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NUTRITIONAL AND SENSORY PROPERTIES OF HIGH ENERGY/NUTRIENT DENSE COMPOSITE FLOUR PORRIDGES FROM GERMINATED MAIZE AND ROASTED BEANS FOR CHILD-WEANING IN DEVELOPING COUNTRIES: A CASE FOR UGANDA

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The study aimed at increasing the energy and nutrient density of traditional weaning porridges from germinated maize and decorticated bean flours. Proximate analysis showed that the porridge from the composite flour had a higher protein and energy density than typical weaning porridges made from maize alone. For a breastfed infant, the blend could meet 75% of the remaining required energy, compared to 52% provided by the porridge from maize alone. Untrained sensory evaluation panelists scored the porridge from the blend as acceptable. This blend therefore has great potential as a weaning food in resource-poor and technologically under-developed countries.

KEYWORDS weaning/complementary foods, developing countries, maize, germination, East Africa

INTRODUCTION

The importance of adequate nutrition as a foundation for health and development cannot be overemphasized. Poor nutrition, particularly of

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infants and young children, leads to retarded growth and increased morbidity and mortality. Globally, over 50% of childhood mortality is directly or indirectly attributable to malnutrition (SCN News, 2003). The problem of malnutrition is complex with multiple causes which include social, economic, environmental, and cultural factors. However, inappropriate foods and feeding practices play a major role in the etiology of malnutrition, particularly in developing countries (Walker, 1990; Kikafunda et al., 1998a; Brown et al., 1998). Although sub-Saharan Africa is well endowed with rich agricultural produce that could be harnessed through processing to produce adequate infant foods, early childhood malnutrition is still rampant (ACC/SCN, 2000). In Uganda, the focus of the present study, successive national health and demographic surveys, have found high prevalence of childhood malnutrition with 38–39% of all the children under 5 years of age stunted and 23–26% underweight (UDHS, 1995, 2000/2001). The prevalence of micronutrient malnutrition, particularly vitamin A deficiency (VAD) and iron deficiency anemia (IDA) are also reported to be very high.

Weaning or complementary foods, which are foods introduced to the infant after 6 months of age need to be rich in energy and nutrients in order to complement breast milk (WHO, 2000). However, it has been reported that infants and young children in developing countries are fed on a diet poor in energy and nutrients (Walker, 1990; Savage and Burgess, 1993). Weaning foods in developing countries are mainly made from starchy staples which, when cooked with water, become viscous and bulky with low energy and nutrient density. The accompanying sauce, though nutritious, is normally not fed in adequate quantities to compensate for the low energy and protein content in the staple (FAO, 2001; Kikafunda et al., 2003). Germination (malting) of the cereals (Mosha and Svanberg, 1990; Mensah and Tomkins, 2003), enrichment of cereals with nutrient-dense ingredients (Kikafunda et al., 1997), and mixing food with micro-nutrient sprinkles (Nestel et al., 2003) are some of the household technologies that can be used to address the problem of bulky low energy/nutrient complementary foods in developing countries.

The introduction of complementary foods, usually accompanied by stress and ill health, is a critical period for the infant. This is especially so in developing counties where the foods are not properly tailored to the infant's nutritional and gastric needs (Kakitahi, 1981; Rowland et al., 1986; Svanberg, 1988; Uwaegbute, 1991). The low energy and nutrient density of such foods is an important cause of growth faltering during the weaning period (Ljungqvist et al., 1981; Walker, 1990). On the other hand, appropriate complementary feeding promotes growth and prevents childhood malnutrition (Dewey, 2003). In addition, breastfeeding to accompany complementary feeding plus environmental sanitation and health care should always be promoted (SCN News, 2003). The new global strategy for infant and young child feeding provides an excellent first step in this process (Piwoz et al., 2004).

The present study was therefore undertaken to investigate different ways of reducing the viscosity and increasing the energy and nutrient density of cereal-weaning porridges in developing countries, using Uganda as a case study. The sensory attributes and acceptability of the formulated complementary/weaning porridges were also investigated.

MATERIALS AND METHODS

Materials

Beans, the white cultivars of *Phaseolus vulgaris* (Namulonge bean variety 6) from Namulonge Agricultural and Animal Research Institute (NAARI) and maize (*Zea mays L.*) from certified seed companies in Kampala, Uganda were used in this study.

