Sweet potato-based complementary food for infants in low-income countries

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Abstract

Background. *In low-income countries, most infants are given cereal-based complementary foods prepared at the household level. Such foods are high in phytate, which limits the bioavailability of nutrients, including iron, calcium, zinc, and in some cases proteins, which are crucial to the development of infants.*

Objective. *To compare the levels of macronutrients (protein, fat, and carbohydrate), gross energy, and fructose in sweet potato-based (denoted ComFa) formulations and enriched Weanimix (dehulled maize–dehulled soybean–groundnut blend with fish powder and sugar incorporated). The phytate level was also compared.*

Methods. *A composite flour of sweet potato and soybeans containing fish powder was processed by oven toasting as a home-based complementary food. Another blend containing skim milk powder was processed by extrusion cooking or roller drying as industrial-based prototypes. The macronutrient composition and the levels of fructose and phytate were determined in the ComFa formulations and enriched Weanimix.*

Results. *The ComFa formulations and the enriched Weanimix met the stipulated values in the Codex Alimentarius Commission standard for energy (400 kcal/100 g), protein (15 g/100 g), and fat (10 to 25 g/100 g) for complementary food, with the exception of the industrial-based ComFa formulations, which satisfied 83% of the protein requirement (15 g/100 g). The ComFa formulations had a quarter of the phytate level of enriched Weanimix. The fructose level in the sweet potato-based complementary foods was more than five times that in enriched Weanimix.*

Conclusions. *The sweet potato-based formulations were superior to enriched Weanimix as complementary foods for infants in low-income countries, based on the fructose (which makes the porridge naturally sweet) and phytate levels.*

Key words: Complementary food, fructose, phytate, sweet potato

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Introduction

Malnutrition among infants in low-income countries can be related to the composition of the complementary foods introduced after the period of exclusive breastfeeding. The high incidence of anemia among children in sub-Saharan Africa is partly due to poor iron bioavailability from their diet, which tends to be high in the antinutrient phytate [1]. Phytate is the storage form of phosphorus in plants [2] and limits the bioavailability of essential nutrients such as iron [3, 4], zinc [5], probably calcium [6], and protein [7]. Improved starch and protein digestibility has also been observed in foods when the level of phytate was reduced [8, 9].

Cereals and legumes processed into dried products and reconstituted as porridge are widely promoted as complementary foods in sub-Saharan Africa by researchers and health organizations. Such food mixes have improved protein and energy contents compared with cereal-only gruel [10]. In Ghana, for example, collaboration in 1987 between UNICEF-Ghana and the Ghanaian Ministry of Health led to the development of Weanimix, a complementary food blend of maize (75%), soybean–cowpea (15%), and groundnuts (10%) [11]. The composition of Weanimix formulations has been the prototype of other cereal-based complementary foods developed in sub-Saharan Africa [10, 12, 13]. Although Weanimix has adequate protein (15 g/100 g) and energy (435 kcal/100 g) contents [11], it is a combination of high phytate-containing food crops, hence the high phytate level in the product. The phytate contents of maize, soybeans, and groundnuts are 0.80, 1.5, and 1.8 g/100 g, respectively [14]. Lartey et al. [15] reported the level of phytate in Weanimix processed from unrefined maize (75%), unrefined soybeans (15%), and groundnut (10%) as 480 mg/100 g.

Complementary foods based on either root or tuber crops have been shown to be significantly lower in phytate (by 3% to 20%) than cereal- and legume-based foods [16, 17]. A level of 0.01 g/100 g of phytate has been found in sweet potato [14]. The inhibitory effect of phytate has been shown to be dose-dependent [18]; hence the use of sweet potato to process complementary food is likely to result in a product that would be low in phytate.

