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Research Application Summary

Development of a Millet-Sesame-Soy complementary food composite for rural communities

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Abstract

Complementary feeding still remains a challenge to many rural mothers in Uganda and Africa at large. Commercial complementary food formulae available on the market are too expensive and not easily accessible to poor people in developing countries who live mainly in rural areas. The use of locally available food resources to produce locally-adapted composites has been suggested as a potential option for complementary feeding in rural areas. This study experimented the feasibility of this option in Acholi Sub-region of Uganda using millet, sesame and soy. These food resources are locally available in the area and have nutritional values. Various combinations of millet, sesame and soy were compounded to produce complementary food formulae corresponding to energy content of 200, 300 and 550 Kcal for children of age category 6-8 month, 9-11 months, and 12-23 months, respectively. The combinations were processed into flour under village conditions. The flour formulae were reconstituted into porridge and evaluated for sensory attributes and acceptability among mothers and caregivers of children 6-23 months old to enable them select the most preferred formula for each energy category. Based on the results of overall acceptability evaluation, the community selected 92 % millet, 0.8% sesame, 7.2% soy (F13); 75 % millet, 10% sesame, 15% soy (F21); and 12.1% millet, 10% sesame, 77.9% soy (F31), as the most preferred formula for children aged 6-8 months, 9-11 months and 12-23 months, respectively. Laboratory analyses revealed that the selected formulae had energy and nutrient density within the recommended levels for complementary food formulae. Interestingly, mothers and caregivers who participated in the study expressed willingness to start using the formulae with immediate effect. Awareness campaigns are needed to extend the technology to the wider community in the sub-region. The results of this study demonstrate that use of locally available food resources to develop complementary formulae is indeed a feasible option for management of child undernutrition in rural areas.

Key words: Acholi-sub-region, complementary feeding, 6-23 months old children, Uganda

Résumé

L'alimentation complémentaire reste un défi pour de nombreuses mères rurales en Ouganda et en Afrique. Les formules commerciales alimentaires complémentaires disponibles sur le marché sont trop chères et ne sont pas facilement accessibles aux pauvres des pays en développement qui vivent principalement dans les zones rurales. L'utilisation de ressources alimentaires localement disponibles pour produire des composites adaptés localement a été suggérée comme une option potentielle pour l'alimentation complémentaire dans les zones rurales. Cette étude a permis d'expérimenter la faisabilité de cette option dans la sous-région d'Acholi en Ouganda en utilisant du millet, du sésame, et du soja. Ces ressources alimentaires sont localement disponibles dans la région et ont des valeurs nutritionnelles. Des diverses combinaisons du millet, de sésame et de soja ont été combinées pour produire des formules alimentaires complémentaires correspondant à une teneur énergétique de 200, 300 et 550 Kcal pour les enfants de 6 à 8 mois, de 9 à 11 mois et de 12 à 23 mois, respectivement. Les combinaisons ont été transformées en farine dans des conditions de village. Les formules de farine ont été reconstituées en bouillie et évaluées pour les attributs sensoriels et l'acceptabilité par les mères et les soignants des enfants de 6-23 mois pour leur permettre de sélectionner la formule la plus préférée pour chaque catégorie d'énergie. Sur la base des résultats de l'évaluation globale de l'acceptabilité, la communauté a choisi 92% de millet, 0,8% de sésame, 7,2% de soja (F13); 75% de millet, 10% de sésame, 15% de soja (F21); Et 12,1% de millet, 10% de sésame, 77,9% de soja (F31), comme la formule la plus préférée pour les enfants âgés de 6 à 8 mois, 9-11 mois et 12-23 mois, respectivement. Des analyses de laboratoire ont révélé que les formules sélectionnées présentaient une densité énergétique et une densité nutritive étant dans les limites recommandées pour les formules alimentaires complémentaires. Curieusement, les mères et les aide-malades qui ont participé à l'étude ont exprimé leur volonté de commencer à utiliser les formules immédiatement. Des campagnes de sensibilisation sont nécessaires pour étendre la technologie à la collectivité dans la sous-région. Les résultats de cette étude démontrent que l'utilisation des ressources alimentaires disponibles localement pour élaborer des formules complémentaires est en effet une option possible pour la gestion de la sous-alimentation des enfants dans les zones rurales.