Methods

Preparation of Samples. Maize grains were sorted and divided into two portions. One portion was dehulled and milled (as a control) while the other was germinated. Germination was done by soaking the grains in 70% ethanol for 2 minutes and thereafter soaked in an equal amount of water to their volume, for 24 hs. They were then washed with distilled water, spread one centimeter thick between wet cotton cloths for 3 days in the dark at room temperature to germinate. The germinated grains were then oven dried at 60°C overnight. Milling was done using a laboratory mill (Christy Hunt Agricultural Ltd., Foxhills Industrial Estate, Scunthope, North Lincolnshire, UK).

The beans were soaked in 70% ethanol for 2 minutes, then soaked in an amount of water equal to their volume overnight, followed by boiling for 25 minutes and removing the testae. The seeds were oven dried at 65°C for 8 hours and toasted at 110°C for 15 minutes, then milled.

Determination of Proximate Composition. All the proximate analyses were determined using AOAC (1999) methods with minor modifications as follows:

Moisture content of the samples was determined indirectly using the air oven method No. 925.10 and gross energy was determined using a bomb calorimeter (GALLENKAMP Auto bomb, SG96/02/536; London, UK). Sugar and starch content were determined using method No. 996.11E. In addition, sugar and starch extraction were done using ethanol and percholic acid, respectively. The Micro kjeldahl method No. 960.52 was used for crude protein analysis while the soxtec method No. 920.85 for ether extraction was used for fat analysis. Micro fiber system method No. 920.86 and Griffin electrical furnace method No. 923.03 were used for crude fiber and ash content, respectively.

Determination of Proportions of Mixing Maize and Beans. Mixing of 79.08 g of maize and 20.92 g of bean flour would give the required amount of protein per day for children. This indicated that the flours could be mixed in a ratio of 4:1. Energy contained in every 100 g of the mixture was also computed from the proteins, fats, and carbohydrates in bean and maize flour, using Atwater factors. The germinated maize flour and roasted bean flour were blended in the following proportions of maize to beans: 70:30 and 80:20 to make two blends of composite flours.

Preparation of the Porridges. Traditional methods of porridge preparation were used after adapting to laboratory conditions. To every 900 ml of boiling water, 50 g of flour mixed in 100 ml of cold water was added. The porridge was boiled for 15 min.

Measurement of Viscosity of the Porridges. To 40 ml of porridge, 160 ml of water was added and these were homogenized using a magnetic stirrer. The density of the porridges was measured using a pyknometer (Simax, Prague, Czech Republic), while the Haake ball-falling sphere (Gebrüder Haake K.G., I Berlin 46. Siemens Strasse 27. RUF: 0311-726611, West Germany) was used for viscosity. Total solids were obtained by calculation.

Sensory Analysis. Sensory evaluation was determined using 35 untrained panelists, between 10 a.m. and 12 noon. According to Amerine et al. (1965), during this time-range, panelists are neither too satisfied nor too hungry, assuming that they took breakfast in the morning. Hence it is assumed that they can give good judgment on the product. A nine-point hedonic scale was used with one signifying "like extremely" and nine "dislike extremely." The following attributes were tested for: color, smell, taste, texture, and overall acceptability.

Data Analysis. Data were analyzed using analysis of variance (ANOVA). The General Linear Model (GLM) of SAS (Statistical Analysis System, SAS Institute, inc., Cary, NC), was used. Differences between treatments were determined by the LSD method. Statistical significance was set at $P < 0.05$. A multiple (Pearsons) correlation was carried out to determine how the sensory attributes influenced overall acceptability of the porridges.

RESULTS

Proximate Composition of the Flours

The results of proximate composition of the maize and bean flours per 100 g are summarized in Table 1.

Moisture Content and Gross Energy. The moisture content of the ungerminated maize flour (10.83%) was significantly ($p \leq 0.0001$) higher than that of the germinated maize flour (6.17%). This may have been due to the exposure of germinated maize grains to high temperatures (65°C) during drying after germination. Low moisture content of the flours prevents microbial activity and extends the shelf life of the flour. The moisture content of the roasted bean flour was 6.83%.

Table 1. Proximate composition of the maize and bean flours per 100 g

Food	Moisture %	Energy		Starch %	Sugar %	Protein %	Fat %	Fiber %	Ash %
		Kcal	*kJ*						
U.maize[1]	10.83^a	428^a	102.39	76.23^a	3.45^a	10.12^a	2.41^a	0.50^a	0.56^a
G.maize[2]	6.17^b	456^b	109.09	67.14^b	8.43^b	10.22^a	1.52^b	0.83^a	0.53^a
Beans	6.83^c	456^b	109.09	29.83^c	12.15^c	31.07^b	2.67^a	1.67^b	2.14^b

[1]ungerminated maize.
[2]Germinated maize.
Values within the same column with different superscript letters (a, b, c) are significantly different from each other ($p < 0.05$) while those with same superscript letters are not significantly different ($p < 0.05$).

