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EFFECT OF SOY FORTIFICATION ON THE NUTRIENT COMPOSITION AND ACCEPTABILITY OF KENYAN CASSAVA BASED PORRIDGES

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Protein energy malnutrition affects children below five years resulting into poor growth, development and performance in adulthood. In most parts of Kenya, cassava is a staple food normally consumed in the form of drinking (*uji*) or stiff (*ugali*) porridges either singly or composited with cereals. However, it is deficient in protein but can be improved by fortification with soybean which is locally available. The study investigated the effects of soy fortification on proximate composition and acceptability of cassava based porridges. Proximate composition of porridges made using variations of cassava composited with maize, sorghum or millet was analyzed using standard methods and consumer acceptability evaluated. Results showed a significant ($P \leq 0.05$) increase in protein, mineral and lipid content of both pure cassava and composited products by 89%, 71% and 67 % at 30% fortification while at 50%, 95%, 89% and 79%, respectively. Consumer panelists preferred the darker coloured fortified porridges especially cassava-millet (30:50) and cassava-soy 50%. Porridges fortified at 30% provided 50% of the daily protein requirements per 100 g for children aged 1 to 3 years. Fortified porridges have increased protein content and nutrient density. They are recommended for supplementary feeding of school children in Kenya and developing countries.

Keywords: Children, Cassava, Protein energy Malnutrition, Soy fortification

INTRODUCTION

Malnutrition remains an important public health issue particularly for children under 5 years whose morbidity and mortality rates are high. Globally, 155 million children under 5 years are stunted, and 52 million are wasted (UNICEF/WHO/World Bank, 2017) with most residing in developing countries. Of importance, is that most households in such countries depend on staple diets providing plenty of carbohydrates, but which are unable to meet their minimum daily protein requirements FAO/WFP/IFAD (2012). The quality of foods for children determines their vulnerability to Protein Energy Malnutrition (PEM (Anuonye, 2011). For instance, traditional weaning foods in African households are derived from cereal staples (Ugwu, 2009) with little or no addition of protein rich foods (Bwibo and Neumann, 2002). It is necessary to develop nutrient dense foods that provide better quality diets.

Cassava a drought resistant staple important for food security (International Institute of Tropical Agriculture (IITA), 2008) is consumed by more than 800 million people globally, most of whom are small holder farmers in developing countries (FAO, 2013). Unfortunately, cassava has very low protein content, approximately 1.4 g/100 g (Olumide, 2004) and poor protein quality. Studies have shown that fortifying starchy staples with legumes improves the quality of diets (Mutambuka, 2013; and Ophelia *et al*., 2014). Formulation of foods using low protein quality staples fortified with legumes was proposed

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by FAO/WHO (1994) as one of the most practical and sustainable approaches to improving the nutritional value of foods for children and households in developing countries. Soy bean among legumes contains high quality protein equal to animal source foods (Martin *et al.*, 2010). Therefore, cassava can be fortified with soy bean to improve its protein quality and nutrient density.

In Kenya, cassava is grown throughout the country, although the highest production is in the Western, followed by Coastal and Eastern regions (Githunguri, 1995). A study by Stephenson *et al.* (2010) established that 53% of children aged 2-5 years, in cassava growing and consuming areas of Western Kenya had inadequate protein intake. Another study by Nungo *et al*. (2012) confirmed the poor nutritional status of such children. Western Kenya is also the leading producer of soy bean in Kenya where it has been promoted extensively among small smallholder farmers as a cash crop and cheap source of protein (Chinau *et al.*, 2008), but its consumption is still low in households.

Developing cassava products fortified with soy bean using frequently consumed Kenyan dishes *uji* (drinking porridge) and *Ugali* (stiff porridge) could enhance the utilization of soy bean as a protein to improve quality of diets for young children. Therefore the aim of this study was to determine the effect of soy fortification on the nutrient composition and consumer acceptability of cassava based composite flours and products. The fortified products can be used in all the cassava producing areas of Kenya and other similar areas worldwide.

MATERIALS AND METHODS

Location of the Study

The proximate analyses were conducted in the University of Eldoret, chemistry laboratory while preparation of the food samples and consumer acceptability were done in the food production laboratory of the same University.

Source and Preparation of Materials

Dried cassava pieces, soy bean and the cereal (maize, sorghum and millet) grains were purchased from the Eldoret municipal market in Kenya. Cassava and cereals were cleaned and milled separately using a hammer mill (Powerline®, BM-35, Kirloskar, India) fitted with a 2.0 mm opening screen. Soy bean flour was prepared using the method by IITA (1990) with slight modifications to inactivate anti nutrients. The soy beans were washed, parboiled for 20 minutes, oven roasted at 100-120 °C for 1½ hours and cooled before milling.

