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Full Length Research Paper

Sensory characteristic of corn soya blend and the effects of milk protein replacement

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In the effort to reduce child malnutrition fortified blended foods, especially corn soya blend (CSB), are used as food aid. CSB is a porridge powder consisting of maize and soya flour fortified with vitamins and minerals. Evidence suggests that a substitution of the soya flour with milk proteins would have nutritional benefits. The present study describes the sensory characteristics of four formulations of CSB porridge including CSB with milk proteins either as skimmed milk powder or whey protein. A trained expert panel (n = 7) evaluated the CSBs with descriptive sensory attributes in terms of odor, color, texture, flavor and taste. Addition of milk protein increased the sweetness and flavor of cream cheese of the CSB. Original CSB was perceived as greyer, less yellow and more mealy/dry than CSB with milk proteins. The color of CSB with milk proteins was perceived as greenish and yellowish depending on whether skimmed milk powder or whey protein was added, respectively. The sensory characteristics, especially the sweet taste, of the new formulation of CSB with milk proteins could be positive in terms of acceptability in children. Acceptance testing of this formulation with the target groups is recommended.

Key words: Fortified blended foods, corn soya blend, skimmed milk powder, whey protein concentrate, sensory characteristics, sweetness.

INTRODUCTION

Malnutrition remains a major problem in most low-income countries causing 2.2 million deaths for children less than 5 years of age (Black et al., 2008). Children receiving complementary foods based on cereals and root crops are especially vulnerable to malnutrition, because these foods are characterized by poor protein quality, low energy density as well as inadequate micronutrient content. To combat malnutrition, Fortified Blended Foods (FBFs), mainly Corn Soya Blend (CSB), are widely distributed as food aid to moderately malnourished children aged 6 months to 5 years and to children at risk of malnutrition. Original CSB consists of corn and soya flour fortified with a micronutrient premix and is usually consumed as porridge (World Food Programme, 2002). CSB has been discussed to be nutritionally inadequate to moderately malnourished children due to its content of anti-nutrient factors (phytate, tannins and antitrypsin), suboptimal micronutrient and the lack of animal protein (Pee and Bloem, 2008). Evidence from observational and

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Abbreviations: CSB, Corn soya blend; **FBF,** fortified blended food; **MN premix,** micronutrient premix; **PC,** principal component; **PCA,** principal components analysis, **QDA,** quantitative descriptive analysis; **RUFT,** ready-to-use-therapeutic-foods; **SMP,** skimmed milk powder; **WFP,** World Food Program; **WPC,** whey protein concentrate.

Table 1. Formulations of corn soya blend (CSB) given in % of the respective porridge constituents. The micronutrient premix (MN premix) as well as the milk protein contents (either skimmed milk powder (SMP) or whey protein concentrate (WPC)) varied between the porridges.

Porridges	Name in plots	Maize flour	Soya flour	MN premix	SMP	WPC 34%
CSB (original)	CSB VIT	77	20	3	-	-
CSB without MN premix	CSB	80	20	-	-	-
CSB + SMP	CSB VIT SMP	77	5	3	15	-
CSB + WPC	CSB VIT WPC	77	5	3	-	15

intervention studies indicates that animal foods and milk in particular are important for linear growth and development of young children as reviewed by Hoppe et al. (2006). This has initiated a discussion on addition of milk powders to CSB (Pee and Bloem, 2008). Milk powder is a major ingredient in therapeutic foods used to treat severe acute malnutrition. Energy dense pastes, the so called ready-to-use-therapeutic-foods (RUTFs), are used for community based treatment of severe acute malnutrition and have shown a higher weight gain in children and a shorter length of stay in supplementary feeding programs compared to CSB (Patel et al., 2005; Nackers et al., 2010). Whether this effect is due to the milk protein fraction or other nutrients is still not known. Based on the evidence and the success with RUTFs it has been proposed to reformulate the recipe for CSB (Patel et al., 2005). In a recent review, it was suggested to substitute a quantity of the soya protein with animal protein sources such as Whey Protein Concentrate (WPC) or Skimmed Milk Powder (SMP) in order to improve the nutritional value as well as the sensory characteristic of CSB (Hoppe et al., 2008). Sensory characteristics of a given food cover the perception of appearance, texture, odor, flavor and mouth feel which in turn influence the acceptability and intake of the product (Cardello et al., 2000). Today, original CSB has been reformulated by WFP into a new product containing sugar, oil and dried skimmed milk (CSB plus plus) (World Food Program, 2009a). There is no studies available reporting on the sensory characteristics of the CSB with or without milk proteins. Therefore, there is a need for studies addressing the measurement of sensory properties of CSB products and their acceptance by the end users in supplementary feeding programs. Sensory characterization studies would support the assumption that CSB with milk proteins improve flavor, odor and appearance (Hoppe et al., 2008; World Food Program, 2009a).