Gross energy of the ungerminated maize flour at 428 kcal (102.39 kJ)/100g was significantly ($p = 0.03$) lower than that of germinated maize flour at 456 kcal (109.09 kJ)/100g. However, during cooking, into the same amount of water, more germinated maize flour would be required to make a porridge of a similar consistency to that made from ungerminated flour, hence making germinated flour porridge more energy dense.

Starch and Sugar. Starch content of ungerminated maize flour (76.23%) was within the range reported by Shakuntala and Shadaksharaswamy (1987). Also Kent (1983) quoted starch content values of ungerminated maize flour varying between 77% and 77.5%. The starch content of the ungerminated maize was significantly ($p \leq 0.0001$) higher than that of germinated maize (67.14%).

The lower content of starch in germinated maize was due to the breakdown of starch to simpler sugars by the activated amylase enzymes during germination. It has been reported that when cereal grains are germinated, alpha amylase, beta amylase, and alpha glucosidase enzymes are activated and these break down starch into simpler sugars like dextrin and disaccharides (Briggs et al., 1981; Mosha and Svanberg, 1983; Desikachar, 1980; Svanberg, 1988). These simpler sugars do not become viscous as fast as the starch, allowing more flour and thus more nutrients, to be added to the porridge while still maintaining a semi-solid consistency. The ability to form less viscous porridge is the basis for using germinated cereal flours as weaning foods.

The starch content of the white beans was found to be 29.83%. Saharasrabudhe et al. (1982) reported that starch of white beans has slow gelling properties making them suitable for use in supplementing cereals in weaning foods. The slow gelling starch would prevent the porridge from becoming too viscous.

The sugar content of the ungerminated maize (3.45%) was within the range reported by Shakuntala and Shadaksharaswamy (1987) who quoted it to be 2%. Sugar content of the germinated maize was 8.43%. Tara et al. (1988) reported a higher sugar content of germinated maize of 13.14%, after germination for 4 days. The sugar content of germinated maize was significantly ($p \leq 0.0001$) higher than that of ungerminated maize. As earlier explained, germination enables the conversion of starch into simple sugars thereby raising the sugar contents in germinated maize.

Protein and Fat. There was no significant difference ($p < 0.05$) between the protein content of ungerminated maize (10.12%) and germinated maize (10.22%). The average protein content of the flours is in agreement with Shakuntala and Shadaksharaswamy (1987) who reported protein content of maize as being between 6–12%. Kent (1983) also reported the protein content of maize to be 10%, which is comparable to the value in this study.

The protein content of the white beans was 31.07%, a value that is higher than that quoted by Shakuntala and Shadaksharaswamy (1987) who reported that white beans contained 24.6% protein. Saharasrabudhe et al. (1982) reported similar values of 24.3%. The difference in our results from reported values could have been due to a difference in the variety used. The high protein content of the beans, therefore, supplements that of the maize, making the weaning food mixture attain adequate protein content.

The fat content of the ungerminated maize was 2.41%. According to Kent (1983), the fat content of whole grain maize was as high as 4.5%. Shakuntala and Shadaksharaswamy (1987) reported a value of 3.6%. Although the maize used in this study was not degermed, the process of dehulling involves breaking the maize grain into smaller parts, which leads to loss of some germ and hence some fat. The fat content of the ungerminated maize was significantly ($p = 0.008$) higher than that of the germinated maize (1.52%). The lower fat content in germinated maize may be due to changes within the grains during germination. During germination, there is movement of some nutrients from other parts of the grain into the embryo. The fat contained in the embryo is then oxidized to provide energy that is used in the respiration process of the growing embryo, as the nutrients are used up to develop the embryo (Briggs et al., 1981).

Fat content of the white beans (2.67%) was higher than values reported by Shakuntala and Shadaksharaswamy (1987) and Saharasrabudhe et al. (1982), who reported fat content of white beans to be 1.7% and 1.6%, respectively. The difference could have been due to different processing procedures.

