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Sensory evaluation of improved and local recipes for children aged 6 to 23 months in Bukoba, Tanzania

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Complementary foods are foods other than breast milk or infant formula (liquids, semisolids, and solids) introduced to an infant to provide nutrients as well as energy. To ensure sustainable consumption of the improved recipes, sensory evaluation is important to assess acceptability of the modified recipes among the targeted consumers or population. This study was to assess sensory attributes of the improved recipes for children in two rural villages of Tanzania. Consumer preference of eight recipes was assessed using a nine-point hedonic scale. The results revealed that the improved recipe of '*Katogo*' dry beans with amaranth and palm oil and '*Katogo*' fresh beans, pumpkin leaves and sunflower oil had the highest scores for colour (7.9 to 8.1), aroma (7.6 to 7.7), taste (7.6 to 7.8), texture (7.7 to 7.8) and overall acceptability (7.8 to 7.9) compared to local recipe of '*Katogo*' steamed sardines and improved '*Katogo*' with groundnut flour and pumpkin. Recipe '*Katogo*' fresh beans, pumpkin leaves and sunflower oil was the most preferred recipe compared to other recipes due to its colour, aroma, and taste, which resulted after adding red palm oil and amaranth. Likewise, the preference could have been contributed by the ingredients used in the recipes, which were similar to the local ones. This suggests that the modification improved the nutrient contents without affecting the preference. Porridge prepared using maize flour and orange fleshed sweet potatoes scored the highest for all attributes compared to porridge that had eggs in it (recipe egg porridge) and plain local maize porridge (recipe local maize flour porridge). Knowledge on nutrition education to enable community to accept other tastes than their own for better choice of healthy food is highly recommended.

Key words: Improved recipes, sensory evaluation, infant.

INTRODUCTION

Sensory evaluation is very important for assessing acceptability of developed, improved or modified foods. It is a scientific discipline that is used to analyze and interpret reactions of consumers as related to the

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characteristics of products perceived through the senses of sight, smell, touch, taste and hearing (Svensson, 2012). Sensory attributes of products include colour, aroma, taste, texture (mouth feel), and overall acceptability (Svensson, 2012). Sensory evaluation is also important in assessing acceptability of complementary foods as perceived by mothers or care takers (Phang and Chan, 2009). Tests conducted in sensory evaluation are used to quantify the consumer preference or degree of liking/disliking of a product (Lawless and Heymann, 2010). This study evaluated the sensory attributes of five improved complementary foods formulated to increase the nutrient content of iron, vitamin A and protein in the foods. The purpose was to offer families the opportunity to feed their infants on improved recipes using low cost and locally available foods. The study used mother and/or caregivers and female and male representing the community as the panelist, because they are representative of consuming population. The advantage of using the aforementioned panelists is that they are the representative and/or end users and they give a real life assessment (Xazela et al., 2011).

Worldwide both vitamin A deficiency (VAD) and iron deficiency anaemia (IDA) affected over two billion people, among them 190 million preschool-age children are affected by IDA (Bailey et al., 2015; Detzel and Wieser, 2015). In Tanzania, about one third of children below five years of age are vitamin A deficient (TDHS-MIS, 2015-2016). Similarly, 60% of children below five years of age suffered from iron deficiency and of which 58% are anaemic and 45% of women of reproductive age are anaemic (TDHS-MIS, 2015-2016). The nutrition situation of children of age below five years in Kagera region, north western of Tanzania in the Lake Victoria basin is alarming. Report by NBS (2011) and TDHS-MIS (2015-2016) indicated that vitamin A deficiency is about 47% for children below five years and 58% are anaemic. In the same region, 40% of women aged 15 to 45 are anemic. The level of under nutrition in the country is partly exacerbated by minimal emphasis on the utilization of appropriate complementary foods to control micronutrient deficiency in many communities of Tanzania. Generally, the use of local foods formulated at homes is guided by the following principles: high nutritional value to supplement breastfeeding; use of local food items; low price; and acceptability; (Muhimbula et al., 2011; Pelto et al*.,* 2003).

Local dishes consumed by people in Bukoba Rural district of Tanzania are '*Katogo'* (banana and beans), '*ugali* '(stiff porridge: a staple food in Tanzania prepared from cereals such maize, sorghum, cassava flour, etc.) with beans, cassava mixed with beans, sweet potatoes mixed with beans and porridge made from whole maize flour. All these dishes were low in vitamin A (Godson, 2014). Furthermore, the author observed that '*ugali*', boiled banana and boiled cassava were low in iron content when compared with the recommended dietary allowance (RDA) (Godson, 2014). In addition, the most common complementary food is maize porridge (maize floury + water) prepared as a thin gruel.

Based on the findings by Godson (2014), it was necessary to improve the dishes in order to increase the nutrient contents of the complementary foods consumed by children and the rest of population categories in rural areas of Bukoba. Sensory evaluation of the improved recipes was important for assessing acceptability (culturally and socially) of the improved dishes. The purpose of this study was to assess sensory evaluation and consumer preference of the improved recipes for children below five years of age in the banana based farming systems of Kagera region, Tanzania.

MATERIALS AND METHODS

Study area

Dietary improvement was conducted in Izimbya ward of Bukoba district in Kagera region of Tanzania. The region is located in the North-Western Tanzania, west of Lake Victoria with a population of 2,458,023. Bukoba district has a population of 289,697 (NBS, 2011). Mothers (n = 50) with children aged between 6 and 23 months were randomly selected from Rugaze and Izimbya villages and participated in the recipe formulation/development exercise. They were from four sub-villages of Kakindo and Kyelima (Izimbya village) and Rugaze A and Kikagati (Rugaze village). Each village had 25 mothers and/or caregivers recruited for the exercise. In the same villages, sensory evaluation was conducted.

