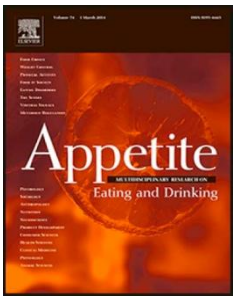
Accepted Manuscript



Title: Acceptability of new formulations of Corn-Soy Blends and Lipid-based Nutrient Supplements in Province du Passoré, Burkina Faso

Author: Ann-Sophie Iuel-Brockdorf, Tania Aase Dræbel, Christian Fabiansen, Bernardette Cichon, Vibeke Brix Christensen, Charles Yameogo, Christian Ritz, Mette Frahm Olsen, Henrik Friis

PII: S0195-6663(15)00204-4
DOI: http://dx.doi.org/doi:10.1016/j.appet.2015.04.058
Reference: APPET 2537

To appear in: *Appetite*

Received date: 20-11-2014
Revised date: 15-4-2015
Accepted date: 19-4-2015

Please cite this article as: Ann-Sophie Iuel-Brockdorf, Tania Aase Dræbel, Christian Fabiansen, Bernardette Cichon, Vibeke Brix Christensen, Charles Yameogo, Christian Ritz, Mette Frahm Olsen, Henrik Friis, Acceptability of new formulations of Corn-Soy Blends and Lipid-based Nutrient Supplements in Province du Passoré, Burkina Faso, *Appetite* (2015), http://dx.doi.org/doi:10.1016/j.appet.2015.04.058.

Acceptability of new formulations of Corn-Soy Blends and Lipid-based Nutrient Supplements in Province du Passoré, Burkina Faso

Ann-Sophie Iuel-Brockdorf[1,2], Tania Aase Dræbel[3], Christian Fabiansen[2], Bernardette Cichon[1,2], Vibeke Brix Christensen[2,4], Charles Yameogo[2,5], Christian Ritz[1], Mette Frahm Olsen[6], Henrik Friis[2]

[1]Médecins Sans Frontières – Denmark, Dronningensgade 68, 3. 1420 Copenhagen, Denmark (A Iuel-Brockdorf MIH, ai@msf.dk; B Cichon, MSc, Bernardette.Cichon@london.msf.org; V Christensen DMSc, vb@msf.dk)

[2]Department of Nutrition, Exercise and Sports, University of Copenhagen, Rolighedsvej 30, DK-1958 Frederiksberg C, Denmark (A Iuel-Brockdorf MIH, ai@msf.dk; C Fabiansen MD, chfr@nexs.ku.dk; B Cichon, MSc, Bernardette.Cichon@london.msf.org; C Ritz PhD, ritz@nexs.ku.dk; Prof H Friis PhD, hfr@nexs.ku.dk)

[3] Department of International Health, Faculty of Health and Medical Sciences, University of Copenhagen, Blegdamsvej 3, 2200 Copenhagen, Denmark (T. A Dræbel PhD, Lecturer, taniadraebel@gmail.com)

[4] Department of Paediatrics, Righospitalet, Blegdamsvej 9, 2100, Copenhagen, Denmark (V Christensen DMSc, vb@msf.dk,)

[5] Research Center in Biological, Food and Nutritional Sciences UFR-SVT/University of Ouagadougou, 03 BP 7131 Ouagadougou, Burkina Faso (C Yameogo MSc, yamway@yahoo.fr)

[6] The Nordic Cochrane Centre, Rigshospitalet dept. 7811, Blegdamsvej 9, 2100 Copenhagen, Denmark (M. Frahm Olsen, PhD, meosmail@gmail.com)

Address for correspondence:
Ann-Sophie Iuel-Brockdorff
Department of Nutrition, Sports and Exercise
University of Copenhagen,
Rolighedsvej 30,
1958 Frederiksberg C, Denmark
Telephone: +45 41 77 74 23
Email: ai@msf.dk

Highlights

- *LNS and CSB products with different milk-quantity and soy-quality are equally well accepted on organoleptic parameters*
- *CSB was not consumed as readily as LNS*
- *Both CSB and LNS products were perceived as easy to administer*
- *Similar CSB and LNS products used in the study location were perceived as beneficial to child health*
- *LNS were to a higher degree associated with medicine or foods with medicinal properties*

Abstract

The objective of this study was to evaluate the acceptability of new formulations of six corn-soy blended flours (CSB) and six lipid-based nutrient supplements (LNS) with different quantities of milk and qualities of soy to be used for the treatment of moderate acute malnutrition (MAM). Furthermore, we wanted to explore the acceptability of foods currently used for the prevention and treatment of malnutrition in Burkina Faso to identify possible barriers that could affect the acceptability of the new formulations of supplementary foods. The study was carried out prior to a randomized controlled trial evaluating the effectiveness of these new formulations.

The study involved an observed test-meal and a three-day take-home ration of the experimental food supplements to 6-30-months-old healthy children, followed by questionnaire-based interviews about the acceptability of these supplements. Interviews and focus group discussions were carried out to explore the acceptability of foods currently used for the prevention and treatment of malnutrition.

The results suggest that both LNS and CSB products with different quantities of milk and qualities of soy are equally well accepted among healthy children in rural Burkina Faso based on general appreciation of the supplements and organoleptic properties. All experimental foods received good ratings and there was no significant difference between the foods. However, after the take-home ration, 58% of participants receiving CSB reported having left-overs at the end of the day compared to 37% (n=33) of the participants receiving LNS (p=0.004), suggesting that CSB was not as readily consumed as LNS. Yet, both CSB and LNS products were perceived as easy to administer and the frequency of feeding was estimated to be adequate. The study also found that similar foods, used for the prevention and treatment of malnutrition, were well appreciated in the study location. LNS were to a higher degree associated with medicine or foods with medicinal properties, but both LNS and CSB were perceived as beneficial to child health.

Keywords

Acceptability, supplementary food, Lipid-based Nutrient Supplement, Corn Soy Blend, malnutrition, moderate acute malnutrition

Introduction[1]

Moderate acute malnutrition (MAM) affects 33 million children worldwide and is a major global health problem as it results in increased morbidity and mortality and delayed cognitive development(M. M. Black et al., 2008; Black et al., 2013; R. E. Black et al., 2008). Yet, there is presently no consensus on supplementary foods for the management of MAM. According to the World Health Organization, (WHO), who are currently reviewing their guidelines, more evidence is needed before clear guidelines can be developed (World Health Organization, 2012).

In recent years different approaches have been introduced for the management of MAM using fortified blended flours, such as enhanced versions of corn-soy blend (CSB) or lipid-based nutrient supplements (LNS) (Lazzerini et al., 2013). These supplementary foods vary in terms of cost, taste, texture, shelf life, how they are used as well as in nutritional composition. These are all factors that may affect the acceptability and thereby the beneficial effect of a nutritional intervention. Acceptability refers to how foods are perceived and acknowledged in terms of recommended quantity consumed, the perceived benefits and/or undesirable effects, ease of use as well as organoleptic qualities of the foods based on test meals and/or take-home rations for a minimum of seven days as described in previous studies(Adu-Afarwuah et al., 2008; Bahwere et al., 2009; Rowe et al., 2008).