Fiber and Ash. Fiber content of ungerminated maize (0.5%) was lower than that reported by Kent (1983) who reported the fiber content of whole grain maize to be 1.7%. However, his value for dehulled maize (0.9%) is comparable to the value in this study. Dehulling removes the hull, which contains much fiber. Although the fiber content of germinated maize was higher than that of ungerminated maize (0.83% vs. 0.50%), the difference was not significant.

Removal of the testa eliminates some anti-nutritional and flatulence factors and lowers fiber content in the flour. It also gives a smooth texture to the food, making it compatible with the delicate intestinal tract of the baby and is therefore a recommendation by Food and Agriculture Organization (FAO). However, cereals for child-weaning should not be overrefined as this increases the viscosity and reduces the nutrient density of the porridges (Kikafunda et al., 1998b).

The ash content of the ungerminated maize (0.56%) and germinated maize (0.53%) varied significantly ($p \leq 0.0001$). Ash content represents the mineral component of the samples. These minerals may include calcium, potassium, phosphorus, iron, sodium, zinc, and magnesium at varying amounts. Ash content of the dehulled ungerminated maize (0.56%) in this study was lower than that of whole grain maize (1.5%) quoted by Kent (1983). This may have been due to loss of some minerals along with the hulls and germ during dehulling. Ash content of the white beans (2.14%) was lower than the average (3.6%) reported by Saharasrabudhe et al. (1982). This may have been due to losses during steeping and decorticating. Decortication has an advantage of lowering the fiber content of the food. It also eliminates flatulence and anti-nutritional factors (Savage and Burgess, 1993).

Viscosity and Total Solids of the Porridges

Results from viscosity measurements are shown in Table 2. The viscosity of the ungerminated maize flour porridges (35.42cP) was significantly ($p \leq 0.0001$) higher than that of the 4:1 germinated maize flour and roasted beans flour blend (24.42cP). The viscosity of the porridge from the 3.5:1.5 germinated maize flour to beans flour blend (26.80cP) was higher than that of the 4:1 blend, though not significantly different.

Table 2. Viscosity and Total solids of the porridges

	Viscosity (cP)	Total Solids (%)
Ungerminated maize porridge	35.42^{a}	5.23^{a}
Porridge of 4:1 blend[1]	24.53^{b}	3.41^{b}
Porridge of 3.5:1.5 blend[2]	26.80^{b}	3.97^{b}

[1]Blend of 4 parts germinated maize flour and 1 part roasted beans flour.

[2]Blend of 3.5 parts germinated maize flour and 1.5 part roasted beans flour.

Values within the same column with different superscript letters (a, b, c) are significantly different from each other ($p < 0.05$) while those with same superscript letters are not significantly different ($p < 0.05$).

Table 2 also shows the percentage total solids in the three porridges made at the same inclusion levels of water and flour. Total solids in the porridge from ungerminated maize flour were significantly different ($p = 0.0069$) from those from germinated maize flour at the same inclusion level of flour to water. There were more total solids (5.23%) in the ungerminated maize flour porridge than in the porridges from germinated flour and beans blend (3.41% for the 4:1 blend and 3.97% for the 3.5:1.5 blend).

There was no significant difference between the porridges made from the two blends. The two blends could therefore be used in preparation of high-energy density porridges. However, the blend of 4:1 ratio had the least amount of total solids showing that it was more suitable than the 3.5:1.5 blend, since more flour could be added to it.

Sensory Evaluation

Results for sensory evaluation are presented in Table 3.

Color. Sight plays a major role in sensory analysis and the appearance of food can have a major effect on its acceptability. In this study, there was a significant difference ($p < 0.001$) between the scores of the color of the porridges from ungerminated maize, germinated maize and from the blends from germinated maize and beans (Table 3). However, there was no significant difference ($p < 0.05$) between the colors of the two blends.

Table 3. Mean scores for the sensory evaluation test parameters

Factor	Color	Taste	Smell	Texture	Acceptability
UMP[1]	1.97^a	2.59^a	4.04^a	2.28^a	2.40^a
GMP[2]	2.89^b	2.79^a	2.76^b	2.86^b	2.43^b
Blend1[3]	3.72^c	3.18^a	2.99^b	4.00^c	3.53^c
Blend2[4]	4.26^c	4.46^b	3.46^b	5.10^d	4.84^d
L.S.D	0.18	0.18	0.21	0.18	0.17
C.O.V	21.38%	20.92%	24.44%	20.72%	19.74%
Mean	3.13	3.2	3.27	3.46	3.23

[1]ungerminated maize porridge.
[2]germinated maize porridge.
[3]Porridge from blend of 4 parts germinated maize flour to 1 part of bean flour (4:1).
[4]Porridge from blend of 3.5 parts germinated maize flour to 1.5 parts bean flour (3.5:1.5).
Values within the same column with different superscript letters (a, b, c) are significantly different from each other (p < 0.05) while those with same superscript letters are not significantly different (p < 0.05).