Sample size and sampling procedure

The study involved random selected 126 panelists, with mothers and/or caregivers (involved in recipe modification) and other stakeholders representing the consuming population (male and females from the study area). Women who participated in the food modification exercise were also invited to participate in the sensory evaluation. The sample was stratified randomly drawn from a village list of households after every 5 names.

Dietary improvement/modification

Mothers and/or caregivers were involved in the modification process and all the modified recipes were improved by using common household cooking methods commonly practiced in the community. During dietary modification, mothers and/or caregivers were asked to give options of improving the type of porridge intended to be fed to children as well as to propose means of improving the local banana diets. The ingredients used for preparation of improved and local recipes are shown in Table 1.

Sensory evaluation

Affective/Consumer test was conducted in two sites of Izimbya and Rugaze A villages in Bukoba rural district. The exercise was conducted for two days in each village during day time at the village office. The first day was used to prepare and assess acceptability of

Table 1. Local and improved recipes composition and preparation technique.

Recipe code and name	Ingredients	Processing method	Nutrient contents per 100g				
Local recipes			**Protein**	**Iron**	**pVACs**	**Bioaccessibility of pVAC %/100 g**	**Bioaccessibility of iron %/100 g**
				Banana and bean			
OA: *Katogo' steamed* sardines	Local 'Katogo' with banana, bean and steamed sardines (*'Luompo')*	Beans were sorted and washed and put into sauce pan, about 1000 ml of water were added and boiled. Banana were peeled and cut into two pieces and then put into sauce pan without water and kept apart. Beans cooked for about 56 min (partially cooked) together with its soup; 500 ml of water was added into unwashed banana and put on fire for the mixture to be cooked. While beans and banana are boiling, sorting of sardines was done and washed once with cold water to remove other dirt mixed with sardines. '*Luompo'* (steamed sardines) after washing and removing the dirt onions were cut and mixed with washed sardines together with salt.	22.10	1.18	43.68	nd*	nd*
				Steamed sardines			
		Mixture of onion and sardines were put on banana leaf and tied closely by using banana ropes and then were put on top of the boiling banana and steamed for 36 min, this type of (food) sardine is called '*Luompo'*. When the mixture of beans and banana is about to be cooked, dilution of salt with cold water was done and diluted salt was added to the food to boil until well-cooked (7 min) before taking out of the fire. Total cooking time was 99 min (Godson, 2014)	9.63	2.83	nd*	nd*	nd*
				Banana and bean			
OB: *Katogo'* stewed sardines	Local 'Katogo' with banana, bean and *stewed* sardines	Beans were sorted and washed and put into sauce pan, about 1000 ml of water were added and boiled. Banana were peeled and cut into two pieces and then put into sauce pan without water and kept apart. Beans cooked for about 56 min (partially cooked) together with its soup; 500 ml of water was added into unwashed banana and put on fire for the mixture to be cooked for 36 min. While beans and banana are boiling, sorting of sardines was done and washed once with cold water to remove other dirt mixed with sardines.	22.10	1.18	43.68	nd*	nd*
				Stewed sardines			
		Tomatoes and onions were washed, peeled and chopped into large pieces. Oil heated into sauce for 5.5 min, the chopped onion were added into the heating oil and fried for 6 min followed by addition of sardines (fried for 3 min), tomatoes (fried for 4.5 min), salt (fried for 7 min), water was lastly added into it and left to boil (10 min) so as to make sauce. Total cooking time was 128 min (Godson, 2014)	9.60	2.60	nd*	nd*	nd*
OI: Local maize flour porridge	Local porridge made from maize and water (*'Obushesha')*	Three cups of water (750 ml) put to boil. Maize flour was placed in a bowl followed by water and stirred into a smooth paste. The smooth paste was added into the boiling water gently while stirring and cooked for 24 min (Godson, 2014)	nd*	nd*	nd*	nd*	nd*

Table 1. Contd.

Improved recipes							
OC: Banana purée '*Nshakala*' dry bean	'Katogo' with *'Nshakala'* (East African highland banana-EAHB) variety dry red kidney beans, amaranths, palm oil	Beans were sorted and washed, placed in saucepan, water was added to immerse beans, then soaked for 8-12 h, soaking water poured out to reduce phytates (Pereira et al., 2014; Saunders et al., 2013). Soaked beans were placed in saucepan, and immersed in water, covered with lid and boiled till tender (60 to 90 min). While beans boiling, red palm oil fruits were cleaned placed in a saucepan with 500 ml of water, covered and boiled for 10 min. Water was poured out and cooled. Red palm oil was pounded in a traditional mortar. About 500 ml of water were added and wringed to get red palm oil. Green banana were peeled using a sharp knife and cut into two pieces per finger then were immersed in water to avoid browning. Bitter tomatoes were cut into two halves and added to the saucepan with bananas. Onions and tomatoes were cut into small pieces and kept aside. The peeled and chopped green banana, onion, tomatoes, bitter tomatoes and red palm oil were added to the boiling beans at 40-70 min of cooking beans. Water was added to submerge the mixture and covered with banana leaves followed by a lid and cooked covered for 20 min (making the 60-90 min). Amaranth leaves were sorted and cleaned and kept aside. To reduce surface area for nutrient loss amaranths were cut into large pieces using a sharp knife. After 20 min amaranth were added to the boiling mixture. Salt dissolved (1 teaspoon) in ¼ cup of water and was added to the cooked food, then the ingredients were mixed by stirring and covered to cook for 7 min. The soup strained and kept aside. Food was mashed into a thick, smooth puree, the consistency depended on the child's age, and the strained soup was added back to the mashed food to avoid loss of nutrient. Total cooking time ranged from 67-97 min (using fire wood in two different villages) and 60 min (using electric cooker *)*	3.40	9.10	58.10	7.9	16.4
OD: Banana purée '*Nshakala' fresh bean*	Katogo' with *'Nshakala'* , fresh red kidney beans, pumpkin leaves, sunflower oil,	Fresh red kidney beans were removed from their pods, sorted, cleaned with water, and placed in a saucepan followed by addition of water. To reduce phytates, beans were boiled for 5 min and water poured out. Water was added to the beans and then covered with lid and boiled till tender (45 to 60 min. While beans boiling green banana were peeled using a sharp knife and cut into two pieces per finger then were immersed in water to avoid browning. Bitter tomatoes were cut into two halves and added to the saucepan with banana. Onions and tomatoes were cut into small pieces and kept aside. The peeled and chopped green banana, onion, tomatoes, better tomatoes and sunflower oil were added to the boiling beans at 25 to 40 min of cooking beans and water was added to submerge the mixture. The mixture covered with banana leaves followed by a lid and cooked covered for 20 min. While mixture boiling pumpkin leaves were sorted and cleaned and kept aside. To reduce surface area for nutrient loss, the leaves were cut into large pieces using a sharp knife. After the above 20 min pumpkin leaves were added to the boiling mixture. One teaspoon of salt dissolved in ¼ cup of water and was added to the cooking food. The ingredients were mixed by stirring and covered and cooked for 7 min. Soup were strained and put aside. Food mashed into a thick, smooth puree, the consistency depends on the child's age. To avoid loss of nutrient all the strained soup were added to the mashed food. Total cooking time ranged from 52-67 min (using fire wood in two different villages) and 45 min (using electric cooker *)*	2.80	6.10	44.5	12.2	18.4