Soy and milk are key ingredients in existing supplementary foods for children with MAM. Soy is used to obtain high levels of protein. Yet unrefined soy contains anti-nutrients and may produce flatulence and abdominal discomfort due to the fermentation of indigestible oligosaccharides. Consequently this may affect the acceptability (Suarez et al., 1999). As an alternative, soy isolate can be used. It has an increased protein content and an enhanced protein digestibility as well as less anti-nutrients and indigestible oligosaccharides (Björck et al., 1983). Milk may have a beneficial impact on growth (Grillenberger et al., 2003; Hoppe et al., 2008), it contains high quality protein and may furthermore influence the acceptability,

[1] **Abbreviations:**
MAM, moderate acute malnutrition; CSB, corn-soy blend; LNS, lipid-based nutrient supplement; WHO, World Health Organization; DS, dehulled soy; SI, soy isolate; DSM, dry-skimmed milk; MUAC, mid-upper arm circumference

as it provides a more sweet and creamy taste (Hoppe et al., 2008). However, both soy isolate and milk are more expensive ingredients.

Only a few studies have compared the acceptability of CSB vs LNS products and found them equally well accepted. However, LNS were less likely to be left-over (Flax et al., 2010) and CSB was more likely to be shared (Flax et al., 2010; Wang et al., 2013). Acceptability of soy vs. milk-based foods have so far also only been compared in a few studies, and only in LNS products, where both types of foods were reported to be well-accepted by the target population (Kuusipalo et al., 2006; Matilsky et al., 2009). One study compared and assessed the acceptability of LNS products with and without milk and found that milk did not affect acceptability (Owino et al., 2014). This was also the case for a study on soy- and rice-based complementary foods with and without milk powder (Paul et al., 2008). However, to our knowledge, no studies have assessed and compared the acceptability of CSB vs LNS products with different quantities of milk and different qualities of soy for the treatment of MAM.

Prior to a randomized controlled trial evaluating the cost-effectiveness of 12 different new formulations of CSB and LNS with different quantities of milk and soy qualities for the management of MAM (ISRCTN42569496 at http://www.controlled-trials.com), we conducted a study to evaluate the acceptability of these new formulations. Furthermore, we wanted to explore the acceptability of foods currently used in the study location for the prevention and treatment of malnutrition, to identify possible barriers that could affect the acceptability of the new formulations of supplementary foods.

Methodology

The study took place in the department of Gonponsom, Yako health district, Province du Passoré in northern Burkina Faso in January-February 2013. The prevalence of MAM and SAM in the area were 9% and 1·4%, respectively ("Ministere de la Santé, Burkina Faso, Direction de la Nutrition. Rapport Enquete Nutritionnelle Nationale," 2013). Regular preventive food distributions by WFP for children 6-36 months-old, with either CSB or ready-to-use foods, depending on availability, were carried out at the local health centres in relation to routine mother-child healthcare activities. A combination of quantitative and qualitative methods was applied to evaluate and compare the extent of acceptability of the new products (part I) and to capture the multitude of views on supplementary foods currently used for the prevention and treatment of malnutrition in the study location(part II).

Methodology Part I: Acceptability of the new supplementary foods

1.1 Participants

A convenience sample of 180 children aged 6-30 months who had initiated complementary feeding, and with mid-upper arm circumference (MUAC) >125 mm were identified by local community health workers. Exclusion criteria were children with moderate or severe acute malnutrition by MUAC, oedema, history of peanut allergy, or who had severe illness requiring hospitalisation or who were registered in a nutritional program. An informed consent form was signed or thumb printed by caretakers prior to participation.

1.2 Design

Children were randomised to one of the 12 different supplements, i.e. 15 children/group, according to a blocked randomisation list with varying block sizes using http://www.randomization.com. Each of the 12 supplementary foods was masked with a one-letter code and participants and all members of the research team were blinded to the soy and milk content of the supplementary foods, but not to the main type of food (CSB or LNS).

The study included an observed test meal (visit 1) and a three-day take-home test (visit 2) with one of the 12 experimental supplementary foods per participant. Both visits included questionnaires evaluating the acceptability of the new foods in terms of organoleptic qualities and perceived ease of use as well as adherence to recommendations. The take-home ration was included, because it was assumed that acceptability could increase over time. Other studies have provided a take-home ration for minimum a week(Hess et al., 2011, Wang et al., 2013). However, in this study, children were not malnourished and a supplement high in calories, fat and protein for a longer period of time could potentially have adverse effects. Therefore, it was decided to limit the take-home ration to three days.

1.3 Intervention

The 12 supplementary foods included six CSB and six LNS products, with either dehulled soy (DS) or soy isolate (SI) and with 0%, 20% or 50% of total protein as dry skimmed milk (DSM). All products were manufactured by GC Rieber Compact A/S (Bergen, Norway) and had similar micronutrient content provided by a pre-mix of vitamins and minerals according to a WHO Technical Note on supplementary foods for the management of MAM (World Health Organization, 2012) (**Table 1**). A daily ration of LNS (92 g) and CSB (120 g) provided 500 kcal per child. LNS products were packed in 92 grams foil sachets containing a daily ration and did not require any preparation prior to consumption. CSB products were packed in foil bags and required cooking to become an edible porridge. The home ration of three daily rations of 120 gram CSB per day was dosed and provided in neutral local plastic bags. Mothers were instructed to prepare the porridge with a CSB-water volume ratio of either 1:3 or 1:4, depending on the desired viscosity. It was advised to

153 serve the porridge in three meals per day, giving 40 gram of CSB (167 kcal) per meal. Individual dose cups
154 (per meal) were provided to all participants receiving the CSB products.

155

Observed test meal (visit 1)

Participants were offered either 40 g of one of the CSB products corresponding to 1/3 of the daily ration or 1 sachet of the LNS products corresponding to a full daily ration. The ration was served by two health workers between 8 am and 12 pm. Caretakers and children were divided into groups, placed in a quiet area, and served one group at a time with a maximum of four children per group at a time. Children in the CSB groups were served first and caretakers were showed how to prepare the porridge hygienically. Caretakers were also instructed to wash their hands before feeding the child. All children were offered water during the meal and there were no restrictions on breastfeeding prior to or during the test. Breastfeeding 30 minutes prior to serving was registered.

After 30 minutes of observed consumption, caretakers were asked to evaluate the supplementary foods in terms of child appreciation, general perception, taste, colour, odour and texture according to their child's reaction and own perception, based on a 5-point hedonic scale, where 1=dislike very much, 2=dislike, 3=neither like nor dislike, 4=like and 5=like very much. The scale was illustrated in a series of human face symbols with varying degrees of smile or discontent. This is a method previously used to measure food acceptability in illiterate populations (Cohuet et al., 2012; Hess et al., 2011). If children were not able to finish the ration within the 30 minutes, caretakers were asked to estimate the quantity of left-overs.