This study aimed to describe the sensory characteristics of four formulations of CSB porridge. In particular, the degree by which the sensory characteristics were affected by replacing soya flour in original CSB by 15% (w/w) WPC or SMP as recommended by Hoppe et al. (2008). A descriptive sensory analysis methodology using a trained sensory panel was applied.

MATERIALS AND METHODS

Sample preparation

CSB porridges were prepared according to four different formulations (Table 1). In CSB with SMP or WPC soya flour was substituted with milk protein to give a milk powder content of 15% (w/w). The substitution was in accordance with the recommendations by Hoppe et al. (2008). The CSB porridges were prepared and cooked in the sensory kitchen from maize flour (Urtekram International A/S, Mariager, Denmark) purchased in a local supermarket. Soya flour and vitamin-mineral mix were provided by Compact A/S (Bergen, Norway), while skimmed milk powder and whey protein concentrate were provided by Arla Foods (Århus, Denmark). The ingredients were weighed and stirred into tap water in the ratio 1:2. A small saucepan was heated at medium heat for two minutes and subsequent mixture of CSB and water were added while stirring to prevent lumps. When the porridge simmered and became stiff (approximately 2-4 min cooking) the saucepan was taken off the heat and the porridge was stored in stainless steel containers with lid to prevent skin formation. The preparation was done as close to two hours upon sensory evaluation as possible. The porridges cooled to room temperature (22°C) before serving to the sensory panel.

Subjects

Seven panelists (1 male, 6 females) were selected from a trained sensory panel at Department of Food Science, University of Copenhagen. The panellists were selected according to ISO 3972:1991. They had completed a general training in participating in sensory testing and demonstrated an ability to perceive and describe differences among the five basic tastes as well as among products from different food categories.

Sensory evaluation

Descriptive sensory analysis derived from Quantitative Descriptive Analysis (QDA®) (Stone and Sidel, 2004) was chosen to identify and quantify the sensory properties of the four CSB porridges. The method included training of panellists, development of a descriptive language and a sensory evaluation of the CSB porridges. Training of the panel led by a panel leader (passive) served to describe the porridges and their properties by means of attributes and to achieve panel consensus. The attributes were all defined by the panel and divided into groups of odor, color, texture, flavor and taste during plenum discussions directed by the panel leader (Table 2). In addition to the descriptive language, a frame of references representing each attribute was used in order to learn and distinguish the attributes from each other as well as to standardize the development of the sensorial language of the porridge samples (Table 2). The sensory evaluation was carried out in a sensory room with booths for each panelist. The room was equipped

Table 2. The sensory attributes arranged into groups of odor, color, texture, flavor and taste. Each attribute was rated on a 15 cm scale anchored from “Nothing → a lot” or “A little → a lot” according to a frame of references.

Group	Attribute	Scale	Reference
Odor (O)	Maize porridge	Nothing → a lot	75 g maize flour (Urtekram International A/S, Mariager, Denmark) in 200 ml tap water
	Boiled milk	Nothing → a lot	Full-fat milk (Øllingegård, Skævinge, Denmark) cooked for one hour at low heating
	Rye crisp oat	Nothing → a lot	Whole grain cereal breakfast product (Quaker Oats Scandinavia)
	Nut-like	Nothing → a lot	Chopped hazelnuts and paranuts (COOP Denmark A/S)
	Broth	Nothing → a lot	One cube of chicken broth (Knorr, Unilever Denmark A/S) in 500 ml boiling water, strained and diluted 1:2.
	Fresh grape seed oil	Nothing → a lot	Grapeseed oil (COOP Denmark A/S)
	Sawdust	Nothing → a lot	Sawdust
	Chemical	Nothing → a lot	Plastic film
	Rancid	Nothing → a lot	Oils that have been exposed to sunlight
Color (C)	Yellow	A little → a lot	-
	Grey	Nothing → a lot	-
	Green	Nothing → a lot	-
Texture (TX)	Gritty	A little → a lot	-
	Mealy/dry	Nothing → a lot	-
Flavor (F)	Maize porridge	Nothing → a lot	75 g maize flour (Urtekram International A/S, Mariager, Denmark) in 200 ml tap water
	Rye crisp oat	Nothing → a lot	Whole grain cereal breakfast product (Quaker Oats Scandinavia)
	Nut-like	Nothing → a lot	Chopped hazelnuts and paranuts (COOP Denmark A/S)
	Fresh grape seed oil	Nothing → a lot	Grapeseed oil (COOP Denmark A/S)
	Cream cheese	Nothing → a lot	Cream cheese (Kraft Foods Denmark ApS)
	Rancid	Nothing → a lot	Oils that have been exposed to sunlight
Taste (T)	Sweet	Nothing → a lot	7 g of saccharose in 1000 ml tap water
	Umami	Nothing → a lot	0.80 g monosodium-glutamate in 1000 ml tap water
	Sour	Nothing → a lot	“Ymer” (a cultured milk product), (Arla Foods, Denmark)
	Bitter	Nothing → a lot	0.04 g Quinine monohydrochloride in 1000 ml water. Diluted 1:5 with tap water.