Table 1. Contd.

OE: *'Katogo'/'matoke'* purée	'Katogo' with *'Nshakala'* variety, pumpkin fruit, groundnuts flour,	Groundnut were sorted and roasted to dry. Left to cool and pounded in a mortor and sieved to get fine groundnut flour. Green banana was peeled using a knife, cut into at least two pieces per finger and placed into a cooking saucepan with water to avoid browning. Pumpkin fruit cleaned with water, cut into small pieces and peeled with a knife. Pumpkin pieces were added into the peeled banana in a saucepan. Bitter tomatoes were into two halves added to the saucepan with banana and pumpkin pieces. Onions and tomatoes were washed, cut into small pieces and added to the mixture in a cooking saucepan and mixed well. Groundnut mixed with 1 cup of water and mixed to a thick puree. Then, puree added to the mixture and mixed well using a cooking ladle/spoon. Water was added to the mixture to submerge the ingredients. The mixture was covered using banana leaves followed by a lid and cooked for 20 min. One teaspoon of salt was dissolved into ¼ cup of water. After 20 min salt was added to the boiling mixture and cooked for 5 min. For children above 11 months the food was allowed to cool and served to the child or kept in a covered dish. Banana puree was prepared for children aged 6-11 months. Half a cup of soup from food was kept apart. One cup of food was placed in a bowl and mashed to make it soft. The remaining soup was added to the mashed food and mixed to get a thick puree. Total cooking time was 25 min (using fire wood in two different villages) and 25 min (using electric cooker *)*	3.8	1.9	137	26.7	12.2
OF: Orange-fleshed sweet potato porridge	Porridge made from fermented maize flour, Orange- fleshed sweet potato (OFSP), groundnuts, and sugar	One cup (250 ml) water and 100 g of maize flour were placed in a bowl and left for 24 h to ferment. Groundnut were sorted and roasted to dry, then pound in a motor to get fine groundnut flour. Unpeeled OFSP washed well with clean water and placed in a saucepan followed by 2 cups of water and covered with banana leaves followed by a lid. To retain nutrients OFSP boiled unpeeled for 30-45 minutes (Berti et al., 2014). Then, OFSP was hand peel, put in a dish and mashed until smooth. Water was added to the mashed OFSP to thick puree, stirred and kept aside. Four cups of water (1000 ml) were put to boil in a saucepan for 5 min. Groundnut flour was added into the fermented flour and stirred into a smooth paste. The smooth paste added into the boiling water slowly while stirring to avoid lumps. OFSP puree was added into the boiling mixture while stirring. The mixture simmered for 10 min. Sugar was added and stirred to mix well. Porridge removed, then cooled and served. Total cooking time ranged from 45-60 min (using fire wood in two different villages) and 30 min (using electric cooker*)*.	3.70	1.60	20.6	31.1	25.9

Table 1. Contd.

OH: Egg porridge	Porridge made from fermented maize flour, eggs, dry red beans, and sugar	Beans were sorted, cleaned with water, and placed in a saucepan followed by addition of water to immerse beans and soaked for 8-12 h to reduce phytates. Soaking water poured out and coats were removed. Beans were placed in a saucepan followed by addition of water to immerse the beans. Beans covered with lid and boil till tender (60-90 min). Beans were mashed and ½ cup of water was added to the mashed beans and keep apart. Four cups of water (1000 ml) put to boil for 5 min. While waiting for water to boil, mashed beans were added into fermented maize flour and stirred into a smooth paste. The smooth paste was added into the boiling water gently while stirring and cooked for 10 min. One egg added to one portion of porridge for baby. This was done after beating the egg and poured it gently into the baby's portion while stirring. Sugar added as an optional. Total cooking time ranged from 75-105 min (using fire wood in two different villages) and 60 min (using electric cooker)	3.00	3.50	1.1*	12.5	nd*

PVACs: Pro-vitamin A carotenoids; For both recipes water added but not weighed 1.1* ~100 g of egg has 227.0 REµg which meet 56.8% RDA vitamin A (Miranda et al., 2015). nd*: not determined.
Source: Mbela et al. (2018).

improved recipes only. On the second day, both improved and local dishes were prepared and tested. This allowed having time for training panelists before the testing exercise for descriptive test in day two. The sensory evaluation involved 88 females and 38 males of age between 17 and 78 years making a total of 126 panelists. Adult panelists were used instead of children, because of their ability to objectively evaluate the sensory attributes of the improved recipes. Panelists were from Kakindo, Kyerima (Izimbya village) and Kikagati, Rugaze A and Rugaze B sub-villages (Rugaze village).