Three cassava based composite flours were formulated by replacing cassava flour with the maize, millet or sorghum at a ratio of cassava: cereal, 60:40. Each composite flour and 100% cassava were then replaced with 30% and 50% soy meal. With the addition of the four unfortified flours, 15 samples were formulated (Table 1).

Preparation of Porridges

Drinking porridge, *uji*, was prepared using the method described by Gomez *et al.* (1997) with slight modifications. To obtain 12.5% solids in porridge, 80 g of flour and 640 ml of water were used. Half the water was boiled in a saucepan

Table 1: Cassava Based Composite Flours at Different Ratios of Soy Fortification

Flours/Composites	Composite Ratio	Soy Fortification (Composite: Soy)	
		70:30	50:50
Cassava: Maize	60:40	Cassava-Maize: Soy	Cassava-Maize: Soy
Cassava: Millet	60:40	Cassava-Millet: Soy	Cassava-Millet: Soy
Cassava: Sorghum	60:40	Cassava-Sorghum: Soy	Cassava-Sorghum: Soy
Cassava	100	Cassava: Soy	Cassava: Soy
Maize	100		
Millet	100		
Sorghum	100		

and the rest mixed with the flour to form a slurry. This was then poured into the boiling water, stirred continuously to gelatinization, and boiled for 20 minutes. Stiff porridge (*ugali*) was prepared using the method of Onyango (2014). Water, 160 ml was heated to boiling in a saucepan and 80 g flour added gradually while mixing to a stiff paste using a wooden spoon. The saucepan was covered with a lid and the ugali cooked for 10±3 minutes, turning at intervals of 2 minutes. The uji was poured in a thin layer onto a tray while the *ugali* was divided into small pieces and also arranged on a similar tray. Both porridges were dried in an oven at 100 °C for 2 hours, followed by 6 hours in the sun. Each sample was milled to fine particles using a food mixer (Kenwood® chef mixer KMC 200, Kenwood, United Kingdom) operated at medium speed, for 10 minutes, sieved, packaged in air tight plastic containers and stored at 4 °C until required.

Proximate Analyses

The moisture, protein (N x 6.25), fat and ash (mineral) contents were determined by oven drying, Kjehdahl, soxhlet and dry ashing, using AOAC International (1995) methods, 925.09, 992.23, 920.29, 923.03, respectively. Carbohydrate content was calculated by difference while energy was calculated using Atwater conversion factors (FAO, 2003).

Consumer Evaluation

Sensory evaluation by consumers was conducted in the food preparation laboratory of the University of Eldoret. A panel of 60 naïve consumers comprising 32 females and 28 males whose ages ranged from 18 to 53 years was recruited for the study. Each panelist signed a consent form informing him/her of the type of samples they would evaluate before engaging in the sensory exercise. Authorization was granted by the National Commission for Science Technology and Innovation in Kenya (Ref No. NACOSTI/P/17/83098/18955)

The evaluation was conducted on one day, in five different sessions of 45 minutes each. The eight variations of cassava based *uji* with 100% cassava, cassava: maize, cassava: millet and cassava: sorghum fortified with soy at 30% and 50% were evaluated by each panelist following a completely randomized design. The temperature of the porridges was maintained at 60 °C by keeping them in a hot water bath. Each sample was served in a white disposable bowl labeled with randomized three digit codes. A nine-point hedonic scale (dislike extremely – 1: neither like nor dislike – 5 and like extremely – 9) was used to determine consumer liking of colour, texture and taste as well as overall acceptability for each sample (Peryam and Pilgrim, 1957).

Statistical Analyses

The proximate analyses for porridge samples were done in triplicate, twice. Data were analyzed using one way analysis of variance (ANOVA) and means were separated using Fisher's Least Significant Difference (LSD) test. The software used was Statistica Software version 8.0 (Statsoft, Tulsa, OK). Consumer hedonic score distribution was illustrated using spider and box and whisker plots.