according to ISO 8589:2007. A 15 cm unstructured line scale with words anchoring each end of the scale was used to evaluate all attributes. Each attribute was scored according to its intensity between “nothing” (0 cm) to “a lot” (15 cm) or “a little” (0 cm) to a “a lot” (15 cm). Odor, flavor and taste were evaluated in relation to a frame of references whereas colour and texture were relative to the colour and texture of the other porridges, respectively. The porridges were served in a randomized order (latin square) and were presented to the panelists in portions of approximately 400 ml. All samples were labelled with a three-digit code and evaluated in triplicates in the same session. The attributes of odor was evaluated by tipping the lid and sniffing. Color was evaluated by placing the sample on a white paper and looking vertically down. Texture was evaluated by taking a spoonful of the porridge into the mouth and pressing it up in the palate with the tongue and finally flavor and taste were evaluated by taking a spoonful of the porridge into the mouth and chewing and holding it for 5 s. The panelists were requested to clean their mouth with cucumber and water before each evaluation of the porridges.

Statistical analysis

The panelist performance was analyzed using Panel Check (www.panelcheck.com). The analysis of the panel performance (on raw data, seven panelists and three replicates) in Panel Check revealed no panelists outliers (data not shown). No modifications were made in the raw data prior to further data analysis.

The sensory profiling data were further analyzed by ANOVA proc mixed models (SAS version 9.2, The SAS Institute Inc., Cary, NC, USA). The intensity of each sensory attribute was tested for systematic effect of sample (CSB porridges), replicate (three replicates) and the interaction sample*replicate. The factor panellist was set as a random effect in the model. For all significant attributes, the porridge effects were assessed using pair-wise comparisons based on SAS least square (LS) means. The criteria for significance was $p<0.05$.

Principal Components Analysis (PCA) was applied to explore similarities and differences between the sensory profiles of the four CSB porridges in a multivariate space. Correlations were examined with CSB porridges as objects and the panel x replicate averaged attribute scores as variables. The sensory variables were auto scaled (1/SD) in order to give variables equal weight in the model. The program LatentiX (version 2.00, Latent5, Copenhagen) was used for the analysis.

RESULTS

The sensory characterization of the four formulations of CSB porridges revealed distinct differences depending on the kind of milk protein and vitamin addition. The sensory panel was able to discriminate the porridge samples in terms of the perceived odor, color, texture, flavor and taste. The mean intensity ratings (±SEM) for the sensory attributes are shown in Table 3. Neither the replicates nor the interaction between replicate and porridge were significant.

Odor

All four porridges had the odor of maize porridge, nut-like, fresh grape seed oil and sawdust. The porridges differed significantly in intensity of the odors rye crisp oat and broth. CSBs without milk protein had the highest intensities of rye crisp oat odor. It was most pronounced for original CSB. CSB with skimmed milk powder had the lowest intensity of the rye crisp oat odor. CSB with skimmed milk powder had the highest intensity of broth odor of all samples.

Color

The porridges differed significantly in their visual appearance. CSB without micronutrient premix (MN premix) and CSB with whey protein were very similar in appearance; they were perceived as yellow, slightly grey and not green. This was opposite to the original CSB and CSB with skimmed milk powder; these samples were perceived as less yellow (6.2-6.9 on a 0-15 scale) than the two other porridges. They were also perceived as more grey and greener than CSB without MN premix and CSB with whey protein. The grey and green color was scored in the range 5.4-7.0 and 4.8-6.6 for all samples, respectively. The only significant color difference between the original CSB and the CSB with skimmed milk powder was that the latter was scored as being less grey.

