Research Journal of Food Science and Nutrition
Volume 6(2), pages 8-13, June 2021
Article Number: EB7E9BB31
ISSN: 2536-7080
https://doi.org/10.31248/RJFSN2021.112
https://integrityresjournals.org/journal/RJFSN
Full Length Research

Nutritional and sensory evaluation of complementary food formulated from maize, pigeon pea and *Moringa stenoptela* leaves in southern Ethiopia

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Received 7th May, 2021; Accepted 7th June, 2021

ABSTRACT: The study was conducted to evaluate the nutritional and sensory attributes of maize based complementary food fortified with pigeon pea and *Moringa stenoptela* leaves. Methods of laboratory analysis and required reagents to determine each proximate composition were of analytical grade. A total of five food samples (FS1, FS2, FS3, FS4 and FS5) were formulated. The formulated five food products were evaluated for proximate composition to determine the nutritional value by using standard methods. The sensory evaluation of the prepared food sample were determined by 30 untrained breast feeding farmers from the study area. The nutritional analysis result indicated that crude protein, crude fat, moisture content, ash content, crude fiber and total carbohydrate of maize+moringa+pigeon pea fortified complementary food were ranged between 8.48-16.32%, 4.56-4.79%,4.60-4.79%, 5.5-7.8%, 1.32-2.60%, 67.21-76.38% respectively and increased significantly ($p \leq 0.05$) with the increasing amount of pigeon pea and moringa. But moisture and total carbohydrate contents decreased significantly ($p \leq 0.05$) when compared with common complementary food that was purely maize based. The sensory evaluation results indicated that appearance, taste, texture, odor and over all acceptance of semi-solid complementary food were ranged between 2.7-4.7, 2.4-4.9, 3.2-4.9, 2.6-4.7 and 1.8-4.8 respectively. The significant ($p \leq 0.05$) difference for sensory evaluation was attained for maize alone (FS1) and food sample with 10% moringa fortified with 5% pigeon pea and 85% maize (FS2), 15% moringa fortified with 10% pigeon pea and 75% maize (FS3), 20% moringa fortified with 15% pigeon pea and 65% maize(FS4) attained at $p \leq 0.05$. In conclusion, increasing moringa and reducing maize during complementary food preparation increased almost all nutrients except its moisture content. However, sensory acceptability of the sample decreased due to lack of familiarization and awareness of the evaluators in the study area.

Keywords: Complementary food, formulation, *Moringa stenoptela*, nutritional value, sensory evaluation.

INTRODUCTION

Child malnutrition is common problem in the developing countries of the world. Developing countries such as Ethiopia, double burden of malnutrition occurs in two ways among these countries, first by lack of appropriate raw food availability due to less production and secondly how to prepare balanced complementary food from the locally available raw food materials by mixing with nutritious multipurpose trees such as *Moringa stenoptela*. At household level, moringa fortified complementary food preparation is very simple and easily exposes to gain important micronutrients commonly called minerals and vitamins that help for both mental and physical growth of children. In Ethiopia, 38% of children under age five are stunted (short for their age); 10% are wasted (thin for their height); 24% are underweight (thin for their age), and 1% are overweight (heavy for their height) (CSA and ICF, 2016). Very few children get diversified diet due to less knowledge and attention given for child feeding traditionally

and also for human nutrition in general. Similar report from Ethiopian Democratic and Health Survey result of 2016 also mentioned that feeding practices of only 7% of children age 6 to 23 months meet the minimum acceptable dietary standards and only 14% of children had an adequately diverse diet (CSA and ICF, 2016). Cereal based complementary feeding is one of common practice among developing countries as well as mothers and care givers of this study area has also similar trend in child complementary food preparation. As above, it has been reported by various researchers that the traditional complementary foods in the developing countries are known to be of low nutritive value and are characterized by low protein, low energy density and high bulk, because they are usually cereal based (Shiriki et al., 2015).

