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ABSTRACT

African Indigenous Vegetables (AIVs) can contribute significantly to food and nutrition security in sub-Saharan Africa, including Kenya. However, the frequency and amounts of AIVs consumed are lower than recommended. In part, this is due to perceived inferior sensory attributes, particularly taste, which is attributed to the use of traditional cooking methods and recipes. Efforts have been made to improve consumption of AIVs in Western Kenya by providing interventions on new AIVs cooking methods and recipes alongside behavior change communication education. This experiment focused on the promotion of three recipes (i). Sautéed Nightshade (Nightshade + groundnut + milk), (ii). Sautéed Greens (Cowpea + tomato + milk); and (iii). African Sticky Soup (Jute mallow + dagaa fish). These recipes adapted the traditional cooking methods with the intention of enhancing flavor, texture, and nutrition. The objective of this study was to assess sensory attributes of new AIVs recipes among the targeted consumers. In March 2019, a total of 113 farmers were involved in the preparation and evaluation of each recipe based on organoleptic properties (appearance, smell, aroma, texture in mouth, and taste) on a 5-point Likert scale and provided an overall ranking of the three recipes. The results show statistically significant differences ($p<0.05$ and $p<0.01$) in perceptions of men and women on organoleptic properties (appearance and aroma; taste and texture respectively). When summing the scores of the Likert scale for the organoleptic properties, Sautéed Nightshade had the highest overall mean score (4.8 for female and 4.6 for male) and the African Sticky Soup had the least (2.4 female and male). The results of Friedman Analysis of Variance revealed that there was a statistically significant difference in perceived ranking of the three recipes ($p<0.05$) (Sautéed Nightshade highest and African Sticky Soup lowest). These findings help to identify

acceptable sensory attributes that can be enhanced to promote consumption of AIVs for both men and women. Further research is required to evaluate chemical properties of the recipes and explore relationships between consumer preferences and measurable chemical properties.

INTRODUCTION

Food security has long been associated with a vision of an abundance of cereals, roots, and tubers – the staple food crops that provide affordable sources of dietary energy. On basis of this vision, the prevalence of hunger globally declined to 795 million in 2015 (FAO et al., 2015), indicating progress in ensuring adequate access to staple foods as measured in terms of caloric intake. Although hunger globally has declined, an estimated two billion people still suffer from a chronic deficiency of essential vitamins and minerals (micronutrients), a condition known as hidden hunger (WHO, 2016) and a further 2.1 billion people are overweight or obese (Ng et al., 2014). To lessen the burden of hidden hunger, overweight and obesity, nutrition security has become embedded in food security agendas and the importance of dietary diversity for good health has moved to the forefront of nutritional interventions. Healthy, high-quality diets require the consumption of a wide range of food categories in the right quantities (Schreinemachers et al., 2019).

Fruits and vegetables are essential sources for the micronutrients needed for healthy diets. Potassium in vegetables helps to maintain healthy blood pressure. Dietary fiber content reduces blood cholesterol levels and may lower the risk of heart disease. Folate (folic acid) reduces the risks of birth defects. Vitamin A keeps eyes and skin healthy, while vitamin C not only keeps teeth and gums healthy but also aids in iron absorption. Recognizing the important nutritional benefits of fruits and vegetables, the World Health Organization (WHO) recommends a minimum intake of 400 grams per capita per day to prevent chronic diseases, especially heart diseases, cancers, and diabetes and supply of needed micronutrients, especially calcium, iron, iodine, vitamin A and zinc (WHO, 2015; WHO and FAO, 2003). However, consumers today, even those with higher incomes, are believed to be missing this target. More attention to filling this dietary gap to tap the nutritional power of vegetables is required.