Texture

The texture of the CSB porridges as perceived in the mouth differed for the attributes gritty and mealy/dry. Original CSB was perceived as the grittiest and the mealiest/driest porridge tested. Original CSB was significantly grittier than CSB without MN premix; furthermore it was significantly mealier/drier than the three other CSB porridges.

Flavor

Among the flavors perceived in the porridges, the attributes rye crisp oat, cream cheese and rancid were different between the porridge samples. Original CSB had the highest intensity of rye crisp oat of the four porridges, this was, however, only significantly higher than for CSB without MN premix. This porridge had more odor of rye crisp oat than flavor. In fact, CSB without MN premix was scored to have the lowest intensity of all flavor attributes, indicating that this porridge was the least flavor intense sample. CSB with milk proteins (both SMP and WPC) had the highest intensity of the cream cheese flavor, this significantly higher than CSB without MN premix. Only CSB with skimmed milk powder was scored significantly higher than original CSB. Original CSB was the significantly most rancid sample of the four; however the score was fairly low: 1.3 on the scale from 0 to 15.

Taste

The CSB porridges with milk proteins had an overall sweet taste (9.4-10.1 on a 0-15 scale) and were not perceived as bitter (2.0-3.7 on a 0-15 scale). Substitution of soya flour with the two different milk proteins increased the sweet taste significantly. CSB with skimmed milk powder or whey protein were not significantly different in sweetness. The most bitter porridge was the original CSB, this was significantly more bitter than CSB with skimmed milk powder. The latter porridge sample was the least bitter tasting of the four porridges.

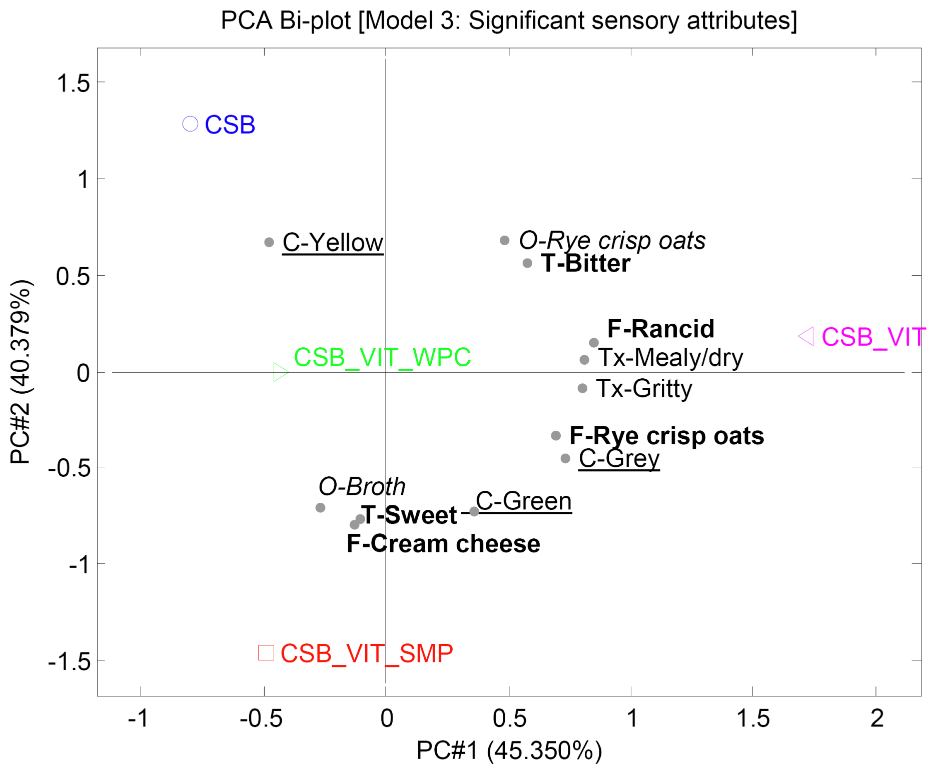

Figure 1. PCA bi-plot (PC2 vs. PC1) of significant sensory attributes of the four Corn Soya Blend (CSB) porridges. Attributes are depicted according to their group (odor (O), color (C), texture (TX), flavor (F) and taste (T)). The four porridges are colored: CSB without micronutrient premix (CSB), original CSB (CSB_VIT), CSB with skimmed milk powder (CSB_VIT_SMP), CSB with whey protein (CSB_VIT_WPC).