The red-, orange-, or cream-fleshed sweet potato (herein referred to as the colored variety) is ideal because it is naturally sweet, liked by young children, well suited to the tropical climate in Africa, and high in β-carotene (the precursor of vitamin A) [19–21]. Sweet potato contains inulin in addition to starch as a carbohydrate reserve [22]. Inulin is a soluble, fermentable, nonstarch carbohydrate containing fructose as monomers [22]. When inulin was added to bread or liquid food in a human feeding trial, it was associated with increased calcium bioavailability [23]. Fructose, as well as imparting sweetness to food [24], could possibly improve iron bioavailability [25]. Human infants were found to consume fructose and sucrose (table sugar) in similar quantities, which indicates that the infants liked the sweetness of fructose [26]; hence the presence of fructose in food would increase food intake without the need to add sweeteners. Daily fructose intake of 50 g or less, or approximately 10% of total food energy, has been recommended as not deleterious [27].

Despite the above-mentioned nutritional benefits to be derived from processing the colored variety of sweet potato into dried products that could be used as complementary foods for infants in Africa, only a few such formulations have been reported in the literature [28, 29]. In these studies, defatted or full-fat soybean flour was added to orange-fleshed sweet potato at various ratios, and the mixture was processed in an extruder. The extrudates were dried and milled into flour that could be used as complementary food. In another study, freeze-dried slices of orange-fleshed sweet potato, fish (skinned *Tilapia* fillets), and sunflower oil with either skim milk or soybean flour [30] were blended into a soft paste and cooked as soup. The cooked soup was then freeze-dried and milled into flour as a complementary food. The nutritional composition and *in vitro* starch digestibility of the freeze-dried processed complementary food compared favorably with that of Nestlé Cerelac, a popular commercial cereal-based complementary food used in Africa. However, Nandutu and Howell [30] did not indicate the levels of phytate in their product. Therefore, in this study we have developed complementary food formulations containing a cream-fleshed sweet potato and determined their phytate contents.

Extrusion cooking and roller drying were used as possible industrial-based processing methods because of their popularity in processing dried food products [31, 32]. Oven toasting was used as a possible home-based processing method. It is noteworthy that heat processes, such as toasting (or other home cooking methods), extrusion cooking, or roller drying, have been shown to be less effective at counteracting the negative effect of phytate on iron absorption [33]. Cooking usually reduces phytate levels by 50%, whereas high-temperature and short-term heat processing, such as extrusion cooking, results in degradation of this antinutrient by about 30% [34].

The purpose of this study was to assess the macronutrient composition and the fructose and phytate contents of cream-fleshed sweet potato-based complementary foods (ComFa formulations) and enriched Weanimix (dehulled maize–dehulled soybean–groundnut blend containing fish powder and sugar).

We hypothesized that the ComFa formulations would be lower in phytate, and that both ComFa formulations and enriched Weanimix would satisfy the recommended macronutrient levels of complementary food according to the Codex Alimentarius Commission standard [35].

Materials and methods

Description of ingredients used in the formulations

Sweet potato (*Ipomoea batatas*), marketed as "gold kumara" in New Zealand and "O'Henry" in the United States, was sourced from Delta Produce Co-op Ltd, Dargaville, New Zealand. The root has a cream flesh with orange streaks and is a variant of Beauregard (an orange-fleshed variety). Fish powder prepared from smoke-dried anchovies (*Engraulis hepsetus*) without the heads was imported from Ghana. Full-fat dehulled soybeans (*Glycine max*) flour (Floursoy 25, The Three Mac Company), soybean oil (AMCO Soya, Goodman Fielder Ltd.), and skim milk powder (NZMP, Fonterra Ltd.) were sourced from companies in New Zealand. Iodized salt and white sugar were purchased from local supermarkets in Palmerston North, New Zealand. The ingredients of enriched Weanimix were refined (dehulled) maize (*Zea mays*) meal (Springbok, South Africa), soybean (*Glycine max*) seed, and groundnut (*Arachis hypogea*) paste. These were obtained from local supermarkets in Palmerston North.