Pigeon pea (*Cajanus cajan* L.) is a nutritionally important grain in the tropics (Rampersad et al., 2003). It is one of the major pulse crops which are commonly produced by farmers in the study area and highly rich in protein than that of cereals such as maize. Its good protein quality and quantity is important to reduce protein energy malnutrition (PEM) which is commonly characterized by kwashiorkor among children of age below five. However, the pigeon pea is protein rich crop, it was underutilized during complementary food preparation in the study districts of southern Ethiopia. It is rich in protein (19 - 26 %) and minerals (Rampersad et al., 2003). The ant-nutrients in pigeon pea are easily removed by house hold processing before complementary food preparation by traditional processing (Odeny, 2007). Studies also indicated that pigeon pea is used to improve the protein quality of starchy staples (Adeola et al., 2012; Muoki et al., 2012).

Researchers indicated that there are more than thirteen species of Moringa trees in the family of Moringaceae in the world (Ebert, 2014). *Moringa stenoptela* is one of the moringacious species which dominantly grown in Konso, Derashe Gamo, Gofa and Wolaita districts of southern Ethiopia. *Moringa stenoptela* mainly grown in Konso, Gamo, Gofa, Wolaita, Sidamo and Kaffa administrative regions and other parts of southern Ethiopia (Seifu, 2015). Moringa is the cultural food for 14 nationalities in the southern region and served as sub dish of their staple food intake including the above mentioned districts. Different researches were conducted in tropics and subtropics of world only focusing on *Moringa oelefera* than *Moringa stenoptela* despite both are grown in aforementioned parts of the world, but the later was underutilized for complementary food preparation (Melesse et al., 2011).

Farmers of Konso, Derashe and Arbaminch zurea districts of Southern Ethiopia use moringa as their side dish and sometimes mix it with common staple foods from cereals such as maize and sorghum. Farmers in the study area were less aware about the nutritional importance of moringa for their children due to traditional beliefs that its consumption causes stomach ache and diarrhea among them.

Commonly known food in those study area that are prepared from maize, wheat and sorghum are kitta (plat bread), kurkufa (moringa mixed with maize oval bread) and posose (maize flour blended with boiled moringa leaves). Aforementioned practice was not age based complementary food preparation but it was general food prepared for whole family members irrespective to children digestive ability and dietary requirements. Lack of knowledge on the benefits of non seasonal, inexpensive and multiple nutrient rich plant such as moringa underutilization while complementary food preparation in the study area initiated us to conduct this study. Hence, the aim of the study was to evaluate the nutritional and sensory qualities of complementary food formulated from maize, pigeon pea and *Moringa stenoptela*.

MATERIALS AND METHODS

Raw materials collection

Moringa stenoptela was collected from small scale farmers' tree and maize and pigeon pea were bought from local markets of Arbaminch, Konso and Derashe districts of southern Ethiopia.

Procedures of flour preparation

All the required materials were collected and cleaned by washing with clean water before flour preparation. Fresh *Moringa stenoptela* was harvested and washed, drained and shade-dried for five days to control nutrient loss by direct sun light at ambient temperature. The dried leaves were pulverized at home with local pulverizer manually and sieved with a fine sieve (500 microns) before packaged in polyethylene bag and stored in the freezer at temperature of -4°C until used for both laboratory analysis and food sample preparation. Maize and pigeon pea were sorted cleaned from any debris and dried pigeon pea was soaked for 24hr at ambient temperature (25±2°C) to reduce anti nutrients such as phytate and tannin common in pigeon pea. The soaked pigeon pea was rewashed with tap clean water drained to remove outer cover (husk) of the seed and boiled for 10 minutes and air dried for 2 days and oven dried at 60°C for 30 minutes in order to minimize the beany flavor which usually comes from legume crops. Both maize and pigeon pea were separately milled and packaged with polyethylene bag and stored in cool freezer at -4°C until used.

Proximate composition analysis

Nutritional analysis of the food sample was conducted at Arbaminch University which was 5 km away from experimental site. The formulated five food products were evaluated for proximate composition (moisture content, ash content, fat content, protein content, fiber content) by

Table 1. Proportion of food formulation from maize, pigeon pea and moringa before food preparation.