RESULTS AND DISCUSSION

Proximate Composition

Tables 2 and 3, show the proximate compositions of drinking porridge (*uji*) and stiff porridge (*ugali*), respectively. The 100% cassava porridges had the lowest protein content of 1.42 g/100 g (*uji)* and 1.91 g/100 g, respectively compared to all the cereals with millet having 6 times higher content than cassava in *uji*. These results are in agreement with USDA (2015) on protein content of these foods and the long held view that cassava is grossly deficient (1-3%) in protein content is corroborated (Li *et al.*, 2012). Compositing cassava with millet, sorghum and maize flours resulted in substantial increase in the protein contents of the *uji* variations by 233%, 158% and 96%, respectively an indication that compositing cassava with cereals is a means of improving protein content. A similar trend was observed for the ugali with 304%, 286% and 217%, respectively in the same order for the cereals. This may be explained by the higher protein content of the cereal flours (Bankole *et al.*, 2013; and USDA, 2015). One reason for compositing cassava with other flours in foods is to improve their nutritional value.

Fortification of the cassava and composite flours with soy meal resulted in a drammatic increase in protein content of all porridge variations. Replacement with 30% soy flour in *uji* resulted in increase ranging from a low of cassava-millet-soy at 187% and a high of 653% for cassava-soy. Further increase of up to 264% for cassava-millet-soy and 985% for pure cassava-soy was realized when the variations were fortified at 50%. This may be attributed to the higher protein content of between 35 and 40% in soy meal compared to the cereals (Serrem *et al.*, 2011) and tuber. Similar results were reported by Mutambuka *et al.* (2013) and Digbeu *et al.* (2013) when soy replaced flours in composite food products.

Ash content was lowest (0.2%) in cassava porridge but millet among the cereals was significantly higher by 165%. The low content is expected because the result

Table 2: Effect of Fortification with Soy Meal on the Proximate Composition of Thin Porridge, *uji* (g/100 g) (Dry Weight Basis)

Porridge	Moisture	Protein (N x 6.25)	Fat	Ash	CHO	Energy (kj)[2] (kj/g 100 g
Cereal/Tuber 100%						
Cassava	6.75[d] ±0.48	1.42[a] ±0.06	1.75[a] ±0.35	0.2[a] ±0.21	89.88[d] ±0.98	1592.14[b]. ±0.71
Millet	9.62[f] ±0.48	9.08[g] ±0.05	4.75[d] ±035	0.53[b] ±0.29	76.02[bc] ±0.56	1598.35[b] ±0.54
Sorghum	7.75[e] ±0.48	8.32[f] ±0.01	2.75[bc] ±0.05	0.35[ab]±0.24	80.83[c] ±0.21	1592.82[b] ±0.96
Maize	9.87[f] ±0.25	6.99[e] ±0.11	3.5[c] ±0.35	0.3[ab] ±0.08	79.34[bc] ±0.13	1573.11[a] ±1.0
Cassava: Cereal						
Cassava: Millet	6.12[d] ±0.41	4.73[d] ±0.48	2.5[ab] ±0.35	0.26[ab] ±0.21	86.39[cd] ±0.33	1616.62[c] ±0.34
Cassava: Sorghum	5.75[c].±0.48	3.66[c] ±0.02	2.25[ab] ±0.25	0.24[a] ±0.24	88.10[cd] ±0.41	1618.17[c] ±0.54
Cassava: Maize	6.42[g] ±0.25	2.79[b] ±0.07	2.45[ab] ±0.35	0.23[ab]± 0.29	88.11[cd] ±0.39	1611.11[c] ±0.17
Soy Fortified 30%						
Cassava: Millet	5.62[c] ±0.48	13.6[k] ±0.22	7.02[g] ±0.35	1.7[d] ±0.22	72.06[b] ±0 .33	1690.93[cd] ±0.43
Cassava: Sorghum	4.75[b] ±0.41	12.52[j] ±0.04	5.75[ef] ±0.35	1.28[c] ±0.23	75.70[b] ±0.34	1687.22[cd] ±0.85
Cassava: Maize	5.75[c] ±0.35	11.82[i] ±0.05	6.25[fg] ±0.35	1.13[c] ±0.11	75.05[b] ±0.29	1682.96[cd] ±0.31
Cassava	5.60[c] ±0.25	10.71[h] ±0.32	5.25[de] ±0.25	1.03[c] ±0.05	77.41[bc] ±0.51	1667.22[cd] ±0.41
Soy Fortified 50%						
Cassava: Millet	4.75[b]±0.29	17.24[n] ±0.46	8.75[h] ±0.05	3.21[f] ±0.25	66.05[a] ±0.36	1714.68 [d] ±0.11
Cassava: Sorghum	4.65[b] ±0.35	16.59[m] ±0.29	8.25[h] ±0.35	2.61[e] ±0.22	67.90[a] ±0.38	1696.35[cd] ±0.62
Cassava: Maize	4.7[b] ±0.48	15.55[l] ±0.16	8.55[h] ±0.05	2.52[e] ±0.38	69.68[a] ±0.23	1739.82[de] ±0.74
Cassava	3.75[a] ±0.35	15.4[l] ±0.27	8.5[h] ±0.25	2.53[e] ±0.03	69.82[a] ±0.28	1737.82[de] ±0.54