Methods

Preparation of cream-fleshed sweet potato flour

The roots of sweet potato were washed, peeled with a kitchen knife, and immersed into 0.5 g/100 g sodium acid pyrophosphate (SAPP) solution to prevent discoloration of the roots. The peeled roots were diced into chips approximately 1.4 cm thick with a Dito-Sama TR 21slicer (Model G59979, Aubasson, France) and reimmersed in the SAPP solution. The chips were then blanched at 90°C for 1 minute in a steam-jacketed pan and dried in a forced-air oven (Whitlock Speedy Smoke "N" Cooker, Progressive Machinery Design Ltd., Auckland, New Zealand) at 60°C to constant weight (final moisture content, 2.5 to 3.3 g/100 g). The dried chips were milled into flour with a grain mill fitted with a 1-mm screen fabricated in China for Plant and Food Research, Palmerston North, New Zealand.

Formulation of sweet potato and soybean complementary foods (ComFa)

The proportions of the ingredients used for each of the processing methods are shown in **table 1**. The composite flour with the entire ingredients (approximately 2.0 kg) was homogenized in a food mixer (NSF, ARM-02, Thunderbird, Canada) with mixing speed set at position 2 for 10 minutes. A computer program (Nutrition Calculator) developed by Global Alliance for Improved Nutrition (GAIN) (Jonathan Siekmann, personal communication, 15 July 2010) was used to calculate the proportions of ingredients needed for an energy content of 400 kcal/100 g, a protein level of 15 g/100 g, and a fat content in the range of 10 to 25 g/100 g, as specified in the Codex Alimentarius Commission guidelines for complementary foods for older infants and young children [35].

In this paper, the ComFa home-based formulation refers to sweet potato–soybean blend enriched with fish powder prepared from smoke-dried anchovies and toasted in an oven, and ComFa industrial-based formulations denote sweet potato–soybean blend enriched with skim milk powder either extrusion cooked or roller dried. We included fish powder as an ingredient in the ComFa home-based formulation and skim milk powder in the ComFa industrial-based prototypes. Fish powder was incorporated in the ComFa home-based formulation as a sustainable source of animal protein, calcium, iron, and omega-3 fatty acids. Skim milk powder was incorporated in the industrial prototypes because of the suggested positive association of milk with linear growth [36]; it is also an ingredient in Nestlé Cerelac.

TABLE 1. Composition of the composite flour for processing sweet potato–soybean complementary food (ComFa)

	Amount (g/100 g)		
	Industrial-based processing		Home-based processing
Ingredient	Extrusion cooking	Roller drying	Oven toasting
Sweet potato flour	72	72	66
Full-fat soybean flour	15	15	10
Soybean oil	6	6	6
Iodized salt	0.5	0.5	0.5
Sugar	0.5	0.5	0.5
Skim milk powder	6	6	—
Fish powder prepared from anchovies	—	—	17

Extrusion-cooked ComFa

A twin-screw extruder (Clextral BC21, Firminy Cedex, France) with a barrel length of 700 mm and seven temperature-controlled barrel sections was used. The temperatures were set from the first barrel (from the feeder end) as 30, 30, 80, 120, 120, 80, and 80°C. The screw speed was 250 rpm, with a feed rate of 165 g/min and a water feed rate of 6.0 g/min. A die with 3.4-mm diameter aperture was used. The moist, noodle-like extrudates were dried in the forced-air oven at 60°C for 48 hours and milled with the grain mill described above to obtain the extrusion-cooked ComFa sample.