All the panelists were asked to complete the consent form before the taste. Three modified and two local banana-based and two modified and one local porridge-based recipes (Table 1) were tested. The improved and local recipes were subjected to sensory evaluation to test the preference. For improved recipes only, the food recipes were organoleptically evaluated for preference test using 85 (females = 58, males = 27) untrained panelists (Affective test). Izimbya village had 45 and Rugaze village had 40 participants. A panel of 41 (30=females, 11=males) of breastfeeding mothers and/or caregivers and male and female from different sub-villages were recruited to evaluate the preference of the improved and local diets for descriptive tests. Izimbya village had 21 participants and 20 participants were from Rugaze A, Rugaze B and Kikagati villages.

The panelists were asked to express their degree for liking the sensory attributes using a 9-point hedonic scale, where 9 (like extremely) was the highest and 1 (dislike extremely) was the lowest score. Thus, 1=dislike extremely, 2=dislike very much, 3=dislike moderately, 4=dislike slightly, 5=neither like nor dislike, 6=like slightly, 7=like moderately, 8=like very much, 9=like extremely (Muhimbula et al., 2011; Lim, 2011). Five ranking score was used to choose the most preferred recipes and the lowest score rated as most preferred and the highest score as least preferred (1=most preferred, 5=least preferred) (Meludu and Fakere, 2013). The samples were evaluated by the panelist for aroma (flavour), texture, colour and overall acceptability. All principles of good sensory practices were followed (Muhimbula et al., 2011). The coded improved and local recipes were presented to each of the panelist. Each panelist was given a serving plate, spoon, cup and a bottle of water to rinse their mouth after each taste to avoid being biased or influenced. The panelists were served with small amount of food sample. Conditions during tasting included rinsing the mouth with water between each recipe to remove the taste of the previous food; panelists were separated during interview for them not to influence each other. The hedonic test was used to quantify the consumer preference of the recipe (Svensson, 2012).

Statistical analysis

Statistical analyses were performed using R statistical package (R Development core team, version 3.00, Vienna, Austria). Two way ANOVA was used for parametric test (hedonic data) and Friedman and Wilcoxon tests were used for non-parametric data (preference ranking). Tukey Honest Significant Difference (THSD) was used to separate means. Least Significant Rank Difference (LSRD) was used to separate median at $p \leq 0.05$. Data on descriptive test was analysed by Principal Component Analysis (PCA).

Ethical clearance and consenting

The community and individuals were informed about the

Table 2. Characteristics of consumer panelists 1 (N=41) and 2 (N=85).

Attribute	Category	Frequency (N)	Percentage
Panelists 1 (N=41)			
Age (Years)	20-35	24	58.5
	36-45	9	22
	Above 45	8	19.5
Sex	Male	11	26.8
	Female	30	73.2
Education level	No formal education	5	12.2
	Primary education	26	63.4
	Secondary education	8	19.5
	Post-secondary education	2	4.9
Occupation	Farmers	39	95.1
	Formally employed	2	4.9
Panelists 2 (N=85)			
Age (Years)	17-35	50	58.8
	36-45	22	25.9
	Above 45	13	15.3
Sex	Male	27	31.8
	Female	58	66.2
Education level	No formal education	9	10.6
	Primary education	61	71.8
	Secondary education	12	14.1
	Post-secondary education	3	3.5
Occupation	Farmers	78	91.7
	Formally employed	7	8.3

study. A written consent to participate in the study was obtained from the panelists. Ethical clearance was obtained from the National Institute for Medical Research (NIMR) permit number NIMR/HQ/R.8a/Vol.IX2202. Permission to conduct the study was obtained from regional, district and ward authorities.

RESULTS

Panel characteristics for tested local and improved recipes

Table 2 shows that the characteristics of consumer panel. For sensory evaluation of local and improved recipes, the panel was dominated by female panelists (73%) of age between 20 and 35 years (59%). About 95% were farmers, 63% had attained primary school education. The consumer panel for improved recipes only was also dominated by female panelists (66%) of age between 17 and 35 years (59%). Most of them have attained primary school education (72%) and 92% of them were farmers.

Preference test for local and improved recipes

Local and improved porridge

Table 3 shows the results for mean hedonic scores for porridge. The scores differed significantly ($p<0.05$) among panelists in terms of liking of colour, aroma, taste, texture and overall acceptability. Porridge prepared using maize flour and orange fleshed sweet potatoes (recipe OF) had the highest scores as compared to porridge that had eggs in it (recipe OH) and plain local maize porridge (recipe OI). The orange fleshed sweet potato porridge

Table 3. Mean hedonic values of porridge recipes (improved and local) (N-41).

Recipe name	Recipe code	Color	Aroma	Taste	Texture	Acceptability
OFSP porridge	OF	8.3±0.76^{a}	7.9± 1.32^{a}	8.2±1.15^{a}	7.9± 1.40^{a}	8.9 ±0.92^{a}
Egg porridge	OH	6.4±1.60^{b}	6.4±1.60^{b}	6.6± 1.43^{b}	6.9± 0.74^{b}	6.7± 1.38^{b}
Popular maize flour porridge	OI	6.4±1.40^{b}	6.4±1.12^{a}	6.4±1.27^{b}	6.9 ± 1.21^{b}	6.4 ±1.33^{b}

Values are expressed as mean ±SD (N=41). Mean values with different superscript letters along the column are significantly different at p<0.05.