Note: Values are means ± standard deviation. Values in the same column with the same superscripts letters are not significantly different at $p<0.05$ as per Least Significant Difference. [1] Carbohydrate was calculated by difference {100-(% protein + % ash + % moisture + % fat)}; [2] Energy calculated by multiplication of the Atwater factors for fat (37 kJ), protein (17 kJ) and carbohydrates (17 kJ).

concurs with that reported by Montagnac *et al.* (2009) of 0.2% to 0.3% in processed cassava. Addition of soy meal to cassava flour and its cereal based composites resulted in significant increase of ash. At 30% and 50% soy replacement, the mineral contents increased three and six times, respectively while its composites, cassava millet had a 13 times increase in ash content at 50% soy replacement. This increase in the ash content was probably caused by the soy meal that has much higher mineral content than cereals and tubers (Smolin and Grosvenor, 2010). Balogun *et al.* (2012) reported 11.35% increase in the ash content of tapioca meal when fortified with soy at 20% while Anuonye (2011) reported a 75% increase at 25% soy substitution of millet flour.

Compositing significantly increased the fat content by 57% and 37% in cassava-millet and cassava-maize variations, respectively. This was probably due to the cereals substantially higher fat content compared to cassava flour (USDA, 2015). Fortification with soy at 30% further increased the fat content by 145% in cassava-millet and 200% in cassava-soy while at 50% fortification the increase was 218% for cassava-millet and 312% in cassava-soy. Increased fat content possibly resulted from the high fat of about 18% in soy beans (Adenekan *et al.*, 2010). Soy beans store more energy in the form of fat than cereals and tubers (Madukwe *et al.*, 2013). Increase in fat content in wheat biscuits (Bunereka and Mahendran, 2009) and cassava wheat biscuits (Ugwuona, 2009) following soy replacement

Table 3: The Effect of Compositing Flours with Soy Meal on Proximate Composition of Stiff Porridge (*ugali*) (g/100 g) (Dry Weight Basis)

Ugali	Moisture	Protein (N x 6.25)	Ash	Fats	CHO[1]	Energy (kJ)[2]
100% Tuber/Cereal						
Cassava	6.33^{a} ±0.28	0.91^{a} ±0.11	0.17^{a} ±0.29	1.75^{a} ±0.35	90.84^{e} ±0.67	1599.68^{a}± 1.01
Millet	8.5^{d} ±0.48	7.24^{f} ±0.01	0.52^{b} ±0.	4.75^{d} ±0.35	78.99^{bc} ± 0.56	1617.26^{a}±0.91
Sorghum	7.63^{ab} ±0.75	6.66^{e} ±0.47	0.25^{ab} ±0.29	2.5^{ab} ±0.35	82.96^{c} ±0.13	1591.52^{a} ±0.83
Maize	8.37^{d} ±0.41	5.49^{d} ±0.31	0.25^{ab} ±0.29	3.50^{c} ±0	82.39^{c} ±0.34	1599.06^{a} ± 0.08
Composites						
Cassava: Millet	6.75^{ab} ±0.25	3.68^{c} ±0.02	0.38^{ab} ±0.29	2.75^{bc} ±0.35	86.44^{cd} ± 0.73	1609.05^{a} ± 0.56
Cassava: Sorghum	6.30^{a} ±0.25	3.51^{c} ±0.05	0.24^{ab} ±0.25	2.25^{ab} ±0.35	87.7^{cd}± 0.53	1608.97^{a}±00.48
Cassava: Maize	6.41^{ab} ±0.25	2.89^{b} ±0.01	0.25^{ab} ±0.29	2.41^{b} ±0.35	88.04^{d} ± 0.91	1610.39^{a} ±0.71
Composites j (30% Soy)						
Cassava: Millet	9.25^{e} ±0.29	12.54^{i}±0.11	1.13^{c} ±0.25	6.75^{fg} ±0.35	70.33^{b}± 0.52	1634.34^{b} ±0.76
Cassava: Sorghum	7.38^{c} ±0.29	12.20^{i} ±0.05	0.88^{c} ±0.25	6.25^{ef} ±0.35	73.29^{b} ±0.07	1659.86^{bc} 0.45
Cassava: Maize	6.73^{d} ±0.29	11.51^{h} ±0.05	0.88^{c} ±0.25	5.5^{de} ±0.35	75.39^{bc} ± 0.41	1655.97^{bc}±0.32
Cassava	6.38^{ab} ±0.25	10.24^{g} ±0.24	0.88^{c} ±0.25	5.25^{d} ±0.35	77.26^{bc} ±0.32	1645.84^{b}±0.62
Soy Fortified 50%						
Cassava: Millet	9.39^{f} ±0.25	17.01^{l} ±0.46	2.42^{e} ±0.25	8.75^{i} ±0.35	62.43^{a} ± 0.06	1650.25^{bc} ±0.12
Cassava: Sorghum	9.02^{d} ±0.47	16.67^{kl} ±0.29	2.13^{d} ±0.25	8.21^{hi} ±0.35	63.97^{a} ±0.32	1650.54^{bc} ±0.29
Cassava: Maize	9.13^{d} ±0.48	15.26^{j} ±0.08	2.13^{d} ±0.25	7.25^{gh} ±0.35	66.23^{a} ±0.81	1629.57^{ab} ±0.19
Cassava	7.63^{ab} ±0.41	14.16^{j} ±0.05	2.25^{d} ±0.29	7.21^{gh} ±0.35	68.75^{ab} ±0.34	1651.87^{bc} ±0.33