Roller-dried ComFa

A laboratory-level roller drier (Richard Simon & Sons Ltd., Nottingham, England) with a revolving drum 200 mm wide and 170 mm in diameter was used. The slurry was prepared by mixing 2.0 kg of homogenized composite flour with 3.5 L of potable water. The slurry was partially cooked in a steam-jacketed pan for 10 minutes at temperatures between 80° and 83°C to partially gelatinize the starch. A tablespoonful of the precooked blend was transferred to the rotating drums of the roller drier to obtain dry flakes. The pressure of the steam was set at 100 kPa and the temperature at 106.7°C. The rollers rotated at 1.2 rpm. The flakes obtained were oven-dried at 60°C for 48 hours and passed through 800-μm mesh to obtain the roller-dried ComFa sample.

Oven-toasted ComFa

The homogenous composite flour was toasted in a commercial oven (AR 85, Electrolux, Steelfort Engineering Company Ltd., Palmerston North, New Zealand) set at 120°C for 30 minutes with intermittent stirring at 5-minute intervals. The oven-toasted ComFa (also referred to as ComFa home-based) was further dried in the forced-air oven at 60°C for 48 hours, as was done for the other ComFa formulations.

Enriched Weanimix

Whole soybean seeds were toasted in an electric frying pan (Kambrook 9708, Hong Kong), dehulled by hand, and milled into flour with the grain mill described previously. The maize meal and groundnut paste were added to the dehulled soybean flour. The composite flour was toasted in the electric frying pan with continuous stirring until the blend turned golden brown. Typically, a blend containing 75%, 15%, and 10% of maize, soybeans, and groundnuts, respectively, is referred to as Weanimix [11]. Fish powder and white sugar were added to Weanimix at 17% and 0.5% by weight, and the complementary food sample obtained was referred to as enriched Weanimix because it contained refined maize and soybean flours and added sugar, which were not used in the earlier formulation.

Laboratory analyses

Three samples of the above formulations were taken and stored separately in airtight plastic containers at −1.0°C prior to analysis. The laboratory analyses were performed on each of the samples.

Nutritional analyses

Proximate composition was determined by the method described by the AOAC International [37]: moisture (AOAC 925.10), crude protein (AOAC 960.52), crude fat (AOAC 922.06), and ash (AOAC 969.32). Moisture analysis was modified as follows. The samples were dried at 108°C overnight (approximately 16 hours). An assay kit (K-ACHDF 11/08; Megazyme Int., Wicklow, Ireland) was used to analyze total dietary fiber and D-fructose contents. Available carbohydrate was estimated by difference as 100 –(moisture + protein + fat + ash + total dietary fiber) [38]. The gross energy content of the formulations was analyzed by the Nutrition Laboratory (Massey University, Palmerston North, New Zealand) using bomb calorimetry.

Phytate analysis

The phytate content of the formulations was determined with an assay kit (K-PHYT 05/07; Megazyme Int., Wicklow, Ireland). Defatted samples were used to reduce the interference of fat during the assay. Briefly, the phytate assay involved an extraction stage using hydrochloric acid followed by an enzymatic dephosphorylation step with phytase and alkaline phosphatase and a precipitation stage using a color reagent prepared from ascorbic acid in sulfuric and ammonium molybdate. The absorbance of phosphorus standards and samples was measured with a UV/Visible spectrophotometer (Pharmacia LKB Ultrospec II, England) at 655 nm.

Statistical analysis

The univariate and ANOVA procedures in SAS, version 9.1, were used to perform descriptive analysis and compare the means of triplicate measurements of macronutrient, fructose, and phytate levels. Means were considered to be significantly different when

TABLE 2. Macronutrient composition of sweet potato- and maize-based complementary foods

