A Report:
Community-level acceptability and feasibility assessments of soy-containing complementary food blends by women and children in rural Ghana

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Summary

Adequate protein consumption is fundamental to human growth and health, especially in the first 1,000 days of life. Complementary nutrition after exclusive breastfeeding is critical for child’s linear growth and development. The Soybean Innovation Lab (SIL), in collaboration with the University for Development Studies (UDS) and Catholic Relief Services in Ghana, studied the acceptability and feasibility of the incorporation of soy meal to enhance the nutrient profile of a complementary food containing orange-fleshed sweet potato (OFSP). A total of 104 mother-infant pairs (6-24 months) living in Ghana’s Northern and Upper West regions participated in the sensory studies. Complementary foods included: 1) a complementary food product developed by researchers at UDS called “Complementary Food for Africa” (ComFA) containing OFSP and roasted soy flour, 2) ComFA variations containing anchovies, and 3) moringa leaves, and a control, 4) Weanimix, a complementary food made from maize, groundnuts, soy, and sugar that is widespread in Ghana. Over the course of 4 days, infants were fed one type of food per day. All subjects tested all the foods. Mothers filled out demographic questionnaires and were asked to provide 100 g of each food to their children and given 10 minutes to feed the child. Leftovers were weighed and compared. All subjects tested all the foods. A sub-group of women (n=20) received the ingredients to prepare the four complementary foods in their homes for 2 weeks. During focus groups, women were asked to explain potential barriers for the preparation of these foods as well as their thoughts about complementary feeding. In general, women liked all the foods evaluated. ComFA with moringa, however, was not as popular. Most women agreed that foods were perceived positively by their children. However, standard ComFA and Weanimix carried slight preference among the children and their mothers. Based on food leftovers, Weanimix was preferred over the ComFA treatments (ANOVA, P<0.05). Food leftovers of ComFA and its variations were similar in weight (Tukey HSD, P>0.05). From focus groups, women indicated that they wanted to try more ingredients with ComFA (e.g., maize and groundnuts). All women agree that the ability to include more ingredients with ComFA was a significant advantage of using ComFA for their children. Although the women indicated that Weanimix preparation took more time and required more water and energy, this needs to be confirmed in further studies. ComFA is a viable alternative as a nutritious complementary food. Its nutrition can be further enhanced with the addition of fruits and alternative soy products such as textured soy protein.

Keywords: Consumer acceptance, complementary food, soy protein, orange-fleshed sweet potato
Key messages

- Both ComFA (orange-fleshed sweet potato and roasted soy flour) and Weanimix (maize-groundnut-soy blend plus sugar) had good consumer acceptability.
- Most children consumed Weanimix more than ComFA products as Weanimix was heavily sweetened with sugar.
- The mothers/caregivers used approximately a third of the water used to prepare Weanimix in the preparation of ComFA.
- Most women were able to easily prepare the different complementary foods at home.
- Most women perceived different ComFA formulations as highly nutritious.
- ComFA with soy is a great alternative, nutritious product for complementary feeding in Ghana as it has significant amount of quality protein and micronutrients, especially provitamin A.

Source of funding

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Conflicts of interest

The authors declare no conflicts of interest. The authors alone are responsible for the content of this report.
Introduction

The high cost of animal protein in lower income countries, and in some cases, cultural practices limit the inclusion of meat, fish, and eggs in the diet of infants. Contrastingly, meat- and fish-based complementary foods are commonly used in developed countries (Dube et al., 2010, Nudda et al., 2011), promoting adequate nutrition for infants in such countries. Adequate nutrition during the first 1,000 days of life is fundamental and a ‘critical window’ for the advancement of optimal growth, and the development of each child’s full human potential (Pan American Health Organization (PAHO) and World Health Organization (WHO), 2003). It is therefore essential for caregivers/nursing mothers to have access to nutritious complementary foods 6 months after giving birth when their children require additional nutrients from other food sources in addition to breastmilk.

In most low-income countries, legumes, particularly soybean, can be an important ingredient in complementary foods due to the quality of their protein (Ma et al., 2015), as well as biofortified food crops such as OFSP and orange maize, both higher in β-carotene than existing white-coloured varieties (van Jaarsveld et al., 2005, Gannon et al., 2014).