Formulations	Maize (%)	Moringa (%)	Pigeon pea (%)
FS1	100	0	0
FS2	85	10	5
FS3	75	15	10
FS4	65	20	15
FS5	55	25	20

using standard methods according to AOAC (2005). Total carbohydrate was calculated from the difference as follow:

%Carbohydrate = 100 - (%protein + %fat + %ash + % moisture + %fiber)

Sensory evaluation procedure

A total of 30 untrained breast feeding farmers whose children were age below two year were selected from the study area and they were first oriented before the assessment of semi-solid complementary food. The food sample was coded with three digit number and presented to the participants. Then, the participants were asked about the products based on appearance, taste, texture, odor and overall acceptance of each of the samples. The five point hedonic scale was used for sensory evaluation: 5 = very liked, 4 = liked, 3 = neither like nor disliked, 2 = dislike, and 1 = extremely disliked.

Food formulations/treatments combination

Treatments: Maize alone (control), Maize 85% + 10% Moringa + 5% pigeon pea flour, Maize 75% + 15% Moringa flour +10% pigeon pea flour, Maize 65% + 20% Moringa flour +15% pigeon pea flour, Maize 55% + 25% Moringa flour+20% pigeon pea flour arranged in Completely Randomized Design with three replications to have uniform flour (Table 1).

Statistical analysis

All the collected data from food sample were subjected to analysis of variance (ANOVA**)** as described by Steel and Torrie (1990) suitable for completely randomized design (CRD) with three replication and analyzed by using SAS software version 9.2. The significance difference attained among the treatments mean were obtained by Fischer's LSD method at $p \leq 0.05$.

RESULTS AND DISCUSSION

Significance difference ($p \leq 0.05$) was obtained for moisture, fat, ash, fiber and carbohydrate when maize was fortified with moringa to formulate complementary food. Sample FS1 has highest amount of moisture (7.8%) which is within the recommended range of 15% for cereal based foods whereas, the lowest (5.5%) record was from FS5 (55% maize blended with 25% moringa and 20% pigeon pea). This result was similar to that of Yibeltal et al. (2016) which indicated that moisture content of sole maize (100%) was 7.82%. As moringa addition to maize and pigeon pea increased, the moisture content decreased generally. This result is in harmony with the results of Abioye (2015) who indicated moisture content reduction from 9.13 to 8.77% as 15% moringa supplemented to 85% maize.

Significance differences were obtained for protein content in all treatments when compared with control sample as indicated in (Table 2). The maximum (16.32%) value for crude protein was recorded from FS5 while the lowest (8.48%) was record from purely maize based (FS1). This result is in accordance with Khavhatondwi (2018) who reported lower protein content of the control sample when compared with maize fortified with moringa. As both moringa and pigeon pea supplementation to purely maize based complementary food increases, the amount protein content in the food also increased. Khavhatondwi et al. (2018) also obtained similar findings on nutritional and sensory properties of instant maize porridge fortified with moringa leaves indicated that protein content of the purely maize based complementary food sample was lower than that of fortified samples.

The result for fat contents of developed complementary food showed significance ($p \leq 0.05$) difference for FS4 and FS5 when compared to other samples (FS1, FS2 and FS3). The highest (4.79%) value record for fat content was from the food sample FS5 while the lowest (4.56%) value record was from FS1 respectively. As the amount of maize decreased and both pigeon pea and moringa increased, the amount of fat in complementary food increased significantly. This may be due to the fact that both moringa and pigeon pea higher amount of fat constituent than maize. Similar report from Adeola et al. (2017) indicated low fat content for complementary food from pigeon pea and sorghum without moringa. Fat content in the current study ranged from 4.56 to 4.79% as it increased from FS1 to FS5 due to the increase in moringa and pigeon pea. This is contrary to findings of Shiriki et al. (2015) who suggested that the crude fat content was reduced from

Table 2. Nutritional composition of complementary food formulated from maize, pigeon pea and *Moringa stenoptela* leaves.