Mots-clés: Acholi-sous-région, l'alimentation complémentaire, les enfants de 6 à 23 mois, Ouganda

Background

At the age of six months, an infant's need for energy and nutrients starts to exceed what is provided by breast milk and as such complementary foods are necessary to meet energy and nutrient requirements (WHO, 2010). This is correlated with data from Uganda that shows that child undernutrition starts to rise at six months after birth (WFP and UNICEF, 2014). It has been observed that development of nutritious low-cost complementary foods tailored to the poor economic situations typical of rural areas in developing countries is still a big challenge (UNICEF, 2012). One potential option to overcome this challenge is the use of locally available traditional and indigenous food

resources to prepare complementary foods (WHO, 2008). On the other hand, it is important to note that the acceptability of complementary foods formulated from the local food resources is a key factor to consider in ensuring the success of such innovations (Konyole *et al.,* 2012). In addition, despite availability of nutritious local food resources within the community, locally-adapted complementary food formulae that meet recommended standards are largely unavailable. This is mainly because local communities in most cases lack technical knowledge required for processing complementary foods in addition to lack of knowledge on nutritional characteristics of local food resources (ACF, 2014). This study experimented at the community level, using the Acholi Sub-region of Uganda as a case study, the feasibility of using locally available food resources (millet, sesame and soy) to produce acceptable complementary food formulae to address child undernutrition in rural areas in developing countries.

Literature summary

Child undernutrition remains one of the main public health problems in developing countries. Prevalance of undernutrition remains higher in the developing countries (13.5%) compared to 11.3% worldwide (FAO, IFAD and WFP, 2014). It is documented that more than a third of under-five mortality in developing countries is due to undernutrition related to inadequate complementary feeding (Semahegn *et al.,* 2014). As such, complimentary feeding interventions in developing countries have received increasing attention (Konyole *et al.*, 2012) and it is strongly believed that locally-adapted innovations based on locally available food resources provide a great potential for addressing child undernutrition in developing countries (Lassi *et al.,* 2013).

Study description

The study was conducted in Acholi Sub-region of Uganda. Millet, sesame and soy, food resources locally available within the community were used to develop complementary food formulae. Various proportions of ingredients (millet, sesame and soy) were compounded to produce complementary food formulae corresponding to energy content of 200, 300 and 550 Kcal as recommended for children of age category 6-8 months, 9-11 months, and 12-23 months, respectively (WHO/PAHO, 2004; Dewey and Adu-afarwuah, 2008), using Microsoft Excel and Harvest Plus Food Composition Table. Through participation of rural women, the ingredients were roasted, compounded and milled into flour. For each energy category, porridge samples prepared were subjected to sensory evaluation by 30 panelists from within the local community according to Wamono *et al.* (2011). The panelists expressed their degree of liking of the products using a 5-point hedonic scale (with ratings ranging from 5 = like very much to 1 = dislike) as applied previously by Fathelrahman *et al.* (2015). Parameters evaluated included taste, aroma, colour, texture, mouth feel, and overall acceptability. Clean and boiled drinking water at room temperature was given to each panelist for mouth rinsing before and after every sample tasting to eliminate carry over effects (Emmanuel-ikpeme *et al*., 2012). The flour formulae were then analyzed for nutrient composition (carbohydrates, moisture,

crude fat, dietary fibre, ash, crude proteins, gross energy, phosphorus, iron, zinc, magnesium and calcium). One way Analysis of Variance (ANOVA) was used to test whether difference existed in aggregate scores for each sensory attribute and overall acceptability among composite formulae within each energy category. The means were separated using the Turkey's method at 5% level of significance. Paired T-test was used to test the effect of roasting on nutritional composition of each composite formula.