Worldwide, there has been over dependency on cereals for complementary feeding because the Codex Standard and Guidelines have cereal as the major ingredient for foods for infants and young children (Codex Alimentarius Commission, 1991, Codex Alimentarius Commission, 2006). For example, in Ghana, Weanimix, a complementary food blend consisting of maize (75%), soybean-cowpea (15%) and groundnuts (10%) (Agble, 1997, Lartey et al., 1999) has served as a prototype for other cereal-based complementary foods in sub-Saharan Africa. However, efforts are being made to introduce complementary foods based on soybean and biofortified sweet potato instead of the existing cereal-legume blends (Amagloh and Coad, 2014, Nandutu and Howell, 2009), and cereal-legume-biofortified sweet potato (Omwamba et al., 2007, Oyarekua, 2013, Mahmoud and Anany, 2014, Nguyen-Orca et al., 2014, Tenagashaw et al., 2017, Adisetu et al., 2017).

Homemade Weanimix is characterized by high phytate concentration (Amagloh et al., 2012c, Lartey et al., 1997); and few essential micronutrients such as β-carotene (provitamin A) (Amagloh et al., 2012b, Amagloh and Coad, 2014, Lartey et al., 1998). The low level of β-carotene is because white maize and legumes are devoid or low in provitamin A (Dewey and Brown, 2003, Nuss and Tanumihardjo, 2010). The high
concentration of phytate limits iron and zinc absorption in humans (Gibson et al., 2010). A recent study has shown that aflatoxin contamination in Weanimix should be of concern, exceeding the 15 ppb limit for food for consumption in Ghana (Kumi et al., 2014). The exposure to the high level of aflatoxin in foods for infant and young children has been reported to be a contributing factor to the high prevalence of malnutrition in children less than 5 years of age in West Africa (Gong et al., 2003, Gong et al., 2004). Although malnutrition is a result of multifaceted causes, its prevalence may largely depend on the diets of infants and young children. Thus, complementary feeding has a crucial role to play in improving the health of this vulnerable group.

Due to the issues highlighted above, alternative complementary food ingredients warrant consideration. Complementary food formulated using tubers or root crops such as sweet potato had lower phytate levels compared with those from cereal and legume blends (Gibson and Anderson, 2009, Gibson et al., 2010). This finding formed the basis of the development of “Complementary Food for Africa” ComFA (Figure 2), an OFSP and soybean complementary food (Amagloh et al., 2012b, Amagloh and Coad, 2014).

Based on the nutrient composition, protein quality, functional properties, and sensory preferences (Amagloh et al., 2012b, Amagloh et al., 2012a, Amagloh et al., 2013, Amagloh and Coad, 2014, Amagloh et al., 2015), the ComFA formulation could be a superior household-level complementary food than Weanimix. Yet, the acceptance of ComFA formulation by older infants (i.e., after exclusive breastfeeding dwindles) has not been assessed in low-income countries. Also, the feasibility of preparation by caregivers of this complementary food at the household level and its ease of feeding is yet to be understood. These studies are crucial if the OFSP and soy-based complementary food, i.e., the ComFA formulation, is to be recommended as an alternative, complementary food in Ghana, and Africa at large. Hence, there is the need to conduct a randomized feeding trial among Ghanaian

Figure 1. Orange-fleshed sweet potato.

Figure 2. ComFA made with soy flour and orange-fleshed sweet potato.
mother-infant pairs to ascertain the acceptability and feasibility of ComFA formulations.

The objectives of the study were to 1) assess the acceptability ComFA and *Weanimix* by mothers/caregivers, and 2) to obtain information on mothers’/caregivers’ experience of preparing and feeding the products to their infants by conducting a two-week home-use trial.

**Materials and Methods**

**Study design and site**

A crossover study design was used to assess the acceptability of the ComFA and *Weanimix* formulations, and a longitudinal study for the two-week home-use trial to obtain information on the feasibility of the formulation in two selected communities Awaradone (Upper East Region) and Yipelgu (Northern Region), both located in a USAID Feed the Future target country, Ghana. Most families live in mud-based huts (Figure 3).

**Materials and proportion of ingredients in the formulations**

OFSP storage roots were acquired from Kokubilla Nasia Farms Ltd. where their cultivation is under irrigation. Moringa leaves were harvested from Bontanga Irrigation fields, shade-dried and pulverized (fine powder). The other ingredients (Table 1) were purchased from the local markets. The proportions were added on “as-is” basis (i.e., as found in the markets).
Table 1. Proportions of ingredients for complementary food formulations

<table>
<thead>
<tr>
<th>Ingredient</th>
<th>ComFA</th>
<th>ComFA + Anchovies</th>
<th>ComFA + Moringa</th>
<th>Weanimix*</th>
</tr>
</thead>
<tbody>
<tr>
<td>OFSP</td>
<td>70%</td>
<td>70%</td>
<td>70%</td>
<td>-</td>
</tr>
<tr>
<td>Soybeans</td>
<td>30%</td>
<td>20%</td>
<td>25% or 27.5%</td>
<td>15%</td>
</tr>
<tr>
<td>Anchovies</td>
<td>-</td>
<td>10%</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Moringa</td>
<td>-</td>
<td>-</td>
<td>5% or 2.5%</td>
<td>-</td>
</tr>
<tr>
<td>Maize</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>75%</td>
</tr>
<tr>
<td>Groundnuts</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>10%</td>
</tr>
</tbody>
</table>

