribute to reducing growth retardation in children (Brown *et al.*, 2002). It will also contribute to improving reproduction in males (Nriagu, 2007) and reduce deficiencies in sickle cell persons (Desphande *et al.*, 2013) as a result of the good zinc content in extended samples. Potassium in the beef sausages ranged from 27.33 - 29.91mg/g. Potassium which is the third most abundant mineral in the body plays important roles including helping in muscle contraction, ensuring the normal functioning of the heart and managing water balance in the body (Pohl *et al.*, 2013). Potassium also

lowers the risk of developing high blood pressure, kidney-stones, osteoporosis (Pohl *et al.*, 2013). However, consuming raw and roasted “Niri” puree sausages will provide lower amount of potassium in ones’ diet compared to the control.

pH of “Niri” puree extended beef sausages

Figure 1 indicates the pH of the beef sausages containing various levels of raw and roasted “Niri” purees. The raw “Niri” puree extended samples had a pH of 5.84 - 6.04, the roasted “Niri” puree extended samples had a pH of 5.84 - 6.15 and the control had a pH of 5.93. pH indicates the longevity of products as high (>7) values promotes the proliferation of microorganisms that deteriorates the quality of products. The pH values in this study will hamper the proliferation of most bacterial pathogens as the values are below 7. This is

because many microorganisms with the exception of *Clostridium botulinum* and *Clostridium sporogenes* do not thrive well under acidic conditions (Dilbaghi and Sharma, 2007). The result of this study is similar to the 5.85 - 6.10 pH values recorded for different sausages marketed locally in São Paulo (Ferrari and Torres, 2002) and the 5.81 - 6.06 in sweet potato puree extended frankfurter sausages reported by Ossom *et al.* (2020b). Bhat and Pathak (2011) also reported increasing pH values as the inclusion level of black beans increased in chicken seekh kababs. The results therefore suggest that, the products are likely to have extended shelf life as they have low acidic values. Dilbaghi and Sharma (2007) reported that acidic conditions result in long shelf life of products.

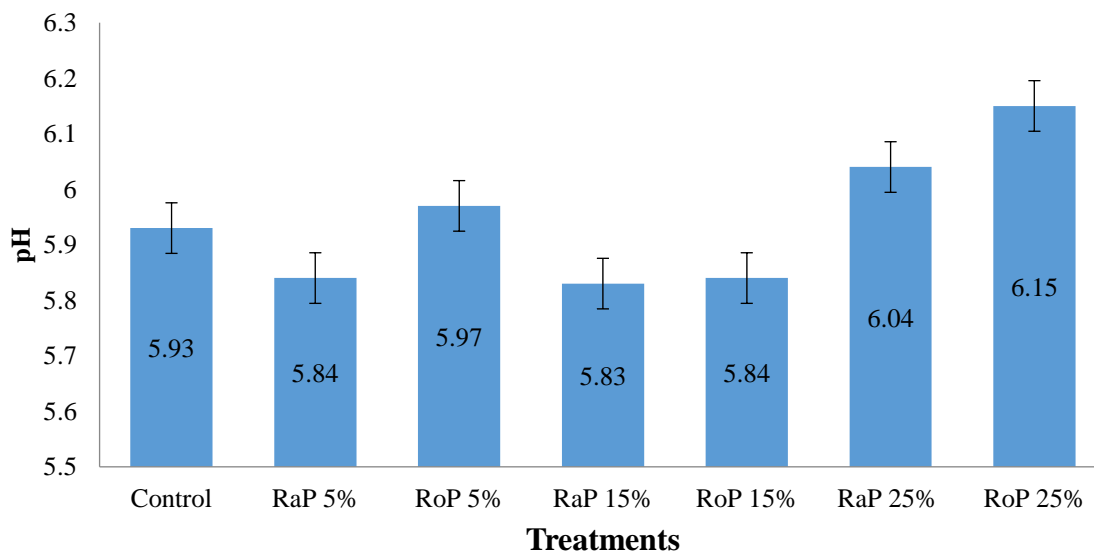


Figure 1. pH of raw and roasted “Niri” extended sausages
Error bars represent standard error of means, RaP – Raw Puree, RoP – Roasted Puree

Sensory characteristics of raw and roasted “Niri” puree extended beef sausages

There were no significant differences ($P > 0.05$) in aroma, flavour liking, juiciness,

tenderness, texture, taste, and overall-acceptability. There were however,

significant differences in samples for colour and tenderness. Consumers are not likely to buy or eat any product that has a colour different from what they are not familiar with. The colour difference in this study was due to the roasting of “Niri” seeds. Roasting resulted in the darkening of seeds (Mishra *et al.*, 2014) causing the dark colour of roasted puree extended beef products (1.733 - 2.667). The raw puree products recorded mean values of 3.467 – 3.600 which indicates neither like nor dislike colour on the hedonic scale. The values are however skewed toward paleness than the control treatment due to the white colour of “Niri” pulp.

Roasted puree products recorded significant ($P < 0.05$) tenderness than raw puree products.

Roasting therefore, resulted in softness of roasted puree extended samples and tenderness correlated with the moisture content of products. Tenderness and colour differences did not result in the dislike of products by panellists.

The addition of raw and roasted “Niri” purees had similar sensory characteristics as the control. The results also agreed with Haluk *et al.* (2014) who reported no sensory difference ($P > 0.05$) except texture between potato puree and bread crumbs (control) in meatballs. The addition of sweet potato purees in frankfurter sausages did not affect the sensory properties of samples Ossom *et al.* (2020b).

TABLE 3. Sensory characteristics of raw and roasted “Niri” puree sausage products

Quality	Control	RaP 5%	RoP 5%	RaP 15%	RoP 15%	RaP 25%	RoP 25%	S.e.d	P-value
Aroma	2.73	3.00	2.60	2.67	2.87	2.73	2.60	0.421	0.960
Colour	2.53 ^b	3.53 ^a	2.66 ^b	3.60 ^a	2.26 ^b	3.46 ^a	1.73 ^{bc}	0.337	<0.001
Flavour	2.47	2.93	3.00	3.00	2.93	3.13	3.00	0.395	0.757
Juici- ness	2.67	2.80	3.20	2.93	3.27	3.40	2.87	0.391	0.399
Tender- ness	2.53 ^b	2.60 ^b	3.66 ^a	3.13 ^a	3.06 ^{ab}	3.53 ^a	3.20 ^{ab}	0.357	0.017
Tex- ture	2.60	3.06	3.40	3.20	3.20	3.53	3.00	0.368	0.252
Taste	3.00	3.26	3.40	3.26	3.20	3.40	2.73	0.309	0.296
Overall accepta- bility	2.867	3.06	3.13	3.33	3.20	3.20	2.86	0.365	0.841

RaP - Raw Puree, RoP- Roasted Puree, S. e. d. – Standard error of difference, Means in a row with the same superscripts are not significantly different ($P > 0.05$)

CONCLUSION AND RECOMMENDATION

The inclusion of “Niri” purees in beef sausages improved proximate (ash, carbohydrate, fat and protein) and mineral (calcium, iron and magnesium) contents of the extended products. The samples were

equally liked as the control. The pH of products was acidic and this could lead to long shelf life of products. “Niri” purees (raw and roasted) can therefore be used as extenders in beef sausages up to 25% inclusion rate. Future studies could consider inclusion level higher than 25%, and peroxide and antioxidant properties of “Niri”

extended sausages as these have an influence on eating qualities of meat products.

Competing Interest: None

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