Food sample	Moisture	Protein	Fat	Ash	Fiber	CHO
FS1	7.8[a]	8.48[e]	4.56[d]	1.32[e]	1.45[e]	76.38[a]
FS2	6.9[b]	10.19[d]	4.58[dc]	1.86[d]	2.5[d]	73.94[b]
FS3	6.5[c]	12.21[c]	4.60[c]	2.06[c]	2.88[c]	71.73[c]
FS4	6.1[d]	14.59[b]	4.73[b]	2.52[b]	3.06[b]	68.94[d]
FS5	5.5[e]	16.32[a]	4.79[a]	2.60[a]	3.51[a]	67.21[e]
LSD(p≤0.05)	0.0862	0.0955	0.0474	0.0745	0.0896	0.2207
CV (%)	0.5	0.29	0.39	1.38	1.29	0.12

Means in the same column with the same letters are not significantly different.Where, FS1= 100% maize (control), FS2=85% maize+10% moringa +5% pigeon pea, FS3=75% maize+15% moringa+10% pigeon pea, FS4=65% maize+20% moringa+15% pigeon pea, FS5 = 55% maize+25% moringa+20% pigeon pea. 1= extremely dislike whereas 5= like extremely.

23.8 to 20.8% in formulations of maize, soya bean, peanut and moringa fortified complementary food. This may be due to moringa variety difference, processing method and peanut and soya bean assumed to have higher fat content than pigeon pea alone. However, the increase in fat content in this study is not above the recommended dietary allowance for children age below three years. Gordon (1999) also reported similar result.

Ash is an indicator of overall mineral content in complementary food formulation. As indicated in Table 2, there was significant difference (p≤0.05) for ash content in all treatments for complementary food formulation. The result indicated that maximum value for ash content was recorded from FS5 (2.6 g/100g) while the minimum value was recorded from FS1 (1.32 g/100g). In general, the amount of ash in the food sample was increased as moringa and pigeon pea increased. This is due to high mineral and vitamin contents in the *Moringa stenoptela* and heat sensitive characteristics, in that it easily changed into ash during analysis. This finding is in accordance with reports of Dooshima et al. (2015) and Nwosu et al. (2014) on nutritional evaluation of complementary food formulations from maize, soybean and peanut fortified with *Moringa oleifera* leaf powder, indicated that ash contents of the diets increased as moringa supplementation increased.

Gordon (1999) mentioned that crude fiber does not contribute nutrients to human body, however, it adds bulk to food thus facilitating bowel movements and preventing many gastrointestinal diseases in man. Fiber content of food analysis showed statisticallysignificance (p≤0.05) difference among all formulated complementary food prepared from maize, moringa and pigeon pea. The value for fiber content in the food samples ranged from 1.45 to 3.51 g/100g. The highest (3.51 g/100g) was obtained from food sample with increased amount of moringa and pigeon pea and reduced maize while the lowest(1.45 g/100g) record was from maize alone(control).

Total carbohydrate in formulated complementary food was calculated from the difference of other nutrients. The amount of carbohydrate in formulation decreased as moringa and pigeon pea content increased. Gernah and Sengev (2011) also reported a low carbohydrate content of 38.20 g/100g. This was due to the fact that vegetables such as moringa had better mineral and vitamin contents when compared with their carbohydrate content. There was statistical difference for carbohydrate content of complementary food in all treatments. The maximum (76.38%) carbohydrate was recorded from sole maize (FS1) based complementary food whereas the minimum (67.21%) value was recorded from maize reduced and both moringa and pigeon pea increased formulation (FS5). Generally, in this study the addition of moringa and pigeon pea to maize increased the proximate nutritional composition of common maize based complementary food. Abioye (2015) also indicated similar results.

There was no significance difference (p≤0.05) between FS1 and FS2 in appearance, taste, texture, odor and over all acceptance of complementary food. Food sample FS4 and FS5 were similar for all sensory attributes except for overall acceptance by evaluators. The appearance of complementary food showed significant difference (p≤0.05) for FS3 (Table 3). The maximum values for appearance (4.9), taste (4.9), texture (4.9), odor (4.7) and overall acceptability (4.8) were recorded from FS1. Whereas the minimum sensory values for appearance (2.7), taste (2.4), texture (3.4), odor (2.6) and overall acceptance (1.8) were from FS5. This may be due to the lack of practice of the moringa utilization at the time of complementary food preparation and cultural ignorance of green leafy vegetables in the study districts.