In Kenya, as in many other countries in sub-Saharan Africa, African Indigenous Vegetables (AIVs), most of which are leafy vegetables, are increasingly recognized as essential for household food security when added to the predominantly cereal-based staple diets and provide a promising economic opportunity to reduce rural poverty. The AIVs are those vegetables whose natural habitat originated in Africa or those that have been naturalized and over generations have been integrated into cultures through natural or selective processes (Maundu et al., 2009). Leaves, fruits, roots, stem, bark, and seed from AIVs have been utilized for nutrition and medicinal purposes in Africa since time immemorial (Gido et al., 2017; Kamga et al., 2013). Cooked leaves from AIVs are traditionally consumed together with starchy staple foods. The AIVs are collected from the wild, grown in home gardens, or purchased commercially (Maundu et al., 2009). Nevertheless, AIV for consumption patterns are still low compared to exotic vegetables, despite AIVs containing micronutrient levels as high as or even higher than those found in most exotic vegetables. In Kenya, there is evidence that demand for AIVs has been growing (Abukutsa- Onyango, 2010; Krause, et al., 2019) due to increased nutritional awareness of AIVs, especially among urban dwellers (Cernansky, 2015; Muhanji et al., 2011; Mwema et al., 2018).

Most vegetables worldwide are cooked before consuming to improve palatability, texture and taste. Cooking also eliminates potential pathogens and neutralizes poisonous or irritating substances while bringing spoilage to a halt. Various cooking methods are used based on convenience and taste preference rather than nutrient retention yet cooking induces significant changes in chemical composition affecting

concentration and nutrient bioavailability (Tumwet et al., 2013). Most consumers are believed to be missing the recommended target of a minimum intake of 400 grams of vegetables per capita per day (WHO, 2015). One potential reason for the low consumption of AIVs is inferior sensory attributes of the prepared meals due to the use of traditional cooking recipes. To address the low consumption, there have been efforts to promote the production and consumption of AIVs in Western Kenya by providing interventions on improved agronomy, introduction of new AIV cooking recipes, and Behaviors Change Communication (BCC) education. The priority AIV species in Kenya include African nightshades *(Solanum scabrum)*, leafy amaranth *(Amaranthus* spp.*)*, spider plant *(Cleome gynandra),* cowpeas *(Vigna unguiculata)*, Ethiopian kale (*Brassica carinata*), and pumpkin leaves (*Cucurbita maxima* and *Cucurbita moschata*) (Abukutsa-Onyango, 2010; Krause et al., 2019).

Three new recipes products were promoted in Western Kenya: Sautéed Nightshade (Night shade+groundnut+milk), Sautéed Greens (Cowpea+tomato+milk), and African Sticky Soup (Jute mallow+*dagaa* fish). Potential preferences and acceptance of these recipe products based on sex of potential consumers are unknown. Yet sensory attributes of the food products play a vital role in their acceptance or rejection by the consumers. To fill this gap, the objective of this study was to assess preferences of sensory attributes and acceptability of new AIV recipes products among the targeted consumers. Sensory evaluations have been proven useful in many food and beverage studies and aid in predicting the success of products within the market. Hence, understanding consumer acceptance of AIVs recipes is important in enhancing their consumption levels to increase micronutrient intake.

MATERIALS AND METHODS

The study area. This study was conducted in Bungoma and Busia Counties in Western Kenya. Agriculture is the main economic activity in both Counties. The staple food crop is maize, often consumed as stiff porridge (*ugali*). Cooked leaves of AIVs are traditionally consumed with starchy staple foods as side dishes (Maundu et al. 2009).

Sampling, data collection and analysis. Approximately 132 farmers who were enrolled in the Horticulture Innovation Project were invited to participate in the preparation and evaluation of the selected recipes at declared venues on specified dates and times during the month of March 2019. However, 113 farmers (77 female and 36 male) participated in five different evaluation sessions, each lasting approximately two and a half hours. The farmers at each evaluation venue were divided into mixed groups of men and women, comprising at most six members to allow active participation. Each group was randomly assigned to prepare one recipe. The researchers from KALRO and AMPATH explained and demonstrated to the participating farmers the protocols for preparation and evaluation of the recipes. After the preparation of the recipes, the products were randomly placed on a table in a spacious and well-lit area and labelled with code numbers to minimize bias before the evaluation process began. To get a better understanding of why farmers as potential consumers prefer particular AIVs recipes products, a sensory analysis was employed to evaluate the three recipes' products. The evaluation was based on six participatory agreed sensory criteria: appearance, color, texture, smell and taste on a 5-point Likert scale (1=dislike very much, 2=dislike, 3=neither like nor dislike, 4=like, 5-like very much). For each sample of recipe products, the respondents first recorded their scores for appearance, followed by scoring for color, smell, taste, and texture (how the food feels in the mouth), respectively. After tasting each sample recipe, the respondents rinsed their mouths with water. Researchers and technicians assisted respondents who could not score on their own due to low literacy and other circumstances. This type of evaluation is known as subjective because it relies largely upon the opinions of selected individuals. Therefore, to triangulate the results, the respondents also did an overall ranking of the recipes, providing rank one for overall best and