Table 4. Sensory attributes of local and improved banana recipes (N=41).

Recipe Name	Recipe code	Color	Aroma	Taste	Texture	Acceptability
'Katogo' steamed sardines	OA	6.4±1.23^{c}	6.9± 1.19^{b}	7.1±1.14^{bc}	6.6± 1.09^{b}	6.7 ±1.06^{c}
'Katogo' stewed sardines	O B	7.6±1.12^{ab}	7.2±1.04^{ab}	7.3± 1.08^{abc}	7.4± 0.74^{a}	7.5± 1.07^{ab}
'*Katogo*' dry beans	OC	8.1±1.04^{a}	7.7±1.10^{a}	7.8±1.00^{a}	7.8 ± 1.04^{a}	7.9 ±1.00^{a}
'*Katogo*' fresh beans	OD	7.9±0.75^{a}	7.6±0.85^{a}	7.6±0.7^{ab}	7.7± 0.59^{a}	7.8±8 0.83^{a}
'*Katogo*' nuts pumpkin	OE	7.0± 1.16^{bc}	7.0± 1.12^{b}	7.0±1.48^{c}	7.5 ±0.84^{a}	7.0 ±1.26^{bc}

Values are expressed as mean±SD (N=41). Mean values with different superscript letters along the columns are significantly different at p<0.05.

had higher scores for colour, aroma, taste, texture and overall acceptability than porridge with eggs and plain maize porridge. Thus porridge with orange fleshed sweet potato had high liking score by consumer compared to porridge with egg and plain maize flour porridge. There was a significant difference between the improved/ modified orange fleshed sweet potato and the other two porridges (improved egg porridge and an improved local popular maize flour porridge) at p<0.05. However, there was no significant between the improved/modified egg porridge and local popular maize flour porridge at p<0.05.

Results of the mean hedonic scores for different recipes are shown in Table 4. The improved '*Katogo'* of dry beans (recipe 3 OC) and '*Katogo*' fresh beans (recipe OD) had the highest scores for colour, aroma, taste, texture and overall acceptability compared to local '*Katogo' steamed sardines* (recipe OA) and improved *'Katogo'* of groundnuts and pumpkin (recipe OE). These recipes had the lowest scores for colour, aroma, taste and overall acceptability. Furthermore, local '*Katogo' steamed sardines (*recipe OA) recipe had the lowest texture score compared to local *'Katogo'* stewed sardines (recipe OB) and improved 'Katogo' of dry beans (recipe OC).

Moreover, the Principal Component Analysis (PCA) bi-plot multivariate analysis (Figure 1) showed that, principal component 1 (PC1) accounted for 93.2% of variability in panelist (trained) liking of recipe and principal component 2 (PC 2) accounted for only 5.9%. The PC 1 was a contrast between recipes of improved *'Katogo'* of dry beans (recipe *OC*) and *'Katogo'* fresh beans (recipe OD); these were highly associated with attributes of aroma, colour, taste and overall acceptability compared to other recipes that had low scores in these attributes. Further analysis (open ended questions) showed that 73% of the panelists liked recipe OC due to its ingredients, 15% liked it due to good aroma and taste and the rest (12%) did not like it.

There was significant difference in rank sum between '*Katogo*' dry beans (recipe OC) and *Katogo'* stewed sardines (recipe OB) having lowest scores of 75 and 113, respectively (Table 5) and other recipes (recipes OA, OD and OE). This shows that the two recipes were most preferred compared to other recipes using a 1 to 5 scale (1 denotes most preferred and 5 lowest preferred).

In addition, PC 1 accounted for 99.6% of the systematic variation in liking and it is a contrast between OFSP porridge recipe associated with liking of all attributes on one side and other recipes with no attributes associated to it (Figure 2). This supported the ANOVA results, which showed higher liking scores of OFSP porridge recipe for all attributes.

Preference test

The rank sum values differed significantly (p<0.05) between the porridge recipes with OFSP porridge having lowest values of 49 (Table 6) than other recipes, which suggests that it was the most preferred recipe. No significant (p>0.05) variation was observed in preference between porridges with eggs and plain local maize.

Improved recipes only

Table 7 shows that the results for mean hedonic scores of improved recipes. There were significant (p < 0.05)