Three day take-home test (visit2)

After the observed test, participants were given a three-day ration to take home and asked to come back the following week to complete the final questionnaire, which included the same questions as in the observed test. Additionally questions related to acceptability and management of the supplementary foods were included. These questionnaires were developed together with an experienced local research assistant fluent in the local language, Mooré, and familiar with the local culture. She also assisted in training and supervision of the two health workers carrying out the serving and the questionnaires on all participants.

Methodology Part II: Perceptions of foods currently used in the study location

Individual interviews and focus group discussions (FGD) were carried out with caretakers of young children to explore the acceptability of foods currently used for the prevention and treatment of malnutrition in the study location.

2.1 Participants

Participants for this part of the study included both caretakers from the quantitative part of the study and other caretakers of young children. The majority of the participants had personal experience with foods

used for the prevention and treatment of malnutrition, having young children that had either been treated for malnutrition or had benefitted from the regular food distributions at the health centres.

2.2 Design

Purposive sampling was used to ensure that data was as diverse as possible in terms of age and number of children of the caretakers. The number of interviews/FGDs was based on the principle of data saturation, including new participants as long as new themes emerged. The aim was to achieve analytical generalization, so that the emerging information would be comprehensive, complete, saturated and would account for deviant cases. The interviews and FGDs were carried out in Mooré by two research assistants trained for the purpose by the first author and a phenomenological approach was applied as described by Kvale (Kvale, 1996). The interviews and FGDs took place at the health centre or in the village of the participants in a secluded area, and lasted between 20-45 minutes. All interviews and FGDs were carried out following a semi-structured interview guide using open-ended questions within topics related to the perception of treatment of malnutrition in the study location. The interview guide was carefully discussed and developed with the two research assistants prior to the study, to ensure semantic coherence and relevance to the context. All interviews and FGDs were recorded, transcribed and translated from Mooré to French by the two research assistants and from French to English by the first author.

Data analysis

Quantitative data were doubly entered into Epidata 3.1 Software (Epidata Association, Odense, Denmark) and analyzed using Stata 12 (StataCorp, College Station TX, USA). Baseline characteristics, performance and management results of questionnaires from the observed and take-home tests were analyzed using chi-square tests, initially considering contingency tables including all 12 supplementary foods. In addition, pairwise comparisons for 2-by-2 tables were carried out separately within the CSB and LNS groups, respectively. In case comparisons within these two groups were non-significant, an overall comparison was made between CSB and LNS. Differences in frequency of feeding between CSB and LNS were analyzed using analysis of variance. Differences in ratings of the organoleptic acceptability between supplementary foods and visits were analyzed using linear mixed models including product-visit interactions as fixed effects and participant-specific random effects. Additionally, all models were adjusted for age and sex. Likelihood ratio tests were used to evaluate product-visit interactions and, if these were non-significant, separate product and visit effects were estimated. Bonferroni adjustment was applied whenever multiple p-values were considered in an analysis. A significance level of 0.05 was used.

Interviews and FGD were analyzed applying qualitative content analysis as outlined by Graneheim and Lundman (2004). First, each interview and FGD was kept intact and read through several times to obtain a

general sense of the content, searching for common themes and identifying manifest and latent content. From the text, condensed meaning units or portions of the text that were connected to a central meaning were formed and coded for that specific meaning. For example, if caretakers were talking about the abilities of supplementary foods, the specific ability would be coded (i.e; *foods provide health)*. These codes were then assimilated into categories (i.e; *abilities of supplementary foods*) and from these, themes emerged (i.e; *perceptions of supplementary foods*). In line with Graneheim and Lundman, meaning units, codes and categories could fit into more than one theme. Finally, findings from each of the interviews/FGDs were compared with the aim of exploring similarities, differences and patterns. The analysis was carried out with a focus on the subject and the context and an emphasis on differences and similarities found in the data, which is characteristic for the direction of qualitative content analysis described by Graneheim and Lundman. This approach rests on the underlying assumption that "*reality can be interpreted in many different ways and the understanding is dependent on subjective interpretation*". Consequently, a certain degree of interpretation is involved in the analysis of data (Graneheim and Lundman, 2004).

Ethical approval

As part of a larger study, this study was approved by the Ethical Committee for Health Research in Burkina Faso (2012-8-059) and consultative approval was obtained from the Danish National Committee on Biomedical Research Ethics (1208204).

Results

Participants characteristics

180 children and their caretakers were included in the study during a period of four weeks. Randomization resulted in baseline equivalence. The mean age of the children were 14 months (SD ±5), 62% (n=112) were males and 95% (n=171) (95%CI: 92-98%) were breastfed at inclusion. 82% (n=146) were reported healthy at inclusion (95%CI: 76-87%), while 15% (n= 27) and 3% (n=6) reported having light or moderate illness respectively (95%CI: 10-20% and 0.7-6% respectively). All children except one completed both visits of the study (**Table 2**).

For the qualitative part of the study, four FGDs and 11 individual interviews were carried out with a total of 38 caretakers, who were all biological mothers of the children. The mean (SD±) age of the caretakers was 29.1 years (SD±8.3), the mean quantity of children per caretaker was 3.6 (SD±1.9) and number of household members was 12.8 (SD±6.5). 84% (n=32) of the caretakers had no education, 11% (n=4) had attended primary school and 5% (n=2) had attended secondary school.

General appreciation and organoleptic qualities of the new formulations

In **Table 3** organoleptic ratings of all products are listed. In terms of caretaker's general perception and the organoleptic attributes related to odor and color of the supplementary foods, results show mean ratings between 3.8 and 4.1.There was no difference between the supplements, neither in ratings, nor how they were rated from visit 1 to visit 2. Similarly, no difference was found between the supplements in terms of rating of taste. However, there was an increase in this rating from visit 1 to visit 2 (0.23, 95% CI: 0.11-0.35, p=<0.001), which was also seen in the mean rating of the child's perceived appreciation of the supplements (0.18, 95%CI: 0.04-0.31, p=0.012). Ratings of texture changed from visit 1 to visit 2 (p= 0.01), however only for some of the products: For CSB DS 0% (1) ratings increased from visit 1 to visit 2, from 3.5 to 4.0 (95% CI:3.2-3.69 and 95%CI: 3.7-4.22, respectively, p= 0.012). For LNS SI 0% (10), the rating decreased from visit 1 to visit 2. However this difference was not significant after Bonferroni adjustment (P=0.12).

Observed test meal – consumption and leftovers

After 30 minutes of consumption of the supplementary foods, 78% (n=137) of participants had leftovers, with no marked differences between the 12 groups (p=0.21). The total mean of participants breastfeeding their children prior to the test meal were 55% (n=92), and presented no clear difference between the products (p=0.58)

52% (n=73) of participants estimated to have half of the ration left, while 32% (n=45) estimated having half of the meal left. No clear differences between the 12 supplementary foods were found (p=0.12), despite the fact that the ration of CSB (40 g/167 kcal) corresponded to 1/3 of a daily ration, while the ration of LNS (92 g/500 kcal) corresponded to a full daily ration. Regardless of the large proportion of children having left-overs, 74% (n=133) of caretakers said that the quantity to consume was adequate, with no clear difference between the products (p=0.47).