three for the least preferred. Data were analyzed by descriptive statistics, including mean scores and sum of ranks. The non-parametric Friedman Analysis of Variance (Lawless, and Heymann, 1999) was used to identify the recipe products that differed among themselves using SPSS software

RESULTS AND METHODS

The results show statistically significant differences ($p<0.05$) in perceptions of men and women on appearance and the aroma or smell of products derived from Sautéed Greens and Sautéed Nightshade recipes. Moreover, color and texture were significantly different ($p<0.01$) for Sautéed Nightshade and African Sticky Soup, respectively (Table 1).When interpreting the results of the Likert-scale, it is important to note that because Likert-scale type data is ordinal, one can only infer that one score is higher than another, not the distance between the points.

Sautéed Nightshade had the mean scores of 4.6 and 4.8 for men and women, respectively. However, these differences were not statistically different. Literature on AIVs consumption notes two main reasons for the low levels of consumption including ethnic meal habits and the negative connotation of AIVs as the "poor people's food" (Pasquini and Young, 2009; Brückner and Caglar, 2016). However, what is rarely mentioned is the role of food preparation and the gender division of labor for understanding food and consumption habits. This points at the need to uncover the complexity of food decisions and to understand the role of social norms and practices as drivers for levels of AIVs consumption. The results, however, corroborate some of earlier studies (e.g., Mezzavilla et al., 2018), which found that taste was one of the main factors determining food choices. Specific to AIVs, Gido et al. (2017) in a study conducted in Kenya also found that AIV buyers' perceived AIV taste as unfavorable.

Overall ranking of recipes.

The results of Friedman Analysis of Variance revealed that there was a statistically significant difference in perceived ranking of the three recipes ($p<0.05$). The best ranked was Sautéed Nightshade and African Sticky Soup last (Figure 1) based on the sum of ranks.

Gido et al. (2017) similarly found that male decision makers had a significant negative effect on acceptance of Jute Mallow, the main ingredient in Sticky Soup, among the urban dwellers in Kenya due to its undesired taste and texture (Jacob and Ashkenazi, 2014).

Comparing differences between recipes.

Further, the analysis found a statistically significant difference in mean ranks of the three recipes (Table 2). The test statistic was 158.309 and degrees of freedom 2. The t-test value for difference in the mean ranks for Sautéed Nightshade and Sautéed Greens, for example, was -0.829 and the p-value was <0.001 (Adjusted Significance). Apart from organoleptic evaluations, about 95% of the respondents perceived that the introduced recipes took relatively less time to prepare compared to the traditional recipes, thus saving time for women to engage in other household chores and productive work. However, this study did not estimate the time taken to prepare each recipe.

CONCLUSIONS

Both women and men perceived that appearance, color, aroma or smell, and texture of some of the recipes as different, whilst tastes of all the recipes products were not perceived to be different by men and women. However, taste had the highest mean score for the most preferred recipe. Overall, Sautéed Nightshade was ranked the best and African Sticky Soup last. These findings help to identify acceptable sensory attributes that promote consumption of AIVs for both men and women. The key lesson learnt from this study is that involvement of consumers at grassroots and community level in whole process from recipe preparation to evaluation has high potential to build farmers' confidence and to hasten identification and preparation of acceptable AIV recipes for increased consumption. Future research should focus on testing of the new recipes alongside existing recipes commonly used by farmers to help the farmers make more informed choices. Further research is required to evaluate

chemical properties of the recipes products to enable promotion of recipes that lead to optimal nutrient retention and bioavailability.

Table 1: Mean scores of key attributes of AIV recipes in Western Kenya.