The color of porridge from ungerminated maize was most preferred followed by the germinated maize porridge and then the 4:1 germinated maize flour to beans blend. The 3.5:1.5 germinated maize flour to beans flour blend was least preferred. The most preferred porridge was the most white in color, while the least preferred was the creamiest in color.

Preference of white color in porridges has been found in many developing countries where mothers, especially those living in urban areas, tend to choose the refined white flour for making porridges for their weanlings (Latham, 1979; Cameron and Hofvander, 1983). However, porridges from refined flours have been found to have low nutritional value compared to those from whole flour porridges (Cameron and Hofvander, 1983; Kikafunda et al., 1998b). The germinated maize porridge was less white probably due to formation of brown pigments (melanoidins) through a maillard reaction when the starch reacted with proteins with exposure to high temperatures during oven drying. According to Kent (1983), presence of sugars from starch hydrolysis may also lead to color changes in the presence of proteins upon exposure to hightemperatures.

Taste. There was no significant difference in the scores for taste of the ungerminated maize porridge, the germinated maize porridge, and the 4:1 germinated maize to beans flour porridge. Although the ungerminated maize porridge was most preferred, absence of a significant difference in the scores implies that the 4:1 germinated maize to beans flour porridge could be equally accepted and can therefore be used in feeding the infants since it can give higher nutrient density. The scores for the 3.5:1.5 blend were significantly different ($p = 0.0004$) from those for the rest of the porridges. This porridge was least preferred. This implies that addition of more bean flour to the maize flour could make the porridge less acceptable; therefore the amount of bean flour added should be limited to an optimum amount

Smell. Scores for the smell of the ungerminated maize porridge were significantly different ($p = 0.0073$) from those of the other porridges. Ungerminated maize porridge was least preferred probably because it had a flat flavor. The germinated maize porridge was most preferred, probably due to the presence of desirable flavors, which are developed during germination. The smell of the 4:1 blend was next preferred, probably due to a high content of germinated maize flour (80%), which may have masked the usually undesirable beany flavor of beans.

Roasted beans also have a better flavor than those that are not roasted (Kordylas, 1990).

Texture (Mouth Feel). There was a significant difference ($p \leq 0.0001$) between the scores for texture of all the porridges. Texture for the ungerminated maize porridge was the smoothest and most preferred followed by pure germinated maize porridge. The texture of the blend with the higher content of bean flour (3.5:1.5 blend) was least preferred, probably due to a course texture imparted to the porridge by the bean flour. Kordylas (1990) reported that bean flour usually has a course texture; yet weaning foods should have a smooth texture.

Overall Acceptability. There was a significant ($p \leq 0.0001$) difference between the scores for overall acceptability of germinated maize porridge and ungerminated maize porridge. Of the blends, the 4:1 blend was more acceptable with an average score of 3.53 compared the 3.5:1.5 blend, which had an average score of 4.84. Generally, all the products were acceptable since their average scores ranged between "like slightly" and "like moderately." This is in agreement with the findings of Mosha and Svanberg (1990). According to these authors, the use of germinated flour to make weaning foods was accepted by almost all the mothers, possibly because an indigenous technology, germinations, was used to tackle a recognized problem.

The Relationship Between Acceptability and Other Test Parameters. Overall acceptability is a composite dependant variable which is determined by a combination of attributes such as the taste, smell, texture, and color of the food under test, in this case, the weaning porridges. The results of how each of the attributes contributed to overall acceptability are presented in Table 4. There was a positive relationship between over-

Table 4. Regression of overall acceptability as a dependent variable against color, smell, taste, and texture as independent variables

Variable	Parameter Estimate	Standard Error	Regression	Pr > (t)
Intercept	−0.14	0.123	−1.08	0.2809
t.color	0.16	0.06	2.65	0.0089
t.smell	0.07	0.056	1.18	0.2398
t.taste	0.47	0.069	6.81	< 0.0001
t.texture	0.37	0.062	6	< 0.0001

all acceptability and all the attributes. The relationship was strongest with taste, (r = 0.75) followed by texture (r = 0.74), then color (r = 0.57), and lastly smell (r = 0.32).