Take home test – consumption and leftovers

The number of caretakers reporting left-overs during the take home test was different between the 12 supplementary foods (p=0.037) and between the CSB and LNS products (p=0.004) (**Table 4**). In the LNS group, 37% (n=33) reported having left-overs at the end of the day, compared to 58% (n=52) of caretakers receiving CSB. In the CSB groups, 46% (n=23) and 44% (n=22) of caretakers reported having less than half or half of the daily ration left, respectively vs 53% (n=17) and 34% (n=11) of caretakers in the LNS groups,

respectively. 10% (n=5) of caretakers in the CSB groups reported having more than half of the daily ration left at the end of the day vs 13% (n=4) in the LNS groups.

Out of the 85 caretakers reporting left-overs, 51% (n=42) stated that another under 5-year-old child ate what was left. 27% (n=22) said that the remains were eaten by the mothers, 15% (n=12) said that it was eaten by an older child (> 5 years), while 7% (n=6) said that it was either thrown out or other.

Administration of the supplementary foods

The reported mean frequency of feeding during the take home test was higher for CSB, than for LNS (**Table 5**). When asked how they perceived the number of times they had been feeding their children with the supplement per day, 83% (n=150) of caretakers said that it had been adequate, while 14% (n=25) thought that it had not been frequent enough. Only 2% (n=4) thought that it had been too much. There was no difference between the 12 supplementary foods (*P=0.23*). The majority of the caretakers (96%) said that the administration of the products was easy, and there was no difference in the perception of administration neither between each of the products nor between the CSB and LNS groups. In the CSB groups, 85% (n=74) of caretakers reported that they preferred a less viscous porridge with a CSB:water-ratio of 1:4, compared to 15% (n=13) who said the preferred a CSB:water-ration of 1:3.

Symptoms of illness after consumption

When asked if the child had been ill following consumption of the supplementary foods, 8% of all caretakers (n=15) reported illness, with no significant difference between the 12 supplementary foods (*P=0.71*). Of the reported illnesses 47% (n=7) was diarrhea, while 13% (n=2) and 7% (n=1) were vomiting and rash respectively. The remaining 33% (n=5) were reported as other symptoms.

Foods used for the treatment and prevention of malnutrition in view

Foods used for the prevention and treatment of malnutrition in the study location included both LNS and CSB products depending on availability. LNS were used for the treatment of severe acute malnutrition, while both LNS and CSB were used for the treatment of MAM and regularly distributed during routine maternal and child healthcare services for the prevention of malnutrition. Both types of foods were perceived as different from traditional/local foods and referred to as "Yombdo" in Mooré which means "wrinkled skin". This is also a word used to describe malnutrition; the largest ethnic group in the study setting, the Mossi people, is known to have a metaphoric and metonymic style of reasoning when defining and categorizing an illness. This way, cause, effect and cure are often grouped together in concrete images, which is used as a way of conceptualizing an illness (Sjaak van der Geest and Meulenbroek, Adèle, 1993).

There were different perceptions of CSB and LNS in terms of the origin of the foods and their respective abilities. Although the ingredients were recognizable and to a large extent familiar in the study location, interviewees emphasized that LNS products were different from local foods. Many believed that it came from the Western part of the world and this was associated with high effectiveness.

> *"If it is this food* [LNS]*, even only with two sachets, the child will be revitalized very fast, but with our local foods, even if you make" Tô" [*local dish of staples*] of millet for the child, you will not see the same results. So you cannot say that it is the same thing, it is not at all the same thing"*
>
> (20-year-old mother of one)

> "*We think it [*LNS*] is peanut butter mixed with oil, but we still think it is the food of the white people*"
>
> (FGD village of Ounon)

CSB products appeared to be more familiar to the caretakers, as the ingredients and the composition of the foods were perceived as similar to local foods and many caretakers thought that CSB could be produced locally. Nevertheless, they believed that the preparation was different and that external aid had been used to refine the foods so that they could be beneficial to the health of the children.

> *"The appearance is a mix of cereals, so this mix must be a combination that tries to improve the health of children…… I don't know how they make it but I think that it [*CSB*] is based on*

our local foods. I think that the composition of the foods includes some of our local crops, and then they have improved it so that it is good for children"

(48-year-old mother of six)

*"You can find healthy foods here but it depends on how you combine it. The white people can transform millet to other things which we cannot. Perhaps the basic building blocks are here, but they have their way of preparing it [*CSB*]. Based on our crops, they are able to make beans, peanut, with lots of vitamins, but we do not know how to do that. Only they know what they are doing and then they send it to us"*

(40-year-old mother of seven)

"*Yes it is possible [*that CSB can be produced here*], the flour used looks like maize flour*"

(FGD village of Ounon)

The perceived abilities of the products also differed. While the LNS products were strongly associated with medicine or perceived as having medicinal properties, no such associations were made for CSB at any point. Some caretakers perceived LNS as being medicine while others perceived them as being foods to improve the child's condition during illness. Finally, some caretakers perceived LNS as being both foods and medicine.

*"…. we believe that it [*LNS*] is a drug, a drug that helps children very much…. This is the drug that saved my child when he was sick"*

(40-year-old mother of six)

"*It [*LNS*] ensures an improvement of his [the child's] condition… this is because it is food*"

(30-year-old mother of four)

*"I believe that it [*LNS*] is both, a drug and food to treat children with malnutrition"*

*(*18-year-old mother of one)

Overall there was a perception that foods used for the prevention and treatment of malnutrition were something that ensured the health of children.

We admire this food that treats our children….. it provides health

(38-year-old mother of five)

These foods are foods for the health

(48-year-old mother of six)

Furthermore, there was a very strong confidence in the foods in terms of their abilities to provide health.

The foods are powerful…… because when eating these foods, the child becomes healthy and strong in no time

(FGD Ounon)

This confidence seemed to be very fundamental. A mother whose child was having diarrhea after consuming LNS products replied the following after being asked if she continued to give the child the foods;

"*How can I do differently? This is what will make him recover"*

(18-year-old mother of one)

Discussion

The primary objective of this study was to evaluate the acceptability of 12 new formulations of supplementary foods for the treatment of MAM with different milk quantity and soy quality. Moreover, we wanted to explore the acceptability of foods currently used for the prevention and treatment of malnutrition in the study location to identify possible barriers for acceptability of new supplementary foods.

All the new supplementary foods received high ratings in terms of caretakers' appreciation, the perceived appreciation by the children and on organoleptic properties. There was no indication that the level of milk or the quality of soy had an impact on these parameters and overall there was little variability in the hedonic ratings. However, this result may not necessarily be conclusive as participants may have been reluctant to give poor ratings, as suggested in other studies (Adu-Afarwuah et al., 2011; Young et al., 2010). Yet, interestingly, ratings increased on certain parameters after the supplementary foods had been tested at home. Children's food preferences are shaped by their early experience, and repeated exposure to foods in a safe and supportive environment increases food preference and acceptance (Birch and Marlin, 1982; Ventura and Worobey, 2013). The fact that the children were exposed to the supplementary foods more than once and that they were fed in their home environment may have increased the acceptability of the foods after the first visit, although the duration of home-feeding was shorter compared to other studies.