*Mothers/caregivers added sugar to taste (200 or 400 g). Only Weanimix was pre-sweetened with sugar

Acceptability trial

Mother/caregiver-child pairs (n = 104) were grouped and randomly assigned to a different complementary formulation on Days 1 to 4. There was a washout period of 24 hours before being assigned another formulation for the acceptability assessment. Both the ComFA and ComFA + anchovies formulations were assessed in both communities; ComFA + 5% moringa was evaluated in Northern Region, while ComFA + 2.5% moringa was used in the Upper East Region. The control, Weanimix, was sweetened with sugar (~400 g) to taste for Day 1 and Day 4, while Weanimix + 200 g sugar was served on Day 2 and 3.

Ingredients were given to the groups to prepare the porridge after giving them the instructions on how to prepare the ComFA as they would at home. Each mother/caregiver pair was served the porridge and they assessed the porridge for appearance, taste, mouthfeel and overall degree of liking using a 3-point Likert scale. As aroma at household-level is appreciated during the cooking, the participants were asked to assess aroma during the porridge preparation.

A 10-minute consumption test was used to indirectly assess acceptance. In this test, women were given 100 g of food and asked to spoon-feed their children within 10 minutes. After 10 minutes, investigators collected the pre-measured plates and recorded the amount of leftover. This test has limitations associated with the manner in which the food is given (e.g., spoon, gavage), the setting (i.e., distractions), and the appetite of the child (i.e., hunger level).

Water used to prepare the food was monitored in all trials. The water used was estimated based on the initial weights of the raw ingredients, the water added, and the final weight of the porridge.
Although most child feeding practices occur at homes, these homes have limited roof coverings and are mostly open air. Thus, investigators identified an open area under a large tree to conduct the sensory studies. This was not the perfect setting for sensory studies, but it was closer to what women experience with their children at homes. In Ghana, extension services for either healthcare or agriculture occur under large trees, which provide good protection under high heat conditions.

**Feasibility test**

Different groups of women \( (n = \sim 20/\text{group}) \) were assigned to one of the formulations to ascertain the feasibility of preparation, particularly the ComFA formulations as women are already familiar with *Weanimix* as a complementary food. On the first day, caregivers/mothers in each group were given a weekly ration of the ingredients and trained on the preparation of the assigned formulation. On the second day, the investigators followed-up with caregivers/mothers on the preparation of foods. The food ingredients were supplied again on Day 7. On Day 14 of the feasibility study, women from the two selected communities were invited to participate in a focus group discussion. During the focus groups, the investigators used a semi-structured questionnaire with the mothers/caregivers to ascertain the general perception and infant’s acceptance of complementary food as well as ease of preparation and use of resources.

**Ethical considerations**

The Ghana Health Service Ethical Review Committee (GHS-ERC:13/01/17) and University of Illinois Institutional Review Board (Protocol #17178) approved the study. An informed consent form attached to the questionnaires was used to seek the consent of all participants before inclusion in the study.

**Statistical analysis**

Statistical analyses were conducted depending on the type of variable under scrutiny. One-way ANOVA was used to evaluate differences among treatments from the results of the 10-minute consumption test. Due to failing the homogeneity of variance and normality tests, the Kruskal-Wallis One-Way Analysis of Variance on Ranks along with Dunn’s *posthoc* tests were used to evaluate the differences between responses to formulas in sensory studies. The Chi-square independence test was used to evaluate differences in responses in the focus groups. The rating scale to quantify affective dimension of the consumer perception of complementary foods was the 3-point Likert
scale. The quantity of complementary food consumed by infant was calculated and expressed as a percentage. Verbal communication expressed during focus group discussion was recorded, and when appropriate, translations were conducted.

**Results**

**Acceptability study**

Sensory acceptability studies are necessary to assert the potential opportunities a food product might have in finding new, profitable markets. This is no difference for complementary foods. Affective or hedonic testing is used to quantify the degree of liking or preference of a product. It is often performed on regular consumers by having them choose amongst product alternatives or rate their degree of liking on a scale (e.g., Likert, yes/no, etc.).