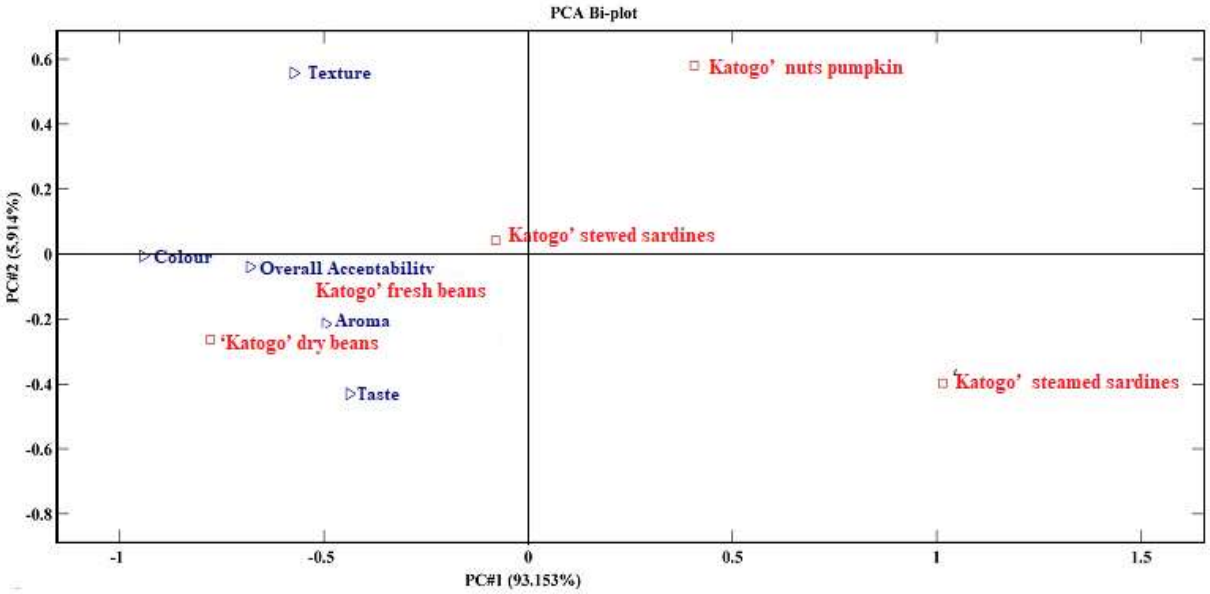

Figure 1. PCA Bi-plot showing systematic variation of recipes and liking of sensory attributes.

Table 5. Median and Rank sum values of local and improved recipes (N=41).

Recipe Name	Recipe code	Median	Rank sum
'Katogo' steamed sardines	OA	3	129[b]
'Katogo' stewed sardines	OB	3	113[ab]
'*Katogo*' dry beans	OC	2	75[a]
'*Katogo*' fresh beans	OD	4	152[b]
'*Katogo*' nuts pumpkin	OE	3	133[b]

Friedman chi-square = 36.915, p-value = 1.875e-07 and Least Significant Rank Difference (LSRD) is 40. Mean values with different superscript letters along the column are significantly different at p<0.05. Scale (1=most preferred, 5= least preferred).

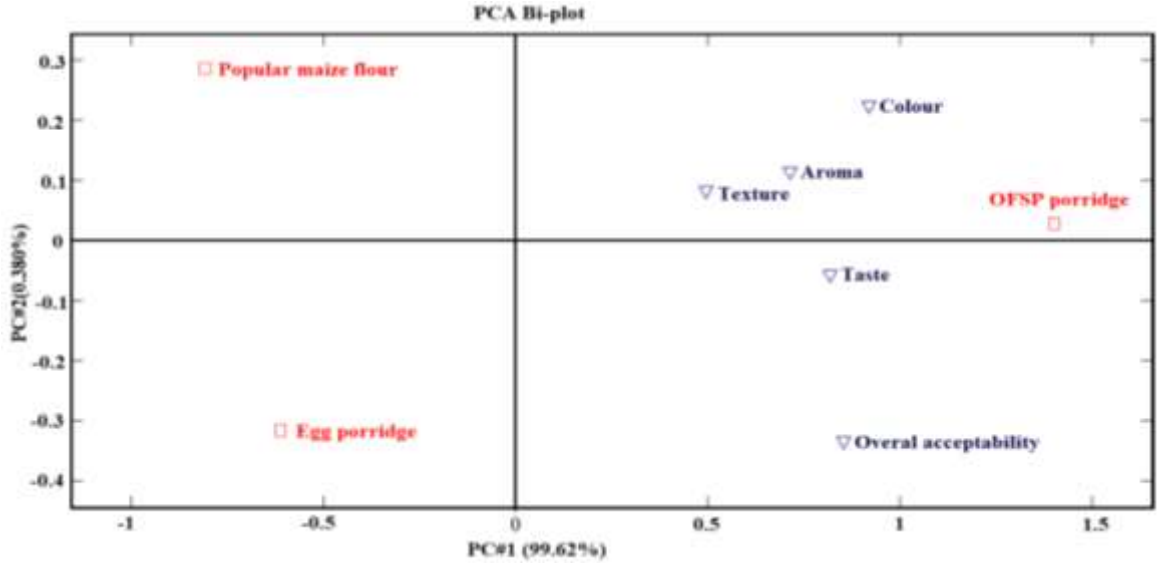

Figure 2. PCA Bi-plot showing systematic variation of porridge recipes and liking of sensory attributes.

Table 6. Median and Rank sum of porridge local and improved recipes (N=41).

Recipe Name	Recipe code	Median	Rank sum
OFSP porridge	OF	1	49[a]
Egg porridge	OH	2	90[b]
Local maize flour porridge	OI	3	101[b]

Friedman chi-squared = 37.55, p-value = 7.017e-09 and the Least Significant Rank Difference (LSRD) is 21. Mean values with different superscript letters along the column are significantly different at p<0.05. Scale (1=most preferred, 5= least preferred).

Table 7. Sensory attributes of improved banana recipes (N=85).

Recipe name	Recipe code	Color	Aroma	Taste	Texture	Acceptability
'Katogo' dry beans	OC	8.3±0.92[a]	8.1± 1.03[a]	8.2±1.17[a]	8.1± 1.30 [a]	8.2 ±1.25[a]
'Katogo' fresh beans	OD	8.2±0.79[a]	8.0±0.85[ab]	8.0± 0.89[a]	8.0± 0.88[a]	7.9± 0.94[ab]
'Katogo' nuts pumpkin	OE	7.5±1.05[b]	7.8±0.98[b]	7.9±1.10[a]	8.1± 1.04[a]	7.8 ±1.10[b]

Values are expressed as mean ±SD (N=85). Mean values with different superscript letters along the column are significantly different at p<0.05.

Table 8. Median and Rank sum of improved banana recipes.

Recipe Name	Recipe code	Median	Rank sum
'Katogo' dry beans	OC	1	119[a]
'Katogo' fresh beans	OD	2	203[b]
'Katogo' nuts pumpkin	OE	2	186[b]

Friedman chi-squared = 47.719, p-value = 4.344e-11 and the Least Significant Rank Difference (LSRD) is 31. Mean values with different superscript letters along the column are significantly different at p<0.05. Scale (1= most preferred, 5= least preferred).