Acceptability of foods in terms of organoleptic preferences is difficult to assess in small children: study findings often reflects the taste and food preferences of the caretakers, which may be different from those of the child and which may not even reflect the real opinion, if participants engage in socially desirable responding. Therefore looking at the quantity of left-over may be a useful indicator of acceptability (Adu-Afarwuah et al., 2011; Flax et al., 2010; Owino et al., 2014).

In this study, the majority of caretakers estimated to have half or less of the ration served left following the observed test meal in all groups. In other studies, it has been suggested that acceptability is reached if 50-75% of the meal is consumed (Adu-Afarwuah et al., 2011; Owino et al., 2014). However, as leftovers in this study were based on caretakers' estimation, it may be difficult to compare these findings with other studies, where leftovers have been weighed and calculated by observers(Adu-Afarwuah et al., 2011,Hess et al., 2011). Yet, it is unexpected that the proportion of participants having leftovers was similar in all groups due to the difference in ration served: In the LNS groups a full daily ration of LNS was served (92 g), while in the CSB groups, the meal was rationed into single meals (40 g). It would therefore have been more likely that participants in the LNS groups had leftovers, as they were served a full day's ration in a single meal as oppose to participants in the CSB groups who were served 1/3 of a full days ration. Additionally, more participants in the CSB groups reported left-overs, after having tested the supplementary foods for three days at home, compared to participants in the LNS groups. These findings suggest that the proposed single meal portion size and the recommended daily ration of CSB were difficult for small children to consume and therefore, that the CSB was not consumed as readily as the LNS . This is in line with a previous study (Nackers et al., 2010) comparing the effectiveness of traditional CSB with a therapeutic LNS product (Plumpy'Nut®, Nutriset). It should be noted that no restrictions on breastfeeding were given prior to eating the supplementary foods, which may have influenced the appetite of the children and their ability to consume the ration served. However, these foods are only supplements to the diet and in order not to interfere with current breastfeeding practices, normal breastfeeding practices were encouraged and no restrictions were made at any point during the study.

The difference in leftovers between CSB and LNS is likely due to the fact, that CSB products are less energy-dense and have high bulkiness and volume compared to the high energy dense and low volume LNS products (de Pee and Bloem, 2009). This means that children receiving CSB have to eat several times the mass of food as children treated with LNS (LaGrone et al., 2012). For this reason, smaller and more frequent meals are recommended for less energy-dense diets, in order not to exceed the gastric capacity of the children (Brown et al., 1995). In our study, the mean frequency of feeding for the CSB products was 2.8 meals/day, providing 40 g of CSB per meal and an increase of recommended feeding frequency could be

considered. However, recommending higher frequency of feeding with CSB may be problematic since preparation of the porridge is time-consuming and requires material for cooking in contrast to LNS which can be eaten directly out of the package. Increasing the frequency of feeding for a longer period of time with meals that require a long preparation may not be sustainable and could influence the acceptability in a context where the working day of the caretaker of children is already overloaded and resources are sparse. Surprisingly, the majority of caretakers reported the administration of the supplementary foods to be easy, regardless of the type of product (> 98%) and despite the fact that the frequency of feeding was higher for CSB than for LNS. In addition the frequency of feeding was perceived as adequate (83%) and only 2% of caretakers said that it was too high. Yet, the duration of the take-home test was short compared to other studies and to the average treatment duration of MAM. Consequently, the administration of the supplementary foods may have been perceived less burdensome than if supplementation had continued for a longer period of time.

The qualitative data suggests that similar foods used for the prevention and treatment of malnutrition were well appreciated in the study location, although especially LNS were considered different from local foods. LNS were associated with both medicine or with foods with medicinal properties while no such reference were made for CSB, although it was considered to have been refined and to be beneficial to child health.

Other studies have shown that in Niger, LNS were mainly considered as medicine (Cohuet et al., 2012), while in Malawi both CSB and LNS were considered as foods (Flax et al., 2009) as well as medical treatments (Matilsky et al., 2009). The perception of foods used for the prevention and treatment of malnutrition as having medicinal properties is likely to have an impact on the acceptability. It may confirm the condition of the child as being ill, which enhances the care and adherence to the treatment and can promote the good intentions of the mother to ensure the health of her child (Whyte et al., 2002). These are important factors that could contribute to the acceptability of the supplementary foods, but would need to be explored further.

Both types of products were perceived as beneficial to child health and there was a high degree of confidence in the abilities of the foods, as they were referred to as “powerful” while others said that they made children “strong in no time”. Whyte et al has suggested that the efficacy of medical treatments is much related to the provenance of the product (Whyte et al., 2002). The fact that the foods were perceived to be developed or refined by ”white people”, could have enhanced their perceived efficacy in this context, where there seemed to be a high confidence in western medicine. This may not be applicable to other contexts.

We believe that the findings from the qualitative part of the study supports and qualifies the findings from the quantitative part: The fact that similar foods currently used in the study location for the prevention and treatment of malnutrition were well appreciated and perceived as beneficial to child health, whether they were considered as medicine, foods with medicinal properties or just refined foods, could explain the high level of acceptability of the new formulations.

Limitations

Still, we also acknowledge the limitations of the study. The relatively small sample size could be a limitation inasmuch as only few differences were found to be significant. Thus, the study lacked power to produce but few claims for individual acceptability outcomes. A larger sample size may have enabled us to find more significant differences between products.Yet, it was sufficient to demonstrate an overall proof of concept. Another limitation is that the quantity of left-overs was estimated by the caretakers and not weighed and calculated by observers as has been done in other studies. For the qualitative part of the study, the duration of the interviews and FGDs were relatively short and time to create trust between participants and the interviewers was therefore limited. Furthermore, community-sensitisation and communication regarding the project had been on-going prior to the interviews/FGDs and the non-local research team had been introduced to the local community. This may have influenced participants to respond more positively. Also, the analysis of qualitative data usually involves some degree of interpretation, while the translation from Mooré to French to English may have involved some loss of meaning. Finally, the acceptability was evaluated in healthy children, although the supplementary foods are designed for the treatment of children with MAM. The appetite of malnourished children is often compromised, which influences consumption and thus the acceptability of foods.

Conclusion

Knowing that foods used for the treatment and prevention of malnutrition are nutritionally and scientifically correct is not enough. The way that they are perceived and accepted by beneficiary populations are important factors determining the beneficial effect of a nutritional intervention. The results from this study showed that LNS and CSB products with different quantities of milk and qualities of soy were equally well accepted among healthy children in rural Burkina Faso on organoleptic parameters. However, participants in the CSB groups were less likely to consume the proposed single meal portion size or finish their daily ration. This may be due to the nature of the products, being high bulkiness foods, but it suggests that CSB is not consumed as readily as LNS. Although home testing of the products was shorter

compared to other studies, both CSB and LNS products were perceived as easy to administer and the frequency of feeding was estimated to be adequate. The study also found that foods, similar to the introduced new formulations, currently used for the prevention and treatment of malnutrition in the study location were well appreciated. LNS were to a higher degree associated with medicine or foods with medicinal properties, but both LNS and CSB were perceived as beneficial to child health. Further research is needed to explore the acceptability of new formulations of supplementary foods among children with MAM and to assess how the perception of foods used for the prevention and treatment of malnutrition as having medicinal qualities may affect acceptability.