Principal components analysis (PCA)

The results from the PCA are shown as a combined scores and loadings plot in Figure 1. The model is based on the sensory attributes that were significant in the ANOVA (highlighted in Table 3). Approximately 45% of the total variance in the data was explained by the first Principal Component (PC) and PC2 explained 40%. In the PCA plot attributes and/or samples placed in close proximity and in the same direction are positively correlated.

From Figure 1 it can be seen that CSB without MN premix had the most negative score for PC1 whereas original CSB had the most positive score. CSB with milk proteins was placed in between. PC2 shows that CSB without MN premix is placed the most far away from CSB with skimmed milk powder. The mealy/dry and gritty texture is related to a flavor of rancid and rye crisp oat that correlated with original CSB. The sweet taste was related to a green appearance, cream cheese flavor and odor of broth correlating with CSB with skimmed milk powder.

Original CSB was perceived to have a more gritty texture, a more rancid and rye crisp oat flavor and more green and greyish appearance than CSB without MN premix.

A porridge with less intense rye crisp oat odor, more yellowness and less grey and green color was obtained when soya was replaced by 15% (w/w) WPC. In addition, the texture became less mealy/dry and the taste was less rancid and sweeter.

The porridge also became less intense in rye crisp oat odor and less grey when SMP partly replaced the soya. This sample also had a more intense broth odor than original CSB. The rancidity decreased and sweetness increased. CSB with skimmed milk powder had higher cream cheese flavor intensity and less bitter taste than original CSB.

DISCUSSION

Substitution of soya with whey protein or skimmed milk powder in CSBs altered the sensory characteristics of the formulations. Addition of milk proteins to CSB increased sweetness and the flavor of cream cheese in comparison with original CSB. Also, the color became less grey and more yellow, however, a greenish appearance was found for CSB with skimmed milk powder.

Table 3. The mean intensity ratings ± SEM (scale 0-15, continuous) of sensory attributes of Corn Soya Blend (CSB) porridges: CSB without micronutrient premix (CSB), original CSB (CSB VIT), CSB with skimmed milk powder (CSB VIT SMP) and CSB with whey protein concentrate (CSB VIT WPC).

Group	Attribute	CSB VIT (original)	CSB	CSB VIT SMP	CSB VIT WPC	Product effect (p value)
Odor (O)	Maize porridge	10.2 ± 0.5	9.9 ± 0.7	10.5 ± 0.5	11.3 ± 0.4	NS
	Boiled milk	3.6 ± 0.6	3.0 ± 0.5	4.5 ± 0.7	3.8 ± 0.6	NS
	Rye crisp oat	8.5 ± 0.7[a]	8.1 ± 0.5[ab]	5.8 ± 0.6[c]	6.3 ± 0.8[bc]	0.0015
	Nut-like	6.2 ± 0.7	4.8 ± 0.6	5.7 ± 0.8	5.9 ± 0.6	NS
	Broth	2.6 ± 0.5[b]	2.8 ± 0.4[b]	4.3 ± 0.6[a]	2.5 ± 0.4[b]	0.0056
	Fresh grape seed oil	4.7 ± 0.6	4.1 ± 0.7	5.3 ± 0.7	4.2 ± 0.5	NS
	Sawdust	4.1 ± 0.6	5.7 ± 0.9	3.9 ± 0.6	4.4 ± 0.6	NS
	Chemical	1.0 ± 0.2	0.8 ± 0.2	1.2 ± 0.4	0.8 ± 0.2	NS
	Rancid	1.0 ± 0.3	0.8 ± 0.2	1.1 ± 0.3	0.6 ± 0.2	NS
Color (C)	**Yellow**	6.9 ± 0.6[b]	12.9 ± 0.4[a]	6.2 ± 0.6[b]	11.6 ± 0.4[a]	<0.0001
	Grey	7.0 ± 0.7[a]	2.5 ± 0.4[c]	5.4 ± 0.5[b]	3.7 ± 0.5[c]	<0.0001
	Green	4.8 ± 0.7[a]	0.5 ± 0.2[b]	6.6 ± 0.8[a]	1.1 ± 0.3[b]	<0.0001
Texture (TX)	**Gritty**	6.9 ± 0.6[a]	4.2 ± 0.8[b]	4.8 ± 0.5[b]	5.6 ± 0.7[ab]	0.0038
	Mealy/dry	9.5 ± 0.8[a]	7.4 ± 0.8[ab]	7.4 ± 0.9[ab]	6.8 ± 0.8[b]	0.04
Flavor (F)	Maize porridge	9.6 ± 0.3	9.5 ± 0.5	9.8 ± 0.5	10.5 ± 0.4	NS
	Rye crisp oat	6.4 ± 0.6[a]	4.1 ± 0.7[b]	5.22 ± 0.6[ab]	5.8 ± 0.6[ab]	0.04
	Nut-like	5.8 ± 0.7	4.5 ± 0.7	6.2 ± 0.7	5.8 ± 0.7	NS
	Fresh grape seed oil	4.3 ± 0.7	4.6 ± 0.8	4.7 ± 0.7	4.9 ± 0.7	NS
	Cream cheese	3.8 ± 0.5[bc]	2.3 ± 0.5[c]	5.9 ± 0.8[a]	5.7 ± 0.7[ab]	<0.0001
	Rancid	1.3 ± 0.4[a]	0.7 ± 0.2[b]	0.6 ± 0.2[b]	0.7 ± 0.2[b]	0.0052
Taste (T)	**Sweet**	6.5 ± 0.8[b]	4.4 ± 0.6[b]	10.1 ± 0.5[a]	9.4 ± 0.6[a]	<0.0001
	Umami	4.4 ± 0.7	3.1 ± 0.6	3.9 ± 0.6	4.0 ± 0.6	NS
	Sour	2.0 ± 0.5	1.8 ± 0.5	2.0 ± 0.4	1.8 ± 0.4	NS
	Bitter	4.4 ± 0.7[a]	3.4 ± 0.7[ab]	2.0 ± 0.4[b]	3.7 ± 0.6[ab]	0.021