DISCUSSION

Viscosity and Overall Acceptability of the Porridges

Viscosity of a weaning food is an important physco-chemical property, which influences the quantity of food and energy taken in by the child (Mosha and Svanberg, 1990). The viscosity of the porridges from the blends of germinated maize supplemented with decorticated beans, in this study, was significantly lower than that of porridge from ungerminated maize flour. This is in agreement with results from other studies (Desikachar, 1980; Mosha and Svanberg, 1983; Svanberg, 1988; Maung et al., 1995), all of whom worked with germinated maize in an effort to find an effective method of reducing paste viscosity in weaning porridges.

In his studies among Tanzanian children, Svanberg (1988) found out that viscosity affected food intake of children more than energy density. In an effort to reduce viscosity and increase energy density of weaning foods, Kikafunda et al. (1997) supplemented maize with groundnuts and/or cow's milk instead of beans. From the study, it was found that other factors that may influence viscosity include particle size, cooking time, temperature, and concentration of the flours.

In addition to investigations on viscosity, energy, and nutrient density of the formulated weaning porridges, this study also investigated the acceptability of the blends. It was found that germination enhanced the overall acceptability of the porridges, in agreement with the results of Mosha and Svanberg's (1990) Luganga Village Study. Even the addition of roasted beans up to one part beans to four parts germinated maize did not significantly reduce overall acceptability of the composite blends. Onyeka and Dibia (2002) also reported that weaning porridges made from malted maize supplemented with soybean and groundnut, were quite acceptable.

Energy and Protein Content of the Germinated and Supplemented Weaning Porridges

The gross energy of the germinated maize was found to be 3.48 Kcal (0.83 kJ)/g, while that of the ungerminated maize flour was found to be

3.81 Kcal (0.91 kJ)/g before cooking. Upon cooking, the addition of about 7% ungerminated maize flour to boiling water gave porridge of drinking consistency. At a consumption capacity of 300ml per feeding (Cameron and Hofvander, 1983; Kikafunda et al., 1998a), a child would be able to get 79.98 Kcal (19.13 kJ) per cup from the ungerminated maize flour porridge. If the porridge were to be served three times a day, the child would get 239.9 Kcal (57.39 kJ) from this porridge. Using the weaning blend flour of germinated maize flour porridge and white beans flour, a similar consistency was obtained by adding 11% flour to boiling water. This would give 114.84 Kcal (27.47 kJ) per cup from the weaning blend porridge compared to the 79.98 Kcal (19.13 kJ) per cup from the ungerminated maize flour porridge. Serving the porridge three times a day would therefore give 344.5 Kcal (82.42 kJ) per day.

During the weaning period, a child is still breast-feeding. The child of 1 year needs not less than 920 Kcal (220.1 kJ)/day (FAO/WHO/UNU, 1985). It is assumed that this child would be obtaining one-half of its energy requirement from breast milk. If the child were to be fed three times a day on porridge, the ungerminated maize flour porridge would provide 52.2% of the child's remaining energy needs, while the weaning blend would provide 74.89% of the remaining energy needs. This confirms our study's hypothesis that the energy density of the composite weaning blend is significantly higher than that of the typical weaning porridges often prepared by mothers in developing countries. Kikafunda et al. (1997) recommended that high energy foods such as ground nuts and/or milk should be added to the weaning porridge because in addition to reducing viscosity and dietary bulk, they add energy and nutrients to the porridge.

For the protein, from the three servings per day, a child would obtain 14.46 g of protein from the weaning blend porridge. This is the recommended amount of protein per day for young children (Cameron and Hofvander, 1983). On the other hand, the child would obtain only 6.3 g/day from the ungerminated plain maize flour porridge, which is less than half of the recommended daily protein intake. The weaning blend is therefore more suitable and nutritionally adequate for child weaning.

CONCLUSION AND RECOMMENDATIONS

This study has shown that the energy and protein density of porridges made from germinated maize flour supplemented with decorticated roasted beans is significantly higher than that of typical weaning maize porridge made with maize alone. The composite blend also has low fiber content, reduced bulk, and reduced viscosity. In addition, porridges from the blend have acceptable sensory attributes. This blend, therefore, has great potential as a weaning food in resource-poor, technologically underdeveloped countries. Mothers and caretakers in developing countries should be equipped with knowledge and skills about household-level technologies that can increase the nutritional value of weaning foods for their children

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