Acknowledgements

We are grateful to the study participants and their families, our research assistants Ms Albertine Ouédraogo and Mrs Adja Belem and the rest of the staff of the Alliance for International Medical Action (ALIMA) for their valuable contribution to this study. We thank the Ministry of Health in Burkina Faso, the health authorities in Province du Passoré, the village authorities and the staff at the healthcenter in Gonponsom for their support to this study. We furthermore thank GC Rieber Compact A/S for their contribution to the development and production of the experimental supplementary foods. Finally, we thank Médecins Sans Frontières in Norway and Denmark and the Danish International Development Assistance (09-097 LIFE) for funding this study as part of the TreatFOOD project.

Conflict of interest

None declared. Neither the funders nor the manufacturer of the experimental food supplements had any role in the design, implementation, analysis or reporting of the results from this study.

References

Adu-Afarwuah, S., Lartey, A., Brown, K.H., Zlotkin, S., Briend, A., Dewey, K.G., 2008. Home fortification of complementary foods with micronutrient supplements is well accepted and has positive effects on infant iron status in Ghana. Am. J. Clin. Nutr. 87, 929–938.

Adu-Afarwuah, S., Lartey, A., Zeilani, M., Dewey, K.G., 2011. Acceptability of lipid-based nutrient supplements (LNS) among Ghanaian infants and pregnant or lactating women. Matern. Child. Nutr. 7, 344–356. doi:10.1111/j.1740-8709.2010.00286.x

Bahwere, P., Sadler, K., Collins, S., 2009. Acceptability and effectiveness of chickpea sesame-based ready-to-use therapeutic food in malnourished HIV-positive adults. Patient Prefer. Adherence 3, 67–75.

Birch, L.L., Marlin, D.W., 1982. I don't like it; I never tried it: effects of exposure on two-year-old children's food preferences. Appetite 3, 353–360. doi:10.1016/S0195-6663(82)80053-6

Björck, I., Noguchi, A., Asp, N.G., Cheftel, J.C., Dahlqvist, A., 1983. Protein nutritional value of a biscuit processed by extrusion cooking: effects on available lysine. J. Agric. Food Chem. 31, 488–492. doi:10.1021/jf00117a006

Black, M.M., Walker, S.P., Wachs, T.D., Ulkuer, N., Gardner, J.M., Grantham-McGregor, S., Lozoff, B., Engle, P.L., 2008. Policies to reduce undernutrition include child development. Psychol. Child Dev. 1.

Black, R.E., Allen, L.H., Bhutta, Z.A., Caulfield, L.E., de Onis, M., Ezzati, M., Mathers, C., Rivera, J., Maternal and Child Undernutrition Study Group, 2008. Maternal and child undernutrition: global and regional exposures and health consequences. Lancet 371, 243–260. doi:10.1016/S0140-6736(07)61690-0

Black, R.E., Victora, C.G., Walker, S.P., Bhutta, Z.A., Christian, P., de Onis, M., Ezzati, M., Grantham-McGregor, S., Katz, J., Martorell, R., Uauy, R., Maternal and Child Nutrition Study Group, 2013. Maternal and child undernutrition and overweight in low-income and middle-income countries. Lancet 382, 427–451. doi:10.1016/S0140-6736(13)60937-X

Brown, K.H., Sanchez-Griñan, M., Perez, F., Peerson, J.M., Ganoza, L., Stern, J.S., 1995. Effects of dietary energy density and feeding frequency on total daily energy intakes of recovering malnourished children. Am. J. Clin. Nutr. 62, 13–18.

Cohuet, S., Marquer, C., Shepherd, S., Captier, V., Langendorf, C., Ale, F., Phelan, K., Manzo, M.L., Grais, R.F., 2012. Intra-household use and acceptability of Ready-to-Use-Supplementary-Foods distributed in Niger between July and December 2010. Appetite 59, 698–705. doi:10.1016/j.appet.2012.07.019

De Pee, S., Bloem, M.W., 2009. Current and potential role of specially formulated foods and food supplements for preventing malnutrition among 6- to 23-month-old children and for treating moderate malnutrition among 6- to 59-month-old children. Food Nutr. Bull. 30, S434–463.

Flax, V.L., Phuka, J., Cheung, Y.B., Ashorn, U., Maleta, K., Ashorn, P., 2010. Feeding patterns and behaviors during home supplementation of underweight Malawian children with lipid-based nutrient supplements or corn-soy blend. Appetite 54, 504–511. doi:10.1016/j.appet.2010.02.003

Flax, V.L., Thakwalakwa, C., Phuka, J., Ashorn, U., Cheung, Y.B., Maleta, K., Ashorn, P., 2009. Malawian mothers' attitudes towards the use of two supplementary foods for moderately malnourished children. Appetite 53, 195–202. doi:10.1016/j.appet.2009.06.008

Graneheim, U.H., Lundman, B., 2004. Qualitative content analysis in nursing research: concepts, procedures and measures to achieve trustworthiness. Nurse Educ. Today 24, 105–112. doi:10.1016/j.nedt.2003.10.001

Grillenberger, M., Neumann, C.G., Murphy, S.P., Bwibo, N.O., van't Veer, P., Hautvast, J.G.A.J., West, C.E., 2003. Food supplements have a positive impact on weight gain and the addition of animal source foods increases lean body mass of Kenyan schoolchildren. J. Nutr. 133, 3957S–3964S.

Hess, S.Y., Bado, L., Aaron, G.J., Ouédraogo, J.-B., Zeilani, M., Brown, K.H., 2011. Acceptability of zinc-fortified, lipid-based nutrient supplements (LNS) prepared for young children in Burkina Faso. Matern. Child. Nutr. 7, 357–367. doi:10.1111/j.1740-8709.2010.00287.x

Hoppe, C., Andersen, G.S., Jacobsen, S., Mølgaard, C., Friis, H., Sangild, P.T., Michaelsen, K.F., 2008. The use of whey or skimmed milk powder in fortified blended foods for vulnerable groups. J. Nutr. 138, 145S–161S.

Kuusipalo, H., Maleta, K., Briend, A., Manary, M., Ashorn, P., 2006. Growth and change in blood haemoglobin concentration among underweight Malawian infants receiving fortified spreads for 12 weeks: a preliminary trial. J. Pediatr. Gastroenterol. Nutr. 43, 525–532.

Kvale, S., 1996. Interviews. An Introduction to Qualitative Research Interviews. SAGE Publications, Thousand Oaks.