Table 9. Mean hedonic values of the improved porridge recipes.

Recipe name	Recipe code	Color	Aroma	Taste	Texture	Acceptability
OFSP porridge	OF	7.6±1.9[a]	7.8±1.65[a]	8.2±1.19[a]	7.8±1.38 [a]	8.2±1.25[a]
Egg porridge	OH	7.3±1.55[a]	7.2±1.58[b]	7.4±1.64[a]	7.5±1.70[a]	7.5±1.66[b]
Statistics						
t value	-	-1.0891	-2.3655	-4.0422	-1.1543	-3.332
P value	-	0.2791	0.020	0.0001168	0.2517	0.001284

Values are expressed as mean ±SD (N=85). Mean values with different superscript letters along the column are significantly different at p<0.05.

mean hedonic scores of colour, aroma and overall acceptability difference among improved recipes. *Katogo*' dry beans (OC) and '*Katogo*' fresh beans (recipe OD) recipes had similar highest scores on colour, aroma, and overall acceptability compared to scores for the recipe with groundnut flour and pumpkin (OE). No significant variation (p>0.05) in taste and texture were observed among recipes.

Furthermore, there was significant (p<0.05) difference in rank sum between the recipes '*Katogo*' dry beans (recipe OC) and other recipes. '*Katogo*' dry beans had lowest score of 119 (Table 8). This shows that 'Katogo' dry bean (recipe OC) was the most preferred recipe as compared to other recipes.

Improved porridge only

The variations between mean hedonic values of aroma and overall acceptability between two improved porridge recipes were significant. OFSP porridge recipe had higher scores compared to the recipe with eggs (Table 9). No significant variations were observed in attributes of colour, taste and texture between the two recipes.

Preference test (by Paired recipe Wilcoxon test) N=85

The rank sum values differed significantly ($p<0.05$) between the porridge recipes with OFSP porridge having the lowest scores (110) compared to porridge with eggs (146). This shows that OFSP porridge was most preferred.

DISCUSSION

Organoleptic evaluation was carried out to determine acceptability and preference of the improved dishes as compared to the local complementary foods. Untrained panelist of mothers and/or caregivers and other stakeholders in the study area participated in this exercise. Affective/Hedonic tests were used to quantify consumer responses with regard to their preferences of the recipes (Svensson, 2012). Panelists were recruited to evaluate the preference of the improved and local diets for descriptive tests.

Generally, all the improved recipes were accepted by all panelists. However, *'Katogo'* dry beans (recipe OC*)* and '*Katogo*' fresh beans (recipe OD) were highly preferred among panelists because of taste, aroma (flavor), and colour attributes. This could have been contributed by the ingredients used in the recipes, which were similar to the local ones. The only difference was the addition of amaranth, palm oil and pumpkin leaves. This suggested that the modification improved the nutrient content without affecting the preference. The recipes were energy- and nutrient-dense; likely to be acceptable; affordable; and sustainable because they were made from culturally appropriate and daily consumed commodities. On other hand, there was an association of high liking scores with taste, aroma (flavor), and colour attributes for the same recipes. '*Katogo*' dry bean (recipe OC) was the most preferred recipe compared to other recipes. This could be due to its colour, taste and aroma that resulted after adding red palm oil and amaranth. The attractive colour was due to palm oil (golden red colour), which contributed to the colour of the food. Colour attribute scored higher than other attributes. The colour attribute is very important for consumer preference, the product might be having high nutritional value but without attractive colour such a product is likely to be not liked by consumers (Tirhas et al., 2015). Colour is a primary attribute, which attracts consumer attention and therefore influences acceptance (Tirhas et al., 2015). Despite contribution of palm oil to colour of the food, red palm oil is a potential source of vitamin A. Texture was an important attribute for consumer preference of the local recipe *'Luompo' (*recipe OA), which scored poorly because panelists disliked the texture. '*Katogo*' dry beans (recipe OD), '*Katogo*' fresh beans (recipe OD) and '*Katogo*' pumpkin seed flour (recipe OE) recipes did not differ in scores for texture, because the consistency was almost the same.

Recipe OC ('*Katogo'* dry bean) and OB (*'Katogo'* stewed sardines) were significantly most preferred recipes compared to others recipes on a 1 to 5 scale. The second was a local diet that was preferred by panelist due to banana bean sardine mixture. This is due to the fact that this was the only animal (fish) source recipe, which is most expensive and therefore consumed occasionally (Kennedy et al., 2010).

Orange fleshed sweet potatoes (OFSP) porridge (recipe OF) scored the highest for all attributes including overall acceptability than other porridges. High score on colour of OFSP porridge could have been contributed by the orange colour of OFSP, which made the porridge to have an orange colour that appealed to panelists. A similar observation was made by Tirhas et al. (2015) where porridges prepared using OFSP were sensorially preferred. Colour is a primary attribute which attracted consumer attention and therefore influences the mind of the consumer (adult and children) when choosing food and therefore acceptance (Pobee et al., 2017). Therefore, to attract consumers, food colour is an important attribute to be considered when preparing food. The low score for recipe OH was attributed to the inclusion of egg which resulted in an aroma not quite familiar to the consumer. Basically the smell of eggs was repulsive and affected acceptability. A study conducted in Ghana (Pobee et al., 2017) observed that the porridge blended with an egg was scored low by panelists due unfamiliar aroma. The basic nutrition education given to mothers during discussions about dietary modification enhanced their knowledge on nutrition and was able to identify recipes that are less nutritious. Recipe IO scored 70% as being not nutritious. This was reason why the local porridge was least preferred compared to all other recipes.

Overall, mothers liked the new recipes and were willing to continue using them and prepare for their children because the local foods are culturally appropriate acceptable, affordable, feasible, and sustainable and are consumed on a daily basis (Ayoya et al., 2010). Five recipes were developed and most of the ingredients can be replaced by other foods from the same food group to make more recipes with similar nutritional values.