Note: Values are means ± standard deviation. Values in the same column with the same superscripts letters are not significantly different at $p<0.05$ as per Least Significant Difference. [1] Carbohydrate was calculated by difference {100-(% protein + % ash + % moisture + % fat)}; [2] Energy calculated by multiplication of the Atwater factors for fat (37 kJ), protein (17 kJ) and carbohydrates (17 kJ).

at 35 and 20%, respectively has been reported. Fat is a concentrated source of energy for humans, and plant sourced fats in the diet are healthy because they promote heart health (Smolin and Grosvenor, 2010).

Both the 100% cassava thin and thick porridges had about 90 g/100 g carbohydrate content. This results are in agreement with Montagnac *et al.* (2009) who show that cassava is an energy dense food probably because tubers store almost all their energy as carbohydrates (Ugwuona, 2009). Fortification of cassava flour with soy meal at 30% and 50% caused a 15% and 24% reduction, respectively in the carbohydrate contents of the ugali variations. This may be attributed to legumes storing less energy in the form of carbohydrates (Madukwe *et al.*, 2013). Other researchers have reported similar results. Opeifa *et al.* (2014) found a 7.1% reduction in the carbohydrate content of maize meal *ogi* at 15% replacement with horse eye bean flour while Serrem *et al.* (2011) reported 28.2% reduction on soy substitution at 50% in sorghum biscuits. Carbohydrates are an important source of energy and spare protein allowing it to be used for the most important body functions rather than energy provision (Rao, 2010).

Fortification of cassava at 50% with soy bean caused a 33.3% increase in thin porridge energy content. This may be due to soy bean having more fat in the form of energy hence a higher caloric value (USDA, 2015). A study by

Kouakou *et al.* (2013) showed that fortification of millet flour with soy beans at 30% increased its energy content by 31.5%. Madukwe *et al.* (2013) also reported a 9.6% increase in the energy content of wheat cookies on fortification of wheat flour at 10% with bambara groundnut flour. At 30% soy replacement in plain cassava porridge, it provides 28.9% of the daily energy requirement for a five year old girl. High energy content in the diet indicates that the body obtains enough calories therefore spare proteins for growth, repair and maintenance (Stipanuk, 2006).

Proximate Composition of Stiff Porridge

Proximate composition of cassava and cassava cereal composites stiff porridges shown in Table 3 followed the same trends as those of thin porridge. However proximate values for proteins were significantly higher in *uji* compared to *ugali*. For instance cassava *uji* had 56% higher protein content compared to the *ugali*, a trend similar to that of the *ugali* and *uji* made from the composited fortified porridges. This may be explained by the differences in the methods used for thermal processing. Wet cooking methods such as boiling which was used for the thin porridge are known to retain more nutrients. However, high temperature, low moisture and long time cooking increase the rate of the maillard reaction between amino acids and reducing sugars that forms chain reactive intermediaries leading to the formation of flavour and melanoidin compounds therefore lowering the protein quality (Blackwell, 2006). This may explain the reason for lower nutrient contents of the thick compared to the thin porridges as longer cooking time with less moisture were required to make *ugali* have an appetizing aroma and flavour.