LaGrone, L.N., Trehan, I., Meuli, G.J., Wang, R.J., Thakwalakwa, C., Maleta, K., Manary, M.J., 2012. A novel fortified blended flour, corn-soy blend "plus-plus," is not inferior to lipid-based ready-to-use supplementary foods for the treatment of moderate acute malnutrition in Malawian children. Am. J. Clin. Nutr. 95, 212–219. doi:10.3945/ajcn.111.022525

Lazzerini, M., Rubert, L., Pani, P., 2013. Specially formulated foods for treating children with moderate acute malnutrition in low- and middle-income countries. Cochrane Database Syst. Rev. 6, CD009584. doi:10.1002/14651858.CD009584.pub2

Matilsky, D., Maleta, K., Castleman, T., Manary, M., 2009. Supplementary Feeding with Fortified Spreads Results in Higher Recovery Rates Than with a Corn/Soy Blend in Moderately Wasted Children. J. Nutr. 139, 773–778.

Ministere de la Santé, Burkina Faso, Direction de la Nutrition. Rapport Enquete Nutritionnelle Nationale, 2013.

Nackers, F., Broillet, F., Oumarou, D., Djibo, A., Gaboulaud, V., Guerin, P.J., Rusch, B., Grais, R.F., Captier, V., 2010. Effectiveness of ready-to-use therapeutic food compared to a corn/soy-blend-based pre-mix for the treatment of childhood moderate acute malnutrition in Niger. J. Trop. Pediatr. 56, 407–413. doi:10.1093/tropej/fmq019

Owino, V.O., Irena, A.H., Dibari, F., Collins, S., 2014. Development and acceptability of a novel milk-free soybean-maize-sorghum ready-to-use therapeutic food (SMS-RUTF) based on industrial extrusion cooking process. Matern. Child. Nutr. 10, 126–134. doi:10.1111/j.1740-8709.2012.00400.x

Paul, K.H., Dickin, K.L., Ali, N.S., Monterrosa, E.C., Stoltzfus, R.J., 2008. Soy-and rice-based processed complementary food increases nutrient intakes in infants and is equally acceptable with or without added milk powder. J. Nutr. 138, 1963–1968.

Rowe, J.P., Brodegard, W.C., Pike, O.A., Steele, F.M., Dunn, M.L., 2008. Storage, preparation, and usage of fortified food aid among Guatemalan, Ugandan, and Malawian beneficiaries: a field study report. Food Nutr. Bull. 29, 213–220.

Sjaak van der Geest, Meulenbroek, Adèle, 1993. Metaphors, Metonyms and Homeopathy: Terms of Illness and Therapy among Mossi People in Burkina Faso. Congrés Eur. Kolloqu. Ethnopharmakologie 285–290.

Suarez, F.L., Springfield, J., Furne, J.K., Lohrmann, T.T., Kerr, P.S., Levitt, M.D., 1999. Gas production in human ingesting a soybean flour derived from beans naturally low in oligosaccharides. Am. J. Clin. Nutr. 69, 135–139.

Ventura, A.K., Worobey, J., 2013. Early influences on the development of food preferences. Curr. Biol. CB 23, R401–408. doi:10.1016/j.cub.2013.02.037

Wang, R.J., Trehan, I., Lagrone, L.N., Weisz, A.J., Thakwalakwa, C.M., Maleta, K.M., Manary, M.J., 2013. Investigation of Food Acceptability and Feeding Practices for Lipid Nutrient Supplements and Blended Flours Used to Treat Moderate Malnutrition. J. Nutr. Educ. Behav. 45, 258–263. doi:10.1016/j.jneb.2012.08.001

Whyte, S.R., Geest, S. van der, Hardon, A., 2002. Social Lives of Medicines. Cambridge University Press.

World Health Organization, 2012. World Health Organization. Technical note: supplementary foods for the management of moderate acute malnutrition in infants and children 6-59 months of age.

615 Young, S.L., Blanco, I., Hernandez-Cordero, S., Pelto, G.H., Neufeld, L.M., 2010. Organoleptic properties,
616 ease of use, and perceived health effects are determinants of acceptability of micronutrient
617 supplements among poor Mexican women. J. Nutr. 140, 605–611. doi:10.3945/jn.109.113498
618
619

620 **Tables**

Table 1. Food composition table of the 12 experimental supplementary foods

		WHO Technical Note	CSB per 120 g[4]								LNS per 92 g			
Product	**Unit**	**2012[23]**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**
Energy	Kcal	500	**500 kcal**								**500 kcal**			
Fat	g	12.5-32.5	11,4	11,7	11,4	11,4	11,4	11,4	31,6	31,5	32,1	31,4	31,5	31,4
Protein	g	10-21.5	16,8	16,5	16,5	15,9	16,2	16,5	13,5	13,5	13,1	12,5	12,8	13,1
Soy quality[5]			Flour	Flour	Flour	Isolate	Isolate	Isolate	Flour	Flour	Flour	Isolate	Isolate	Isolate
DSM[6]	%		0	8	20	0	8	20	0	8	20	0	8	20
Calcium	mg	500-700	600								600			
Iron	mg	9[7] -15[8]	12								12			
Magnesium	mg	140-210	175								175			
Phosporus[9]	mg	425-700	563								563			
Potassium	mg	750-1100	925								925			
Sodium	mg	max 250	<250								<250			
Zinc	mg	10-17.5	14								14			
Copper	mg	0.5-1.8	1.15								1.15			
Manganese	mg	0.5-1.0	0.75								0.75			
Selenium	µg	17.5-45	31.5								31.5			
Iodine	µg	75-175	125								125			
Vitamin C	mg	> 75	188								94			
Thiamin B1	mg	> 0.5	1.0								0.65			
Riboflavin B2	mg	> 2.0	3.0								2.5			
Niacin	mg	> 12.5	20.2								15.5			
Pantothenic acid	mg	> 2.5	4.5								3.2			
Vitamin B6	mg	>	1.8								1.25			
Folic acid	µg	> 200	300								250			
Biotin	µg	> 10	13.8								12.5			

[2] The specifications are calculated as an example when food supplements provide 70% of energy. Note. This is not a recommendation that food supplements should constitute 70% energy intake of MM children. The formulation is such that it would be safe and effective if the quantity taken by MM children represented 100% energy needs and it would also provide benefit, though of a lesser order of magnitude, if taken in lower quantities(World Health Organization, 2012)

[3] The energy density of food supplements when they are ready to be consumed (i.e. cooked foods ready for consumption or ready-to-use foods) should be not less than 0.8 kcal/g(World Health Organization, 2012)

[4] Some of the water soluble vitamins have been overdosed, in order to compensate for the degraded vitamins during preparation of CSB (GC Rieber Compact A/S)

[5] Flour = Dehulled soya flour; Isolate = Soy protein isolate

[6] Percentage of total weight

[7] assuming a 10 % bioavailability(World Health Organization, 2012)

[8] assuming a 5% bioavailability(World Health Organization, 2012)

[9] excluding Phosphorus from phytate because it is not bioavailable(World Health Organization, 2012)