Complementary food[b]	Nutrient composition (g/100 g, except gross energy [kcal/100 g]) dry matter basis[a]						
	Moisture	Protein	Fat	Ash	Total dietary fiber	Available carbohydrate	Gross energy
Extrusion-cooked ComFa	7.33 ± 0.07^{w}	12.39 ± 0.09^{y}	10.07 ± 0.23^{y}	5.45 ± 0.04^{x}	10.25 ± 1.32^{w}	56.07 ± 1.14^{x}	464.24 ± 0.15^{y}
Roller-dried ComFa	3.52 ± 0.06^{y}	12.48 ± 0.09^{y}	$10.39 \pm 0.20^{x,y}$	5.34 ± 0.04^{x}	10.57 ± 0.70^{w}	58.92 ± 0.48^{w}	463.42 ± 0.30^{y}
Oven-toasted ComFa	2.36 ± 0.04^{z}	20.14 ± 0.15^{x}	10.67 ± 0.04^{x}	10.69 ± 0.08^{w}	$8.18 \pm 0.44^{w,x}$	53.28 ± 0.54^{y}	469.66 ± 0.08^{x}
Enriched Weanimix	6.05 ± 0.01^{x}	22.22 ± 0.11^{w}	11.25 ± 0.15^{w}	11.25 ± 0.10^{w}	6.08 ± 0.26^{x}	50.25 ± 0.43^{z}	491.34 ± 0.56^{w}
p value	< .0001	< .0001	.01	< .0001	.01	.0001	< .0001

a. Values are means of triplicate determinations ± standard error of the mean; means with different superscript letters in a column are significantly different ($p < .05$).
b. Extrusion-cooked ComFa and roller-dried ComFa contained 72% cream-fleshed sweet potato flour, 15% full-fat soybean dehulled flour, and 6.0% skim milk powder; oven-toasted ComFa contained 66% cream-fleshed sweet potato flour, 10% full-fat soybean dehulled flour, and 17% fish powder prepared from smoke-dried anchovies; enriched Weanimix contained 75% refined (dehulled) maize flour, 15% full-fat soybean dehulled flour, and 10% groundnut, plus 17% (wt/wt) fish powder and 0.5% (wt/wt) sugar.

$p < .05$. The least significant difference test was used to separate the means when the difference was significant.

Results

Nutrient composition of the complementary foods

The levels of macronutrients (protein, fat, ash, total dietary fiber, and available carbohydrate) and gross energy in the ComFa formulations and enriched Weanimix are presented in **table 2**. ComFa home-based (oven-toasted ComFa) and ComFa industrial-based (extrusion-cooked ComFa and roller-dried ComFa) formulations satisfied the requirements for energy (400 kcal/100 g) and fat (10 to 25 g/100 g), as stipulated in the Codex Alimentarius Commission standard [35]. However, the protein content of the ComFa industrial-based prototypes met 83% of the stipulated minimum level of 15 g/100 g in the Codex standard and was lower than the protein content of the ComFa home-based product, which satisfied the stipulated value. The total fat level was not markedly different between the ComFa home-based and industrial-based formulations. The ash content was 66% greater in the ComFa home-based than the ComFa industrial-based formulations. The total dietary fiber level was not significantly different among the ComFa formulations, but the level was approximately twice the minimum level of 5 g/100 g for dietary fiber specified in the Codex standard [35]. The industrial-based ComFa formulations were approximately 8.0% higher in total available carbohydrate than the home-based product. There was a difference of approximately 1.0% in gross energy content between the ComFa home-based and industrial-based formulations.

Enriched Weanimix met the protein, fat, and energy values stipulated in the Codex standards [35]. Enriched Weanimix contained about 22% more dietary fiber than the level recommended in the Codex standard.

Enriched Weanimix was significantly higher in protein, fat, and energy than all the ComFa formulations but was 40% lower in total dietary fiber than the ComFa formulations. The fructose level in the sweet potato-based complementary foods was more than five times that in enriched Weanimix.

The ComFa formulations and enriched Weanimix satisfied the recommended energy density value of at least 0.8 kcal/g [39] for complementary food (**table 3**). The estimated daily protein and fat intakes from the ComFa formulations and the enriched Weanimix were higher than the suggested intakes from complementary foods (**table 3**), but neither met the suggested daily energy intake of 200 kcal/day [39]. The average daily energy intakes from the ComFa formulations and the enriched Weanimix were about 77% and 81% of the recommended intake, respectively.