Several affective tests were conducted with women living in Ghana's Northern region. The final number of participants were 104 (ComFA), 82 (ComFA+anchovies), 60 (ComFA+2.5% moringa), 57 (ComFA+5% moringa), 58 (Weanimix 200g sugar), and 60 (Weanimix 400g sugar). Figure 4 shows the setting used to conduct the sensory studies. The hours of the day were in the morning to avoid extreme temperatures. The questionnaire had several questions on appearance (i.e., how the product looks), aroma (i.e., how the product smells), taste (i.e., how the product tastes), mouthfeel (i.e., how the product feels in the mouth), and overall acceptability (i.e., overall rating). Women were trained in defining these sensory descriptors and were provided the foods for evaluation. They had to choose on the Likert scale (1-3) what they thought was the closest to their sensing. Although scales with more anchors (1-9) are preferred in adults, in the case of a population with limited training in sensory and literacy, shorter scales are used.

![Figure 4. Sensory evaluation setting in Northern Ghana.](image)
**Appearance.** Figure 5 shows the results for appearance. In general, most women thought that all the products had a good appearance. There were some differences among treatments (Kruskal-Wallis ANOVA; p<0.01), in which the responses for the ComFA+moringa were consistently lower than others. Nonetheless, these scores were higher than the average (Likert scale=2; Neither like nor dislike). There were no differences between ComFA and *Weanmix* types.

![Appearance](image)

**Figure 5.** Average scores assigned by panellist for appearance during sensory evaluation of complementary foods in Northern Ghana.

**Aroma.** Figure 6 shows the results for aroma. In general, most women thought that all the products had a good aroma. There were some differences among treatments (Kruskal-Wallis ANOVA; p<0.01), in which the responses for the ComFA+Moringa were consistently lower than those of others. Nonetheless, these scores were higher than
the average (Likert scale=2; Neither like nor dislike). There were no differences between ComFA and Weanimix types.

**Mouthfeel.** Figure 7 shows the results for mouthfeel. In general, most women thought that all the products had good mouthfeel. There were some differences among treatments (Kruskal-Wallis ANOVA; p<0.01), in which the responses for the ComFA+moringa were consistently lower than those of others. Nonetheless, these scores were higher than the average (Likert scale=2; Neither like nor dislike). There were no differences between ComFA and Weanimix types.
Figure 8 shows the results for taste. In general, most women thought that all the products had good taste. There were some differences among treatments (Kruskal-Wallis ANOVA; p<0.01), in which the responses for the ComFA+moringa were consistently lower than those of others. Nonetheless, these scores were higher than the average (Likert scale=2; Neither like nor dislike). There were no differences between ComFA and Weanimix types.

**Taste.** Figure 8 shows the results for taste. In general, most women thought that all the products had good taste. There were some differences among treatments (Kruskal-Wallis ANOVA; p<0.01), in which the responses for the ComFA+moringa were consistently lower than those of others. Nonetheless, these scores were higher than the average (Likert scale=2; Neither like nor dislike). There were no differences between ComFA and Weanimix types.
Overall acceptability. Figure 9 shows the results for overall liking. In general, most women thought that all the products had good overall acceptability. There were some differences among treatments (Kruskal-Wallis ANOVA; p<0.01), in which the responses for the ComFA+moringa were consistently lower than those of others. Nonetheless, these scores were higher than the average (Likert scale=2; Neither like nor dislike). There were no differences between ComFA and Weanimix types.
While feeding their child, women were asked their perceptions on their children’s preference for the given product (Figure 10). In general, most women thought that their kids liked all products. There were some differences among treatments (Kruskal-Wallis ANOVA; p<0.01), in which the responses for the ComFA+moringa and ComFA+anchovies were consistently lower than those of others. Nonetheless, these scores were higher than the average (Likert scale=2; Neither like nor dislike). There were no differences between ComFA and Weanimix types.

**Figure 9.** Average scores assigned by panellist for overall liking during sensory evaluation of complementary foods in northern Ghana.

**Women perception of liking by their children.**
**Child 10-minute consumption test.** Mothers were provided with 100 g of food and asked to spoon-feed their children within 10 minutes. Then, the investigators weighed the leftovers. Although this test has many limitations during implementation, it is an indirect indicator of acceptance. There were clear differences among treatments (ANOVA and Tukey; p<0.01), in which *Weanimix* types were consumed in higher proportion (>50% of food given) than all ComFA formulas (Figure 11).
Water use. The amount of water added to prepare all ComFA formulations was very consistent (2.8 ± 0.4 kg). The amount of water in *Weanimix* was much higher due to the characteristics of the product, which has more starch from maize, which instead makes it more viscous (8.5 ± 1.6 kg). The relative variability of water added to *Weanimix* was much larger than that for all ComFA formulations (RSD: 19.5% vs. 12.9%).