The result of this study indicated that quantity of moringa and pigeon pea increased in the maize based food, the sensory acceptability decreased in general. This was mainly because unpleasant (beany) flavor which usually comes from pulse crops such as pigeon pea and other legumes. Similar result was reported by Dureto (2018) on sensory evaluation and demonstration of some common bean dishes indicated that overall acceptability of common bean based dishes decreased due to its beany flavor. The findings of Sithandiwe et al. (2019) has also reported that the overall acceptability of soft porridges decreased with increasing amount of moringa. Abilgos and Barba (1999) also confirmed that flat noodles about 5% moringa

Table 3. Mean Sensory evaluation of maize based Complementary food fortified with *Moringa stenoptela*.

Food samples	Color	Taste	Texture	Odor	Over all acceptance
FS1	4.7[a]	4.9[a]	4.9[a]	4.7[a]	4.8[a]
FS2	4.6[a]	4.4[a]	4.7[a]	4.6[a]	4.8[a]
FS3	3.5[b]	4.4[a]	3.7[b]	3.8[b]	3.6[b]
FS4	2.9[c]	3.5[bc]	3.2[b]	3.2[bc]	2.7[c]
FS5	2.7[c]	2.4[c]	3.4[b]	2.6[c]	1.8[d]
LSD(p≤0.05)	0.57	0.63	0.61	0.65	0.61
CV (%)	17.18	19.29	17.20	19.36	19.43

Where: FS1= 100% maize (control), FS2=85% maize+10% moringa +5% pigeon pea, FS3=75% maize+15% moringa+10% pigeon pea, FS4=65% maize+20% moringa+15% pigeon pea, FS5 = 55% maize+25% moringa+20% pigeon pea. 1= extremely dislike whereas 5 = like extremely.

Table 4. The energy value/cal of complementary food from maize, moringa and pigeon pea.

Food samples	Carbohydrate	Protein	Fat
FS1	305.52	33.92	41.04
FS2	295.76	40.76	41.22
FS3	286.92	48.84	41.40
FS4	275.76	58.36	42.57
FS5	248.84	65.28	43.11

Table 5. Proximate composition of moringa stenoptela powder alone based on dry weight.

Phytoconstituent (%)	Mean values of percentage composition (g/100 g of DW) for the current study energy value/kcal	
	Mean value	Energy value
Carbohydrate	43.97 ± 0.72	175.88
Crude protein	12.05 ± 0.62	48
Fat content	4.06 ± 1.63	16
Ash	2.2 ± 0.63	
Crude fiber	3.0 ± 0.45	
Moisture content	4.92 ± 0.02	
Flavonoids	1.12 ± 0.20	
Alkaloids	0.06 ± 0.00	
Phenols	46.81 ± 3.29	
Saponin	14.00 ± 0.51	

substitution was found to be most acceptable when compared with a higher moringa substitution level. In this study participants evaluated all the sensorial acceptability of the prepared complementary food and the result showed that as the amount of moringa addition to complementary food increases the food becomes bitter than the traditional one. This is in line with similar report from Sithandiwe et al. (2019) who indicated that the bitter taste in the moringa-added porridges contributed most to the decrease in the overall acceptability of the moringa-added porridges. This could be solved through timely practice of moringa utilization during complementary food preparation. As input to study participants, the nutrition education was provided to create awareness through focus group discussion (FGD) after the end of sensory evaluation.

Conclusion

As moringa supplementation to commonly used maize based complementary food increases, the sensory acceptability of the sample decreased. This may be due to lack of familiarization and awareness of the evaluators in the study area. In the formulation of complementary food from maize with nutrient dense multi-purpose tree such as

moringa increases, the proximate nutritional composition of the complementary food also increased. Increasing moringa and reducing maize during complementary food preparation increased almost all nutrients except its moisture content. Reduced moisture content during complementary food preparation is important because it extends the shelf life of food by inhibiting microbial growth.

COMPETING INTEREST

The authors declare that there is no competing interest on this research work that would bias the collection, analysis, reporting or publishing of this paper.

ACKNOWLEDGMENT

Special thanks to Southern Agricultural Research Institute for their financial support. Our heartfelt thanks also go for Arbaminch University for permitting us to carry out laboratory analysis of food samples and crop research work coordinator for his facilitation till the end of this research work.

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