Results

Based on overall acceptability evaluation, formulations F13 (92% millet, 0.8% sesame, 7.2% soy), F21 (75% millet, 10 % sesame, 15 % soy) and F31 (12.1 % millet, 10 % sesame, 77.9% soy) corresponding to energy category 200, 300 and 550 Kcal recommended for children 6-8, 9-11 and 12-23 old, respectively were most preferred and selected by the community (Table 1).

Table 1: Scores on sensory attributes of millet-sesame-soy composite formulae by mothers and caregivers of 6-23 month old children

	Taste	Mouth feel	Aroma	Thickness	Appearance	Overall acceptability
			200Kcal			
F11	3.00±1.34^{a}	2.50±1.22^{a}	2.07±1.17^{a}	2.67±1.35^{a}	1.97±1.25^{a}	2.37±1.45^{a}
F12	3.67±1.03^{b}	4.00±1.05^{b}	3.87±1.04^{b}	3.83±1.09^{b}	4.07±1.08^{b}	3.77±1.19^{b}
F13	4.73±0.64^{c}	4.43±0.73^{b}	4.77±0.43c	4.47±0.51^{b}	4.67±0.48^{b}	4.77±0.43^{c}
			300Kcal			
F21	4.33±0.94^{b}	4.40±0.81^{b}	4.03±0.89^{b}	4.23±1.10^{b}	4.07±1.11^{b}	4.80±0.38^{c}
F22	3.87±1.33^{b}	3.90±1.16^{b}	3.73±1.44^{ab}	3.83±1.44^{b}	4.00±1.29^{b}	3.83±1.53^{b}
F23	3.00±1.68^{a}	2.93±1.60^{a}	3.07±1.57^{a}	2.60±1.35^{a}	3.07±1.46^{a}	2.30±1.58a
			550Kcal			
F31	4.23±1.19^{b}	3.93±1.33^{b}	4.13±1.20^{b}	4.27±1.05^{b}	4.27±1.13^{b}	4.83±0.38^{b}
F32	3.73±1.17^{ab}	3.90±1.30^{b}	3.97±1.13^{b}	3.87±1.14^{b}	4.07±0.98^{b}	3.67±1.35^{a}
F33	3.07±1.44^{a}	2.60±1.38^{a}	2.90±1.54^{a}	3.00±1.64^{a}	2.83±1.58^{a}	3.03±1.65^{a}

Values show mean ± S.D (n=30) of scores for each sensory attribute based on a 5-point hedonic scale (ranging from 1 = dislike very much, to 5 = like very much). Means in the same column with different superscripts are significantly different ($p \leq 0.05$). F11: 91.8 % millet,0.7% sesame,7.5% soy; F12: 92.2 % millet,0.9% sesame-6.9% soy; F13: 92% millet, 0.8% sesame,7.2% sesame; F21: 75% millet,10 % sesame, 15% soy; F22: 65% millet, 5 % sesame-30% soy; F23: 71% millet, 8% sesame, 21% soy; F31: 12.1% millet,10% sesame-77.9%soy; F32: 16.1% millet, 11.9% sesame, 72% soy; F33: 18.1% millet; 12.9 % sesame, 69 % soy.

The nutrient content of the selected formulae (Table 2) are in line with the minimum recommended requirements for a complementary food (WHO, 1994; Dewey and Adu-afarwuah, 2008) and are also comparable to other formulae produced for local communities in other developing countries such as Kenya (Konyole *et al.,* 2012) and Bangladesh (Satter *et al.,* 2013). It is well known that several rural communities still use complementary foods that are nutritionally inadequate (Gibson *et al.*, 1998). In practice, most communities use cereals or legumes singly, a practice which creates

deficiency in certain nutrients especially amino acids. However a combination of both cereals and legumes can bring complementarity in nutrient pooling. Generally, cereals are low in the essential amino acid lysine, while legumes are low in essential amino acids methionine and cysteine, but are high in lysine (Nour *et al.*, 2014). Therefore combining grain legumes and cereals as shown in the current study improves and compensates for amino acid deficiency of both (Thapliyal and Singh, 2015). Considering that the knowledge on nutritional quality of foods is lacking in many rural communities in developing countries (Saaka, 2014), this study therefore illustrates how knowledge institutions (e.g. universities) can work with rural communities to find solutions to complementary feeding problems. However, community-wide information sessions are necessary to enable diffusion and uptake of the technology in the sub-region.