**Figure 11.** Average amount of food consumed by child during the 10-minute consumption test with complementary foods in northern Ghana.
**Feasibility study**

The feasibility study took place in the same regions in Ghana. The study was designed to allow mothers to prepare all products at home. The mothers received the ingredients for all product formulations. No gas or other means of energy to cook was provided. The report follows the questionnaire provided to mothers during the focus groups. There were four focus groups, each at the end of the two weeks after using each of the food formulas, i.e., ComFA, ComFA+moringa, ComFA+anchovies, and Weanimix.

All mothers prepared the foods themselves. However, 16% (n=25) of the women modified the recipe procedure. Those that modified the recipes did so to modify ComFA (68%). They mostly modified ComFA to add sugar. This is an interesting finding as this formula was supposed to be the sweetest of the recipes. Other modifications included the addition of other ingredients (e.g., salt, oil, maize) or changes in the steps (e.g., first cooking the sweet potatoes or cooking them together) in the preparation of any of the complementary foods.

Almost all women (91%) said they would recommend the ComFA formulations to other mothers in their households. Those that said no (9%) said that either the ComFA+moringa or the ComFA+anchovies had a strong aroma or taste. Other reasons were that there were mothers living in the same household that were part of the project. Some of the thematic reasons why women would recommend the products to other mothers in the household were associated with a benefit to their children using descriptors such as good, helpful, nutritious or healthy. Women also described the products’ beneficial attributes such as easy to prepare, liked by their children, or tasteful.

These responses were similar to those that the women provided when asked if they would like to recommend the product to their communities. Almost all women (92%) said they would recommend the new complementary foods to other women in their communities. Those who did not want to recommend the products had just prepared ComFA with anchovies or moringa. They pointed out similar reasons as before associated with sensory issues. Women also mentioned that other women won’t listen to them or won’t have the time to do it.

When women were asked whether they would discuss the new formulations with their families and friends at social gatherings, most women said ‘yes’ (87%) and only 13% said ‘no.’ Those that said ‘no’ had only prepared ComFA with moringa or anchovies.
The main reason, however, had nothing to do with the products but with the women’s limited time to visit with relatives (62%). The remaining women alluded to more self-effacing reasons such as “I am shy,” “they won’t listen to me,” or “they will insult me.” For the most part, women will promote the use of these products using descriptors similar to those indicated above. When talking about ComFA, some mothers said:

“I would recommend... because the ingredients are simple and available for easy adoption.”
- Participant from Yipelgu

“I would recommend... because wish all community member to benefit to help alleviate poverty.”
- Participant from Yipelgu

“It is nutritious especially the soya beans added.”
- Participant from Awaradone

Two specific questions had to do with the ease of preparation of the products at home and the ease of consumption of the products by their children. Some women included specific terms such as the products are rich in vitamins and have vitamin A.

**Ease of preparation.** Women were asked about the ease of preparation of the formulas at home. The question was *Please rate your perceived ease of preparation of project food?* Table 2 shows the results of this question.

**Table 2.** Ease of preparation responses (number and %) among women participating in the feasibility study.

<table>
<thead>
<tr>
<th>Formula</th>
<th>Extremely easy to prepare</th>
<th>Slightly easy to prepare</th>
<th>Indifferent</th>
<th>Slightly difficult to prepare</th>
<th>Extremely difficult to prepare</th>
</tr>
</thead>
<tbody>
<tr>
<td>ComFA</td>
<td>Number 12</td>
<td>19</td>
<td>4</td>
<td>3</td>
<td>2</td>
</tr>
<tr>
<td></td>
<td>% 30</td>
<td>47.5</td>
<td>10</td>
<td>7.5</td>
<td>5</td>
</tr>
<tr>
<td>ComFA+ Moringa</td>
<td>Number 23</td>
<td>17</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td></td>
<td>% 57.5</td>
<td>42.5</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>ComFA+ Anchovies</td>
<td>Number 24</td>
<td>9</td>
<td>1</td>
<td>5</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>% 60</td>
<td>22.5</td>
<td>2.5</td>
<td>12.5</td>
<td>2.5</td>
</tr>
<tr>
<td>Weanimix</td>
<td>Number 22</td>
<td>11</td>
<td>1</td>
<td>5</td>
<td>0</td>
</tr>
<tr>
<td></td>
<td>% 55</td>
<td>27.5</td>
<td>2.5</td>
<td>12.5</td>
<td>0</td>
</tr>
</tbody>
</table>

Overall, most women (86%) said they were able to prepare all the recipes in a slightly or extremely easy way (total n=159). A contingency table was constructed grouping the indicators extremely and slightly easy vs. extremely and slightly difficult to prepare in order to evaluate differences among formulas. Chi-square test of independence
analysis showed no differences among formulas ($\chi^2 = 7.06 \; ; \; P=0.07$). Therefore, all formulas were easy to prepare.