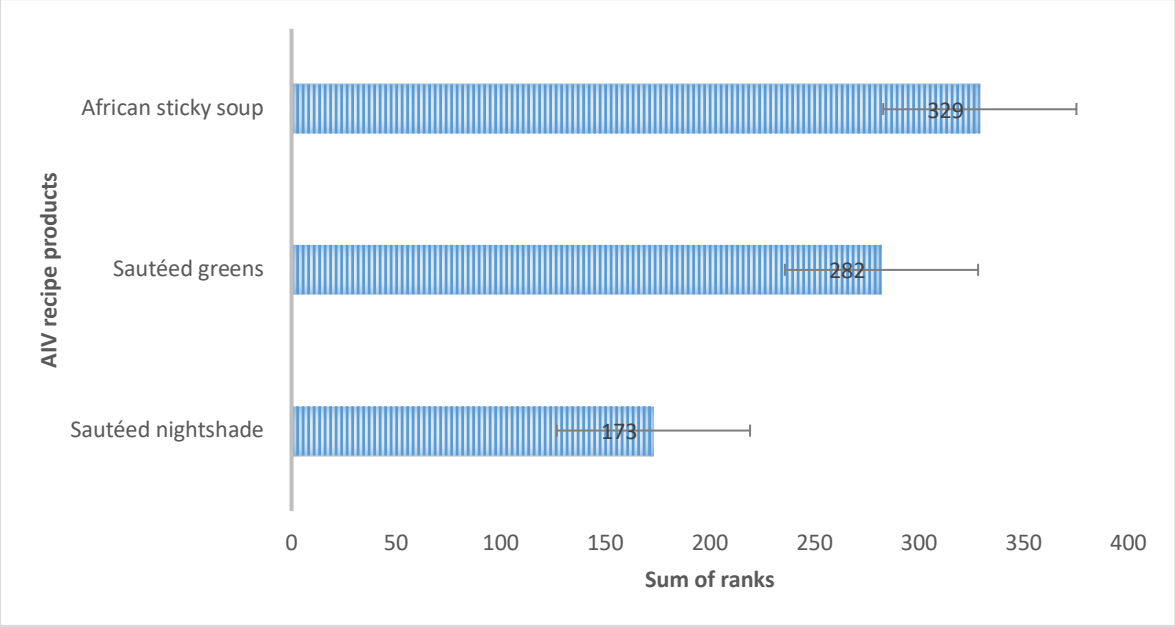
ATTRIBUTE	RECIPE	MALE	FEMALE	P-VALUE	SIGNIFICANCE
APPEARANCE	Sautéed Nightshade	4.2	4.7	0.038	**
	Sautéed Greens	3.8	4.5	0.032	**
	African Sticky Soup	3.9	4.5	0.059	*
COLOR	Sautéed Nightshade	4.3	4.6	0.001	***
	Sautéed Greens	3.8	4.4	0.064	*
	African Sticky Soup	3.8	4.3	0.101	
SMELL	Sautéed Nightshade	4.1	4.7	0.028	**
	Sautéed Greens	4.1	4.5	0.036	**
	African Sticky Soup	3.6	4.3	0.061	*
TASTE	Sautéed Nightshade	4.6	4.8	0.193	
	Sautéed Greens	4.0	4.5	0.111	
	African Sticky Soup	3.7	4.0	0.301	
TEXTURE	Sautéed Nightshade	4.7	4.6	0.727	
	Sautéed Greens	3.9	3.9	0.893	
	African Sticky Soup	3.6	4.3	0.040	**

Notes: Scores: 1=dislike very much, 2=dislike, 3=neither like nor dislike, 4=like, 5=like very much
Asterisks: ** and *** denote significant levels of 5%, and 1%, respectively

Table 2: Test of differences in mean ranks of recipes.

Recipe1-Recipe2	t-test	Adj.Sig
	-0.829	0.000
SG-ASS	-1.255	0.000
SN-ASS	-0.426	0.005

Note: 1. SN=Sautéed nightshade; SG=Sautéed greens; ASS=African Sticky soup;
2. Each row tests null hypothesis that distributions of recipes1 and recipe 2 are the same



*Lower rank sum scores indicate higher overall preference and higher rank sum indicate lower preference. Error bars represent 95% Confidence Interval

Figure 1. Sum of ranks of AIVs recipes products in Western Kenya.

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