Consumer Acceptability

Table 4 shows that dark coloured porridges were preferred and scored higher. This may be attributed to familiarity by panelists with porridges made traditionally from millet and sorghum grains (Muoki *et al.*, 2015). The dark colour in cassava millet porridge may be derived from condensed tannins in the form of anthocyanidins which occur naturally in millet and which are concentrated in the seed coat more than in other cereals (Taylor *et al.*, 2013) in this study, millet grains were milled whole making cassava millet porridges darker than the rest.

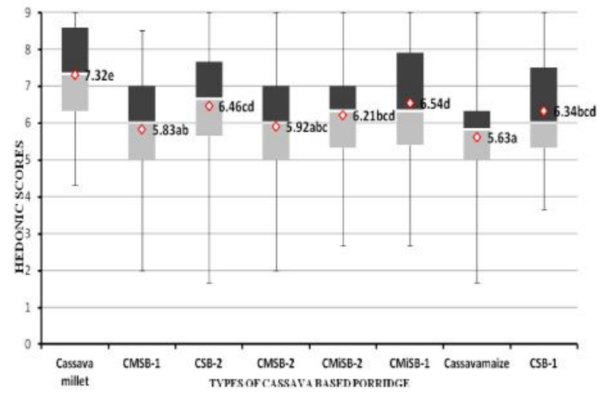
The best liked porridge for taste by consumers was cassava-millet which was 18% higher than cassava-maize-soy the least liked. It is possible that addition of soy in the latter porridge introduced the beany taste which

Table 4: The Effect of Fortifying with Soy Meal on Consumer Perception of Thin Porridge (*uji*) Sensory Attributes

Porridge	Colour	Taste	Texture
Composite Flour			
Cassava- Millet	7.70^{d}±1.58	7.08^{c}± 1.70	7.18^{e}±1.96
Cassava-Maize	5.04^{a}± 1.77	5.82^{ab}±1.66	6.06^{abc}±2.05
Composite + Soy 30%			
Cassava-Millet-Soy	6.38^{c}±2.12	6.56^{bc} ±1.96	6.68^{bcd} ±1.80
Cassava-Maize-Soy	5.88^{bc}±2.11	5.80^{a}± 2.00	5.70^{a}±2.07
Cassava-Soy30%	6.06^{bc}±1.86	6.16^{ab}±1.67	6.78^{cd}±1.78
Composite + Soy 50%			
Cassava-Millet-Soy	6.52^{c}±1.79	6.16^{ab}±2.03	5.98^{ab} ±2.06
Cassava-Maize-Soy	5.34^{ab}± 5.34	6.08^{ab}±2.10	6.28^{abc} ± 1.91
Cassava-Soy	6.40^{c}±1.87	6.22^{b}±2.05	6.80^{cd} ± 2.30

Note: Values are means ± standard deviation. Values in the same column with the same superscripts letters are not significantly different at $p<0.05$ as per Least Significant Difference.

Figure 1: The Effect of Fortifying Composite Flours with Soy Meal on the Total Quality of Porridge (*uji*)



Note: The means were separated using L.S.D and those with different letters are significant at $p<0.05$). The upper percentile is the dark shaded area and represents where 75% of the values fell, the bottom represents the value below the median mark that were 25% and below while in between is the median where 50% of the values fell above and 50% below. Hedonic rating scale, 1 = dislike extremely, 5 = neither like nor dislike, 9 = like extremely. CMi = cassava millet, CM = cassava maize, CMSB1= cassava maize soy 30%, CMiSB1 = cassava millet soy 30%, CSB1 = cassava soy 30%, CMSB2 = cassava maize 50%, CMiSB2 = cassava millet soy 50% and CSB2 = cassava soy 50%.

characteristically affects acceptability of soy based foods (Serrem *et al.*, 2011).

Cassava-maize-soy porridge texture was liked least by panelists while cassava-millet was again liked best. This low score for cassava-maize may have been a result of the coarseness of maize particles (Nkhabutlane *et al.*, 2014) resulting in a grainy mouth feel after swallowing, which was disliked. Fortification with soy flour however did not improve on this texture making all porridges with maize to score poorly for texture. Similarly, Serere *et al.* (2016) reported that addition of finger millet flour into maize based porridges did not improve their texture therefore were disliked by panelists.

CONCLUSION

Compositing cassava flour with maize, millet and sorghum improves the nutrient composition and increases the protein content of porridges. Fortification with soy at 30 and 50% dramatically increases the protein content and nutrient density of cassava porridges. Cassava based thin porridge (*uji*) has significantly higher protein content than the stiff porridge. Consumers have significantly higher preference for the darker coloured porridges compared to the lighter ones.