**Ease of child consumption.** Women were asked about the ease of consumption of the formulas at home. The question was *Compared to other solids you have been feeding your child, how easy is it to feed the project food to your child?* Table 3 shows the results of this question.

**Table 3.** Ease of consumption by children responses (number and %) as perceived by women participating in the feasibility study.

<table>
<thead>
<tr>
<th>Formulas</th>
<th>Project food easier to feed</th>
<th>Project food more difficult to feed</th>
<th>Same level of ease with other solids</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>ComFA</strong></td>
<td>Number 31</td>
<td>5</td>
<td>4</td>
</tr>
<tr>
<td></td>
<td>% 77.5</td>
<td>12.5</td>
<td>10</td>
</tr>
<tr>
<td><strong>ComFA+ Moringa</strong></td>
<td>Number 27</td>
<td>9</td>
<td>4</td>
</tr>
<tr>
<td></td>
<td>% 67.5</td>
<td>22.5</td>
<td>10</td>
</tr>
<tr>
<td><strong>ComFA+ Anchovies</strong></td>
<td>Number 23</td>
<td>5</td>
<td>12</td>
</tr>
<tr>
<td></td>
<td>% 57.5</td>
<td>12.5</td>
<td>30</td>
</tr>
<tr>
<td><strong>Weanimix</strong></td>
<td>Number 25</td>
<td>11</td>
<td>3</td>
</tr>
<tr>
<td></td>
<td>% 62.5</td>
<td>27.5</td>
<td>7.5</td>
</tr>
</tbody>
</table>

Overall, above two-thirds of the women (67%) said their kids were able to consume products from the project more easily than other food available for complementary feeding (total n=159). A contingency table was constructed to evaluate differences among formulas. A chi-square test of independence analysis showed no differences among formulas ($\chi^2 = 3.377; \; P=0.33$). Therefore, women considered that all formulas were easier to consume by their children than other complementary foods.
**Discussion**

ComFA is a new complementary food and as such it requires evaluation before its scaling up into agricultural development and nutrition programs. The sensory trials were designed to estimate the acceptability of ComFA (OFSP + soy flour) and its variations (with moringa or anchovies) in comparison with the mainstream complementary food *Weanimix*. The latter has been promoted in the country for several years as a response to failing growth among children (i.e., stunting), especially in the northern regions of Ghana.

*Weanimix* is a blend of groundnuts, maize, and beans. There are homemade and commercial versions of *Weanimix*. Mothers prepare *Weanimix* by combining groundnuts, beans, and maize, in the ratio 1:1:8 (w/w/w), respectively; which can change depending on the availability of ingredients. Mothers roast the ingredients and mill them at home. This powder is cooked in water and sugar is normally added. Although there are some guidelines in the amount of water needed to make *Weanimix* so as to make a porridge of adequate nutrient and energy content and consistency (i.e., not too thick or thin), the amount of water added depends on the person preparing it. The porridge is spoon-fed to children at any time at home. It is promoted among women as a good complementary food after exclusive breastfeeding (6 months) as recommended by health authorities.

Although *Weanimix* is a nutritious complementary food, it is prone to aflatoxin contamination from maize and groundnuts. A recent report from scientists at the Noguchi Memorial Institute for Medical Research in the University of Ghana, Accra indicated that a subsample of these foods collected in the Ashanti region (83%) had aflatoxin contamination above the established cut-off (20 ppb). This could negatively impact children’s health, especially their immunity to disease and growth (Kumi et al., 2014). Thus, alternative ingredients, which are nutritious and safer for consumption, are sorely needed.
ComFA is an alternative for children’s nutrition (Amagloh and Coad, 2014), and can possibly be produced at a low cost as the women mentioned in the focus group discussion that it is naturally sweetened (no need to add sugar), and uses fewer resources such as water and fuel during its preparation. These comments, however, require further evaluation, potentially by recording the use of fuel and the amount of water needed to prepare both cereal-legume blends and ComFA.