Conclusion

The results showed that the improved recipes as complementary foods which are nutrient-dense were accepted by the panelists. The improved banana recipes were preferred to local recipes. Thus, the three improved banana-based and two porridge-based recipes were in generally preferred by panelists. Mothers liked the new recipes and were willing to adopt and continue using

them to feed their children because they are prepared from local foods which are culturally appropriate and acceptable. Consumption of the improved complementary food by children aged 6 to 23 months could help solve the problem of vitamin A, iron and protein energy malnutrition. The community needs nutrition education for better choice of healthy foods for their children to eat. Sensory evaluation is an important component in developing complementary foods.

CONFLICT OF INTERESTS

The authors have not declared any conflict of interests.

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REFERENCES

Ayoya MA, Kodio J, Iknane AA, Sodjinou R (2010). Nutritional value of locally produced foods and potential for developing age-appropriate complementary foods for children under 2 years of age in Mali. Food and Nutrition Bulletin 31(3):391-399.

Bailey RL, West Jr. KP, Black RE (2015). The epidemiology of global micronutrient deficiencies. Annals of Nutrition and Metabolism 66(2):22-33.

Berti C, Faber M, Smuts CM (2014). Prevention and control of micronutrient deficiencies in developing countries: Current Perspectives. Nutrition and Dietary Supplements 6:41-57.

Detzel P, Wieser S (2015). Food fortification for addressing iron deficiency in Filipino children: Benefits and cost-effectiveness. Annals of Nutrition and Metabolism 66(2):35-42.

Godson N (2014). Nutrient content of the local dishes consumed by children below five years of age in banana growing communities: A Case study of Bukoba rural district, Tanzania. MSc thesis, Sokoine University of Agriculture. Morogoro, Tanzania P 101.

Kennedy G, Razes M, Ballard T Dop MC (2010). Dietary diversity: A simple tool for developing and evaluating food and nutrition security interventions. food-base approaches for improving recipes and raising level of nutrition. In: I. S. FAO (Ed.). Rome 7-9 December.

Lawless HT, Heymann H (2010). Sensory evaluation of food – Principles and practices. 2nd edn., Springer New York Dordrecht Heidelberg, London P 587.

Lim J (2011). Hedonic scaling: A review of methods and theory. Food Quality and Preference 22:733-747.

Mbela DEN, Kinabo J, Mwanri AW, Ekesa B (2018). Modification of local recipes to improve vitamin A, iron and protein contents for children aged 6 to 23 months. African Journal of Food, Agriculture, Nutrition and Development (AJFAND) 18(1):13129–13153.

Meludu NT, Fakere BF (2013). Sensory Evaluation of Diversified Sweet Potato Drinks among Consumers: Implication for Malnutrition Reduction in Nigeria. International Journal of Food Engineering 7(10).

Miranda JM, Anton X, Redondo-Valbuena C, Roca-Saavedra P, Rodriguez JA, Lamas A, Cepeda A (2015). Egg and egg-derived foods: Effects on human health and use as functional foods. Nutrients 7(1):706-729.

Muhimbula HS, Abdulsudi I-Z, Joyce K (2011). Formulation and sensory evaluation of complementary foods from local, cheap and readily available cereals and legumes in Iringa, Tanzania. African Journal of Food Science 5(1):26-31.

National Bureau of Statistics (NBS) (2011). Tanzania Demographic and Health Survey 2010. Dar es Salaam, Tanzania: NBS and ICF Macro. pp. 165-178.

Pelto GH, Levitt E, Thairu L (2003). Improving Feeding Practices: current patterns, common constraints, and the design of interventions. Food and Nutrition Bulletin 24:24-82.

Pereira EJ, Carvalho LMJ, Dellamora-Ortiz GM, Cardoso FSN, Carvalho JLV, Viana DS, Freitas SC, Rocha MM (2014). Effects of cooking methods on the iron and zinc contents in cowpea (*Vigna unguiculata*) to combat nutritional deficiencies in Brazil. Food and Nutrition Research 58:1-7.

Phang YL, Chan HK (2009). Sensory descriptive analysis and consumer acceptability of original “kaya” and “kaya” partially substituted with inulin. International Food Research Journal 16:483-492.

Pobee RA, Oduro-Obeng H, Johnson P-NT, Akonor PT (2017). Complementary foods from rice and six other ghanaian food ingredients provide sufficient macro and micronutrients for infants 6-12 Mo of Age. Journal of Food, Nutrition and Science 5(3):79-85.

Saunders AV, Craig WJ, Baines SK (2013). Zinc and Vegetarian Diets. Medical Journal of Australia 199(4):17-22.

Svensson L (2012). Design and performance of small scale sensory consumer tests. MSc. thesis. Swedish University of Agricultural Sciences, Uppsala, Sweden.

Tanzania Demographic and Health Survey and Malaria Indicator Survey (TDHS-MIS) (2015-16). Ministry of Health, Community Development, Gender, Elderly and Children (MoHCDGEC) [Tanzania Mainland], Ministry of Health (MoH) [Zanzibar], National Bureau of Statistics (NBS), Office of the Chief Government Statistician (OCGS), and ICF. 2016Dar es Salaam, Tanzania, and Rockville, Maryland, USA: MoHCDGEC, MoH, NBS, OCGS, and ICF.

Tirhas MG, Geremew B, Sirawdink FF, Tessema A (2015). Nutritional quality and acceptability of sweet potato–soybean–moringa composite. Nutrition and Food Science 45(6):845-858.

Xazela NM, Chimonyo M, Muchenje V, Marume U (2011). Consumer sensory evaluation of meat from South African goat genotypes fed on a dietary supplement. African Journal of Biotechnology 10(21):4436-4443.