Phytate content of the complementary foods

There were no differences in phytate content between the extrusion-cooked, roller-dried, and oven-toasted ComFa formulations (**table 4**). The phytate content of the ComFa formulations was one-quarter of that in the enriched Weanimix.

Discussion

The high protein and ash (an indication of the mineral level) contents in the ComFa home-based formulation compared with ComFa industrial-based prototypes may be attributed to the proportion of fish powder used, which was 17% (wt/wt), compared with 6.0%

TABLE 3. Estimated daily nutrient intakes from sweet potato- and maize-based complementary foods against recommended daily requirements for 6- to 8-month-old breastfeeding infants in developing countries[a]

Nutrient composition	ComFa[b]			Enriched Weanimix[c]	*p* value	Reference value[d]
	Extrusion-cooked	Roller-dried	Oven-toasted			
Energy density (kcal/g)	4.64 ± 0.00[y]	4.63 ± 0.00[y]	4.70 ± 0.00[x]	4.91 ± 0.01[w]	< .0001	≥ 0.8
Energy (kcal/day)	153.20 ± 0.0[y]	152.93 ± 0.1[y]	154.98 ± 0.0[x]	162.14 ± 0.1[w]	< .0001	200
Protein (g/day)	4.09 ± 0.03[y]	4.12 ± 0.03[y]	6.64 ± 0.05[x]	7.33 ± 0.04[w]	< .0001	2
Fat (g/day)	3.32 ± 0.07[y]	3.43 ± 0.06[x,y]	3.52 ± 0.02[x]	3.71 ± 0.05[w]	.01	0

a. Values are means of triplicate estimations ± standard error of the mean for ComFa formulations and Weanimix based on estimated average daily intake of 33 g (dry weight) of complementary food foods from findings by Lartey et al. [11]; means in the same row with different superscript letters are significantly different ($p < .05$).

b. Extrusion-cooked ComFa and roller-dried ComFa contained 72% cream-fleshed sweet potato flour, 15% full-fat soybean dehulled flour, and 6.0% skim milk powder; oven-toasted ComFa contained 66% cream-fleshed sweet potato flour, 10% full-fat soybean dehulled flour, and 17% fish powder prepared from smoke-dried anchovies.

c. Enriched Weanimix contained 75% refined (dehulled) maize flour, 15% full-fat soybean dehulled flour, and 10% groundnut, plus 17% (wt/wt) fish powder and 0.5% (wt/wt) sugar.

d. Source: Dewey and Adu-Afarwuah [39] for 6- to 8-month-old infants on average daily breastmilk intake (600 to 650 mL/day).

TABLE 4. Fructose and phytate levels of sweet potato- and maize-based complementary foods[a]

Complementary food[b]	Fructose (g/100 g)	Phytate (g/100g)
Extrusion-cooked ComFa	8.44 ± 0.15[w]	0.19 ± 0.03[x]
Roller-dried ComFa	8.48 ± 0.32[w]	0.20 ± 0.02[x]
Oven-toasted ComFa	7.92 ± 0.14[w]	0.23 ± 0.03[x]
Enriched Weanimix	1.45 ± 0.05[y]	0.80 ± 0.03[w]
p value	< .0001	< .0001

a. Values are means of triplicate determinations ± standard error of the mean; means with different superscript letters in a column are significantly different ($p < .05$).

b. Extrusion-cooked ComFa and roller-dried ComFa contained 72% cream-fleshed sweet potato flour, 15% full-fat soybean dehulled flour, and 6.0% skim milk powder; oven-toasted ComFa contained 66% cream-fleshed sweet potato flour, 10% full-fat soybean dehulled flour, and 17% fish powder prepared from smoke-dried anchovies; enriched Weanimix contained 75% refined (dehulled) maize flour, 15% full-fat soybean dehulled flour, and 10% groundnut, plus 17% (wt/wt) fish powder and 0.5% (wt/wt) sugar.