Most importantly, the addition of soy (Figure 13) to the recipe guarantees the addition of energy (440 kcal per 100 grams), protein, and the presence of all essential amino acids required for growth and development. Soy protein offers quality protein at a low cost, along with a large proportion of the recommended dietary allowance of other important nutrients such as magnesium, phosphorus, calcium, potassium, iron, zinc, riboflavin, thiamine, niacin, folic acid, pyridoxine, and vitamins E and K. Finally, soy has less susceptibility to aflatoxin contamination. Although a version of ComFA using cream-fleshed sweet potatoes and soy was evaluated previously, the acceptability of OFSP and soy (Figure 12) and the feasibility of preparation at homes have not been completed.

In general, most women accepted the products under evaluation (Figure 14). There were clear differences for the ComFA formulations with moringa leaf powder and anchovies. These products consistently received lower rates in all sensory descriptors including overall liking. Nonetheless, the sensory scores were higher than the average (i.e., Likert scale= 2; Neither like nor dislike). This means that, at least for ComFA, its acceptability is comparable to that of Weanimix.
Most women also perceived that their children liked all the products, but this was not consistent for the ComFA formulas with moringa or anchovies. The 10-minute consumption test was used to provide another measurement of product liking (Figure 15). This test, when used in standard laboratory conditions for sensory, can provide the quality of data needed for interpretation. In this study, results from the 10-minute consumption test showed that most children left a significant amount of product on the plate (i.e., on average ~80% food was consumed). Results also showed that children consumed a larger proportion of Weanimix preparations (~74%) than ComFA alone (61%), or ComFA+moringa (~47%) and ComFA+anchovies (56%). A problem with this test was the setting which was not appropriate for conducting a sensory study and the availability of other foods for children while waiting for participation (i.e., some mothers breastfed their infants) (Figure 16).

The amount of water used in products was lower for ComFA and higher for Weanimix. This is due to two main reasons associated with each product. First, OFSP has a larger amount of moisture when harvested compared to Weanimix. The second reason for the higher water needed in Weanimix is its starch content. Weanimix has more starch than ComFA, which changes its consistency upon addition of water and heat. Starch absorbs water and changes the consistency of food products rendering them more viscous. As the final doneness test for foods is performed by tasting them, most mothers add more water to Weanimix to reach a thinner porridge, for its easier delivery to their children. This water addition, or thinning, although important for appropriate feeding, might reduce the number of calories and nutrients provided to children with the same volume of food. Complementary foods should be both adequate in terms of nutrient content and energy density (0.8 kcal/g) and consistency. Based on these results, ComFA is a great complementary food alternative to Weanimix as it has a better profile of nutrients at the appropriate feeding consistency (Table Y, Appendix 1).
The feasibility trial was designed to obtain information on the preparation of ComFA and its different variations as well as Weanimix at homes (Figure 17). In Ghana, cooking is a gender-related activity. Women in the household conduct most of the food preparation activities, especially for children. Thus, this study recruited only women. It is possible that in some households some men take the responsibility to prepare the meals for all family members. This is a significant limitation of this study as the investigators did not attempt to find these specifics cases.

For the most part, the preparation and consumption of ComFA in the household are similar to preparing Weanimix. Most women were supportive of ComFA and its variations in general. However, a few women thought the variations with moringa and anchovies were difficult to eat due to their distinctive flavor and aroma. Moringa leaves have been identified as a great source of protein and micronutrients. Dry anchovy powder is available in the markets in northern Ghana. There is much history of consumption of this powder owing to its distinctive flavor and nutrient content. Nonetheless, most households in Ghana use anchovy powder in dishes consumed by all family members, not necessarily infants.

**Conclusions and Future Directions**

This study shows the potential of ComFA, a new complementary food for low-income families living in rural areas in Northern Ghana. ComFA has several advantages over the current product (Weanimix) including ease of preparation and lower use of resources, improved nutritional composition by blending soy with OFSP, high acceptability by both children and women, and lower risk for aflatoxin contamination. Studies evaluating ComFA’s ability to support linear growth within the first 1,000 days of life are warranted. Our feasibility study supports the implementation of village level training in the use of both soy flour and orange-fleshed sweet potatoes to prepare ComFA and other variations with fruits (e.g., orange fleshed bananas) at homes. These trainings should leverage the many efforts to improve nutrition and health currently in place.
### Table 4. Complementary Foods meeting the CODEX Alimentarius Guidelines and US RDAs