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REFERENCES

- Adenekan M K, Awoniri S O, Oguntoyinbo S L, Nupo S S and Odunmbak C A (2010), "Functional Properties and Pastry Characteristics of Flour Made from Five Varieties of Nigerian Pigeon Pea (*cajanus cajan*)", *Journal of Biological Sciences and Bio-Conservation*, Vol. 6, No. 1, pp. 73-84.
- Anuonye J C (2011), "Utilization and Fortification of Indigenous Foods in the Times of Climate Change", available from: http://www.intechopen.com
- AOAC (1995), *Official Methods of Analysis*, 16th Edition, Association of Official Analytical Chemists, Methods 925.09, 992.23, 920.29, 923.03, Washington DC.
- Balogun M A, Karim O R, Kalowole F L and Solarin A O (2012), "Quality Attributes of Tapioca Meal Fortified with Defatted Soy Flour", *Agro-Science*, Vol. 1, pp. 61-66.
- Bankole T O, Tanimola A O, Odurukan R O and Samuel D O (2013), "Functional and Nutritional Characteristics of Cassava Flour (*Lafun*) Fortified with Soybeans", *Journal of Educational and Social Research*, Vol. 3, No. 8, pp. 163-170.
- Blackwell W (2006), *Text Book of Food Science and Technology*, 2nd Edition, John Wiley and Sons Ltd., New York.
- Bunereka V D and Mahendran T (2009), "Formulation of Wheat - Soybean Biscuits and their Quality Characteristics", *Tropical Agricultural Research & Extension*, Vol. 12, No. 2, pp. 1-5.
- Bwibo N and Neumann C (2003), "Animal Source Foods to Improve Micronutrient Nutrition and Human Function in Developing Countries", *The Journal of Nutrition*, Vol. 133, pp. 3936s-3940s.
- Chinau J N, Vanlauwe B, Mahasi J M, Katungi E, Aketch C, Mairura F S, Chinau J N and Sanginga N (2008), "Soybean Situation and Outlook Analysis: The Case of Kenya", KARI.
- Digbeu D Y, Due A E and Dabonne S (2013), "Biochemical Characteristics of Composite Flours: Influence on Fermentation", *Journal of Food Science and Technology*, Vol. 33, No. 4, pp. 599-604.
- FAO (2003), "Food Energy: Methods of Analysis and Conversion Factors, FAO Food and Nutrition Paper 77", pp. 18-37, Food and Agriculture Organization, Rome.
- FAO (2013), "Save and Grow: Cassava, A Guide to Sustainable Production Intensification", Food and Agriculture Organization of the United Nations, Rome.
- FAO/WFP/IFAD (2012), "The State of Food Insecurity in the World", Economic Growth is Necessary But Not Sufficient to Accelerate Reduction of Hunger and Malnutrition, Food and Agriculture Organization, Rome.
- FAO/WHO (1994), *Codex Alimentarius: Foods for Dietary Uses (Including Foods for Infants and Children)*, 2nd Edition, Vol. 4, Joint FAO/WHO Food Standards Programmes, Codex Alimentarius Commission, FAO, Rome.
- Githunguri C M (1995), "Cassava Food Processing and Utilization in Kenya", in: Egbe T A, Brauman A, Griffon D and Treche S (Eds.), *Cassava Food Processing*, pp. 119-132, CTA, ORSTOM, Wageningen.