Table 2: Nutritional composition of the selected millet-sesame-soy composite formulae selected by caregivers

	F13		F21		F31	
Properties	Control (NR)	Roasted	Control (NR)	Roasted	Control (NR)	Roasted
CHO (%)	70.33±0.83^{a}	79.85±3.4^{b}	76.57±3.7^{a}	63.40±0.28^{b}	35.42±1.64^{a}	29.57±0.41^{b}
Moisture (%)	7.87±0.15^{a}	6.59±0.11^{b}	7.79±0.15^{a}	6.17±0.21^{b}	6.86±0.16^{a}	5.24±0.16^{b}
Crude fat (%)	2.05±0.05^{a}	2.64±0.02^{b}	8.38±0.41^{a}	8.62±0.24^{a}	17.32±0.31^{a}	18.52±0.40^{b}
Dietary fibre (%)	9.70±0.34^{a}	10.63±0.61^{a}	8.32±0.38^{a}	11.00±0.95^{b}	13.75±0.99^{a}	17.15±1.55^{a}
Ash (%)	2.93±0.04^{a}	3.01±0.13^{a}	3.13±0.15^{a}	3.44±0.14^{b}	4.99±0.04^{a}	4.92±0.16^{a}
Crude protein (%)	9.77±0.38^{a}	10.25±0.18^{a}	13.52±0.37^{a}	13.18±0.48^{a}	30.30±0.73^{a}	31.27±0.36^{a}
Energy (Kcal)/100g	411.07±0.87^{a}	345.23±1.21^{b}	567.57±2.32^{a}	462.81±2.53^{b}	294.46±0.69^{a}	454.28±1.93^{b}
P mg/100g	325.90±9.6^{a}	393.20±9.9^{b}	346.50±10.8^{a}	419.27±19.1^{a}	573.30±47.8^{a}	577.10±9.5^{a}
Fe mg/100g	78.27±0.49^{a}	86.63±0.35^{b}	80.0±0.44^{a}	100.50±1.71^{b}	99.63±0.31^{a}	107.33±4.41^{a}
Zn mg/100g	1.70±0.20^{a}	1.57±0.15^{a}	1.83±0.15^{a}	1.67±0.06^{a}	4.00±0.00^{a}	4.17±0.15^{a}
Mg mg/100g	78.97±1.53^{a}	86.27±0.49^{b}	89.87±1.78^{a}	91.70±1.61^{b}	115.77±2.46^{a}	121.40±1.97^{b}
Ca mg/100g	682.33±20.1^{a}	642.43±20.1^{b}	708.10±19.7^{a}	797.90±39.9^{b}	960.20±0.00^{a}	990.30±39.6^{a}

Data shows means±SD of triplicate determination. For each composite formula, values bearing the same superscripts in the same row are not significantly different (P>0.05). F13: 92% millet, 0.8% sesame, 7.2% sesame; F21: 75% millet, 10 % sesame-15% soy; F31: 12.1% millet, 10% sesame, 77.9% soy.

Based on the formulae selected, serving 56.5, 64.6 and 121g per day would be required to meet energy intake of 200, 300 and 550 Kcal recommended for children 6-8, 9-11 and 12-23 old, respectively. The flour formulae developed in this study were designed based on nutrient composition of raw food materials but later subjected to heat treatment (roasting) to enhance sensory appeal (Mirdula *et al.*, 2008) and inactivate anti-nutritional factors (Yang *et al.*, 2014). Indeed as shown in Table 2, roasting significantly affected nutrient composition of various flour formulae ($P \leq 0.05$) but the effect did not compromise nutrient level compared to the recommended levels (Dewey and Adu-afarwuah, 2008).

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