<table>
<thead>
<tr>
<th></th>
<th>ComFA</th>
<th>Weanimix</th>
<th>Cerelac</th>
</tr>
</thead>
<tbody>
<tr>
<td>Energy (4 kcal/g in dry basis)</td>
<td>4.9 kcal</td>
<td>4.9 kcal</td>
<td>4.8 kcal</td>
</tr>
<tr>
<td>Protein In wet basis % RDA 6-12 months</td>
<td>20%</td>
<td>12%</td>
<td>18%</td>
</tr>
<tr>
<td>Fat (at least 20% energy)</td>
<td>21%</td>
<td>17%</td>
<td>20%</td>
</tr>
<tr>
<td>Micronutrients &gt;65% requirements in 100 g dry basis</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Iron (mg)</td>
<td>71%</td>
<td>59%</td>
<td>80%</td>
</tr>
<tr>
<td>Calcium (mg)</td>
<td>243%</td>
<td>189%</td>
<td>197%</td>
</tr>
<tr>
<td>Zinc (mg)</td>
<td>72%</td>
<td>74%</td>
<td>84%</td>
</tr>
<tr>
<td>Sodium (mg)</td>
<td>38%</td>
<td>25%</td>
<td>64%</td>
</tr>
<tr>
<td>Iodine (µg)</td>
<td>24%</td>
<td>22%</td>
<td>48%</td>
</tr>
<tr>
<td>Vitamin A (µg RE)</td>
<td>223%</td>
<td>1%</td>
<td>45%</td>
</tr>
<tr>
<td>Vitamin C (mg)</td>
<td>65%</td>
<td>0%</td>
<td>106%</td>
</tr>
</tbody>
</table>

![Figure 18](image-url)

**Figure 18.** Contribution of Complementary foods (100 g wet basis) to Daily Nutrient Requirements for Children 6-12 months
Table 5. Nutrition composition of 100 g of ComFA, Weanimix and Cerelac on wet basis* and contribution (%) to US RDA for children 6-12 months.

<table>
<thead>
<tr>
<th>Nutrient</th>
<th>OFSP ComFA</th>
<th>US RDA</th>
<th>Weanimix</th>
<th>US RDA</th>
<th>Cerelac</th>
<th>US RDA</th>
</tr>
</thead>
<tbody>
<tr>
<td>Energy (kcal)</td>
<td>48.5</td>
<td>27.2</td>
<td></td>
<td>59.4</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Protein (g)</td>
<td>2.2</td>
<td>1.3</td>
<td>1.3</td>
<td>12%</td>
<td>1.9</td>
<td>18%</td>
</tr>
<tr>
<td>Total fat (g)</td>
<td>1.1</td>
<td>0.5</td>
<td></td>
<td>1.3</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Ash (g)</td>
<td>0.5</td>
<td>0.2</td>
<td></td>
<td>0.4</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total dietary fiber (g)</td>
<td>1.2</td>
<td>0.4</td>
<td></td>
<td>0.2</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Insoluble dietary fiber (g)</td>
<td>0.9</td>
<td>0.4</td>
<td></td>
<td>0.1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Soluble dietary fiber (g)</td>
<td>0.3</td>
<td>0.0</td>
<td></td>
<td>0.1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Available Carbohydrates (g)</td>
<td>4.0</td>
<td>3.1</td>
<td></td>
<td>8.2</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Starch (g)</td>
<td>1.3</td>
<td>2.7</td>
<td></td>
<td>3.9</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sucrose (g)</td>
<td>0.6</td>
<td>0.1</td>
<td></td>
<td>0.9</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Iron (mg)</td>
<td>0.8</td>
<td>0.4</td>
<td>0.4</td>
<td>3%</td>
<td>1.1</td>
<td>10%</td>
</tr>
<tr>
<td>Calcium (mg)</td>
<td>62.2</td>
<td>27.4</td>
<td>64.0</td>
<td>25%</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Zinc (mg)</td>
<td>0.2</td>
<td>0.1</td>
<td>0.1</td>
<td>4%</td>
<td>0.3</td>
<td>10%</td>
</tr>
<tr>
<td>Sodium (mg)</td>
<td>26.4</td>
<td>9.8</td>
<td>56.0</td>
<td>8%</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Iodine (µg)</td>
<td>3.0</td>
<td>1.6</td>
<td>7.8</td>
<td>6%</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Vitamin A (µg RE)</td>
<td>109.7</td>
<td>0.2</td>
<td>28.4</td>
<td>6%</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Vitamin C (mg)</td>
<td>3.2</td>
<td>0.0</td>
<td>6.6</td>
<td>13%</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

*ComFA was prepared using 33 g of dry materials and adding 150 mL of water, Weanimix was prepared using 33 g of dry material and adding 210 g of water; Cerelac was prepared using 50 g of material and adding 150 g of water. The amounts were converted per 100 g in wet basis.
References


Gannon B., Kaliwile C., Arscott S.A., Schmaelzle S., Chileshe J., Kalungwana N., et al. (2014) Biofortified orange maize is as efficacious as a vitamin A supplement in Zambian children even in the presence of high liver reserves of vitamin A: a