- Gomez M I, Obilana A B, Martin D F, Madzavamuse M and Mongo E S (1997), "Manual for Laboratory Procedures for Evaluation of Sorghum and Pearl Millet", ICRISAT Andhra Pradesh, India.
- IITA (1990), "Soy Beans for Health: How to Grow and Use Soy Beans in Nigeria", pp. 23-36, IITA Publ.
- Kouakou B, Marie N K A, Halbin J, Tagro G, Guessan K F and Dago G (2013), "Biochemical Characterization and Functional Properties of Weaning Food Made from Cereals (Millet and Maize) and Legume (Beans and Soy Beans)", *Journal of Food Chemistry and Nutrition*, Vol. 01, No. 01, pp. 22-32.
- Li M H, Robinson E H, Oberle D F and Boswoth B G (2012), "Evaluation of Corn Gluten and Cotton Seed Meal as Partial Replacement of Soybean Meal and Corn for Pond-Raised Hybrid Cat Fish", *Journal of World Aquaculture Society*, Vol. 43, No. 1, pp. 107-113.
- Madukwe E U, Edeh E I and Obizoba I C (2013), "Nutrient and Organoleptic Evaluation of Cereal Legume Based Cookies", *Pakistan Journal of Nutrition*, Vol. 12, No. 2, pp. 154-157.
- Martin H, Laswai H and Kulwa L (2010), "Nutrient Composition and Acceptability of Soy Bean Based Complementary Foods", *African Journal of Food Science Agriculture and Development*, Vol. 10, No. 1, pp. 2040-2049.
- Montagnac J A, Davis C R and Tanumlharjo S A (2009), "Nutritional Value of Cassava for Use as Staple Food and Recent Advances for Improvement", *Comprehensive Reviews in Food Science and Food Safety*, Vol. 8, pp. 181-194.
- Muoki P N, Kinnear M, Emmambux M N and De Kock H L (2015), "Effect of Soy Flour Addition on Sensory Quality of Extrusion and Conventionally Cooked Cassava Complementary Porridges", *Journal the Science of Food and Agriculture*, Vol. 95, No. 4, p. 730.
- Mutambuka M (2013), "Iron Bioavailability and Consumer Acceptability of Extruded Common Bean (*Phaseolus vulgaris*) Flour", Graduate Thesis and Dissertation Paper 13234, Iowa State University, available from: http://www.lib.dr.state.edu
- Nkabutlane P, du Rand G E and De Kock (2014), "Quality Characterization of Wheat, Maize and Sorghum Steamed Breads from Lesotho", *Journal of Food and Agriculture*, Vol. 94, pp. 2104-2117.
- Nungo R A, Okoth M W and Mbugua S K (2012), "Nutrition Status of Children Under-Five Years in Cassava Consuming Communities in Nambale, Busia of Western Kenya", *Food Science and Nutrition*, Vol. 3, pp. 796-801.
- Olumide O T (2004), "Cassava for Livestock in Sub Saharan Africa", FAO/IFAD.
- Onyango C (2014), "Physical Properties of Dry-Milled Maize Meal and their Relationship with the Texture of Stiff and Thin Porridge", *African Journal of Food Science*, Vol. 8, No. 8, pp. 435-443.
- Opeifa A O, Olatidaye O P, Adejalo S O and Fyomi M J (2015), "Production and Quality Evaluation of Ogi Produced from Fermented Maize and Horse Eye Bean (*Mucuna ureus*)", *Pakistan Journal of Nutrition*, Vol. 14, No. 7, pp. 417-425.
- Peryam D R and Pilgrim F J (1957), "Hedonic Scale Method of Measuring Preferences", *Journal of Food Technology*, Vol. 11, pp. 9-14.
- Serere H J, Bangamusewe B, Matiringe I and Chinofunga D (2016), "Development of Fermented Corn and *rapuko* Blend Instant Porridge", Vol. 5, No. 4, pp. 246-254.
- Serrem C A, de Kock H L, Oelofse A and Taylor J R (2011), "Rat Bioassay of the Protein Nutritional Quality of Soy Fortified Sorghum Biscuits for Supplementary Feeding of School Children", *International Journal of Food Science and Technology*, Vol. 46, pp. 74-83.
- Smolin L and Grosvenor M B (2010), *Nutrition Science and Applications*, 2nd Edition, John Wiley and Sons Inc., USA.
- Stephenson K, Amathor R, Mallowa S, Nungo Busie M, Gichuki S, Mbanaso A and Monary M (2010), "Consuming Cassava as a Staple Food Places Children 2-5 Years at Risk of Inadequate Protein Intake: An Observational Study in Kenya and Nigeria", *Nutrition Journal*, Vol. 9, No. 9, pp. 134-143.
- Stipanuk M H (2006), "Protein and Amino Acid Requirement", Biochemical, Physiological, Molecular Aspects of Human Nutrition, Sounders Elsevier, MO.
- Taylor J R N, Dlamini B C and Kruger J (2015), "25th Anniversary Review: The Science of the Tropical Cereal Corghum, Maize and Rice in Relation to Larger Beer

Brewing" [cited June 20], available from http// www.wileyonlinelibrary.com

- Ugwu F M (2009), "The Potential Roots and Tubers as Weaning Food", *Pakistan Journal of Nutrition*, Vol. 8, No. 10, pp. 1701-1705.
- Ugwuona F U (2009), "Chemical and Sensory Evaluation of Soy Fortified Cassava Wheat Biscuits", *Agio-Science Journal*, Vol. 8, No. 1, pp. 55-59.
- UNICEF/WHO/World Bank Group (2017), "Joint Malnutrition Estimates", United Nations Children's Fund, New York.
- USDA (2015), "National Nutrient Database for Standard Reference Release 26", USDA Agricultural Research Services, available from http//www.wileyonline library.comwww.ars.usda

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