Vitamin B 12	µg	2.5	4.1	3.15
Retinol	µg	1000 - 1500	1375	1250
Vitamin E	mg	> 15	22.8	19
Vitamin D	µg	10-30	22.0	20
Vitamin K	µg	25	34.7	31.5

621

622

Table 2. Baseline characteristics among 180 children

Product	CSB						LNS					
Soy quality	Dehulled Soy			Soy Isolate			Dehulled Soy			Soy Isolate		
DSM %	0% (1)	20% (2)	50% (3)	0% (4)	20% (5)	50% (6)	0% (7)	20% (8)	50% (9)	0% (10)	20% (11)	50% (12)
Participants	15	15	15	15	15	15	15	15	15	15	15	15
Age (months) mean (±SD)	13 ±5	15 ±5	12 ±6	14 ±6	15 ±7	15 ±5	15 ±5	14 ±5	13 ±5	15 ±6	16 ±5	12 ±5
Males % (n)	73(11)	53(8)	40(6)	67(10)	73(11)	80(12)	67(10)	60(9)	40(6)	80 (12)	47(7)	67(10)
Breastfeeding % (n)	100(15)	100(15)	100(15)	93(14)	93(14)	100(15)	93(14)	87 (13)	93(14)	100(15)	80(12)	100(15)
Health status at inclusion[10]												
Healthy % (n)	86(13)	86(13)	87(13)	79(11)	66(10)	93(14)	80(12)	73(11)	73(11)	80(12)	93(14)	80(12)
Light illness, no medication % (n)	7(1)	7(1)	13(2)	7(1)	27(4)	7(1)	20(3)	27(4)	20(3)	20(3)	7(1)	20(3)
Moderate illness, medication but no hospitalization % (n)	7(1)	7(1)	0	14(2)	7(1)	0	0	0	7(1)	0	0	0

[10] Missing data on one participant in the CSB SI 0%-group

Table 3. Estimated mean perception (scale from 1 to 5[11]) of the 12 experimental foods at two visits

Product		CSB						LNS						Mean per visit	95% CI	P-values		
Soy quality		Dehulled Soy			Soy Isolate			Dehulled Soy			Soy Isolate							
DSM (%)		0% (1)	20% (2)	50% (3)	0% (4)	20% (5)	50% (6)	0% (7)	20% (8)	50% (9)	0% (10)	20% (11)	50% (12)			product-visit interaction♦	product main effect♣	visit main effect♠
Child's appreciation	Visit 1	3.7	3.8	3.7	4.1	4.0	4.1	3.6	4.1	4.1	4.3	4.1	4.1	4.0	[3.9-4.1]	0.63	0.24	*0.012*
	Visit 2	4.1	4.3	4.1	4.1	4.2	4.3	4.0	3.9	4.3	4.1	4.3	4.2	4.2	[3.9-4.4]			
General perception	Visit 1	4.1	3.9	4.1	4.2	4.1	4.0	4.0	4.1	4.3	4.1	4.1	4.1	4.1	[3.9-4.2]	0.4	0.11	0.66
	Visit 2	4.1	4.1	4.1	3.9	4.0	4.1	4.0	4.0	4.3	4.0	4.1	4.1	4.1	[4.0-4.1]			
Taste	Visit 1	3.8	3.5	3.8	3.9	3.5	3.8	3.8	3.9	4.1	3.8	3.9	4.0	3.8	[3.7-3.9]	0.48	0.23	*<0.001*
	Visit 2	4.1	4.1	4.0	4.2	4.0	3.8	3.9	3.9	4.1	4.0	4.3	4.1	4.0	[3.8-4.3]			
Odor	Visit 1	4.0	3.7	3.9	3.7	4.0	4.1	3.9	3.9	3.9	3.9	4.0	4.0	3.9	[3.9-4.0]	0.68	0.86	0.8
	Visit 2	4.0	4.0	3.9	3.9	3.9	3.9	4.0	3.9	3.9	3.8	3.8	3.9	3.9	[3.8-4.1]			
Colour	Visit 1	4.2	4.1	4.1	4.1	3.8	4.1	3.9	4.0	4.2	4.0	4.1	3.9	4.0	[4.0-4.1]	0.66	0.27	0.09
	Visit 2	4.0	4.0	4.0	4.0	4.0	4.0	4.0	3.9	4.0	3.9	4.0	3.8	4.0	[3.9-4.1]			
Texture	Visit 1	3.5	3.6	3.9	3.9	3.9	3.7	3.7	3.7	3.9	4.1	3.8	3.6	3.8	[3.7-3.8]	*0.01*	-	-
	Visit 2	4	4	3.9	4	4	4	3.9	3.7	3.9	3.7	4	3.8	3.9	[3.8-4.1]			

623

[11] Organoleptic ratings on a 5 point hedonic scale where 1=dislike very much, 2= dislike, 3=neither like or dislike, 4 =like, 5= like very much

♦ Evaluation of differences between combinations of product and visit effects by means of linear mixed models with adjustment for age and sex and differences between children (random effects) .

♣ In case product-visit interaction is non-significant, evaluation of differences between products (also using linear mixed models)

♠ In case product-visit interaction is non-significant, evaluation of differences between the two visits (also using linear mixed models).

Table 4. Leftovers during take home test on 179 children

Product		**CSB**						**LNS**							
Soy quality		**Dehulled Soy**			**Soy Isolate**			**Dehulled Soy**			**Soy Isolate**				
DSM %		**0%**	**20%**	**50%**	**0%**	**20%**	**50%**	**0%**	**20%**	**50%**	**0%**	**20%**	**50%**	**Total**	**P-value**
		(1)	**(2)**	**(3)**	**(4)**	**(5)**	**(6)**	**(7)**	**(8)**	**(9)**	**(10)**	**(11)**	**(12)**		
Left-over at the end of the day	% (n)	67 (10)	53 (8)	64 (9)	60 (9)	47 (7)	60 (9)	67 (10)	27 (4)	47 (7)	40 (6)	13 (2)	27 (4)	48 (85)	*0,037*
CSB vs LNS		58 (52)						37 (33)							*0.004*
Quantity of left-over	< than half	40 (4)	37.5 (3)	45 (4)	62.5 (5)	43 (3)	50 (4)	40 (4)	75 (3)	50 (3)	50 (3)	100 (2)	50 (2)	49 (40)	
	half	50 (5)	37.5 (3)	33 (3)	37.5 (3)	57 (4)	50 (4)	30 (3)	25 (1)	50 (3)	33 (2)	0	50 (2)	40 (33)	*0.84*
	> than half	10 (1)	25 (2)	22 (2)	0	0	0	30 (3)	0	0	17 (1)	0	0	11 (9)	

Table 5. Administration of products during take-home test on 179 children

Product		**CSB**	**LNS**		
Frequency of feeding/day,	Mean (Std. Err)	2.8 (0.08)	2.3 (0.07)		*0.000*
Administration of the products % (n)	difficult	1 (1)	0	0.6 (1)	
	indifferent	1 (1)	0	0.6 (1)	
	easy	96 (84)	97 (85)	96 (169)	
	very easy	2 (2)	3 (3)	2.8 (5)	*0.5*

624