(wt/wt) of skim milk for the ComFa industrial-based formulations. The amount of skim milk used could be increased in the ComFa industrial-based formulations to increase the protein content to that of the ComFa home-based product. The absence of a significant difference in fat content between the ComFa home-based and industrial-based formulations suggests that the fish powder did not significantly contribute to the total fat content in the ComFa home-based formulation. The higher total dietary fiber in the ComFa formulation compared with the requirement for complementary food specified in the Codex standard could be the only concern for the use of these sweet potato-based formulations as complementary foods. However, a significant proportion of the fiber in ComFa formulations is likely to be soluble fiber, as it has been reported that about 25% to 50% of the total dietary fiber in sweet potato is soluble [40, 41]. The benefits of soluble fiber as a fermentable substrate for lactobacilli and bifidobacteria (health-promoting bacteria) [42, 43] and in improving calcium bioavailability [23] suggest that the high level of total dietary fiber in the ComFa formulations could be beneficial. The difference in gross energy content between the home-based and the industrial-based ComFa formulations was due to the relatively high protein content, since the ComFa industrial-based formulations were higher in total available carbohydrates.

The estimated intake level of fructose (on a daily intake of 33 g [dry weight]) [11]) from the ComFa formulations is about 2.6 g/day, which is much less than the recommended daily maximum intake of 50 g/day [27]. This suggests that the benefits of fructose in imparting sweetness [24], subsequently leading to increased food intake [26, 44], could be achieved better from ComFa formulations than from enriched Weanimix. Therefore, the higher level of fructose in the ComFa complementary foods could be a nutritional advantage.

The recommendation of Dewey and Adu-Afarwuah [39] for 200 kcal/day of energy from complementary food could be satisfied if the daily portion is increased, which is likely for the sweet potato-based formulations due to the level of fructose. A daily portion intake of 43 g (dry weight) of ComFa formulations instead of 33 g would meet the suggested requirement.

The phytate levels of the home-based and industrial-based ComFa formulations were not different, which confirms that the effect of thermal processing on phytate degradation is minimal, as observed in another study [33]. In that study, the use of home cooking, roller drying, and extrusion cooking as thermal processing methods did not affect iron absorption. Since the inhibitory effect of phytate on micronutrient bioavailability is dose-dependent [18, 45], it is expected that micronutrient bioavailability from ComFa formulations would be higher than that from the enriched Weanimix. This finding also suggests that formulating complementary foods using ingredients such as sweet potato, which is low in phytate, is a viable option to reduce the intake of this antinutrient.

Although the research focused on complementary food intended for infants (6 to 8 months of age) in sub-Saharan Africa, the findings can be translated into processing of similar products for other regions. The use of colored-fleshed sweet potato varieties (not white-fleshed variety) in complementary foods (such as ComFa) will help meet the recommended daily intake of vitamin A–rich fruits and vegetables by infants and young children [46]. In comparison with maize (corn)–soybean blends used by international organizations in food aid programs, ComFa has lower phytate and higher fructose levels, both of which are beneficial to the health of infants.

In conclusion, sweet potato can be combined with soybeans, soybean oil, and either fish powder or skim milk powder and processed into a complementary food suitable for 6- to 8-month-old infants using home-based methods such as oven toasting and by industrial-based processes such as extrusion cooking or roller drying. The levels of energy, protein, and fat in ComFa formulations and enriched Weanimix compared favorably with those stipulated in the Codex Alimentarius Commission guideline for complementary foods for infants and young children. Although the ComFa industrial formulations contained slightly less protein than specified in the Codex standard, the formulations met the suggested daily intake of protein from a complementary food for breastfeeding infants 6 to 8 months of age. The levels of phytate and fructose in the sweet potato-based formulations make them superior to enriched Weanimix as complementary foods.

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