Attributes highlighted in bold have significant product effect in the ANOVA proc mixed model. NS refers to a non-significant p value of greater than 0.05. Within each attribute, any two means not sharing the same letter differ significantly from each other (p<0.05) in a pair-wise comparison based on SAS least square (LS) means.

Sensory changes in taste and flavor

The present study showed that the sensory characteristic of original CSB was affected when replacing soya flour by 15% (w/w) milk protein powder. The dominating sensory attributes of CSB with milk protein (either as skimmed milk powder or whey protein) were the flavor of cream cheese and sweet taste. The increased sweetness could be positive in relation to palatability (Perez et al., 1994). The sweet taste could derive from the relatively high lactose levels (approximately 50 g/100g) in both skimmed milk powder and whey protein (Hoppe et al., 2008).

Sensory changes in color

The two different sources of milk protein seemed to affect the odor and appearance of CSB differently. The perceived greenish appearance of CSB with skimmed milk powder supports previous observations of correlations between low milk fat content and greenish appearance (Phillips et al., 1995). CSB with whey protein was perceived as being significantly more yellow than CSB with skimmed milk powder. The yellowish appearance of a product with added whey has also been found in a study evaluating the sensory change in yoghurt when milk powder was substituted with whey (Gonzalés-Martínez et al., 2002). In comparison, original CSB was characterized by a greyish, yellow appearance in which green color also dominated. The difference in the perceived appearances among the porridges could be explained by different light reflection of the proteins that is, casein in skimmed milk powder, beta-lactoglobulin and alpha-lactalbumin in whey and different proteins in soya flour (Berlitz et al., 2004). Appearance could be important for initial choice/rejection of foods. The altered appearance into more yellow or green color of CSB in which soya is substituted with whey or skimmed milk powder, respectively, could thus have an effect on acceptance. It would therefore be relevant to investigate acceptance levels for moderately malnourished children and children at risk of malnutrition who are the target groups of CSB distribution.

Sensory changes in odor

CSB with skimmed milk powder had a significantly stronger "broth-like" odor than the other CSB formulations. This can be explained by the sensory characteristic of the skimmed milk powder. In an earlier study, where a descriptive sensory language for skimmed milk powders was developed, potato/broth was a frequently noticed aromatic attribute (Drake et al., 2003). Whether this attribute is positive or negative in terms of acceptance will need further investigation. However, it is suggested that an odor of broth may be associated with meat or vegetables and hereby providing a distinct odor to CSB with milk proteins in contrast to the odor of the typical cereal based diets in low-income countries.

Sensory characteristic of vitamin/mineral fortification

A typical concern in mineral fortified foods such as original CSB is to overcome unwanted sensory changes (Hurrell, 2002). The present study shows, that the sensory characteristic of original CSB is affected by the fortification of vitamin and minerals. The more greyish appearance and more rancid flavor of original CSB may be due to iron, which can cause off-coloring and rancidity due to oxidation processes (Hurrell, 2002).

The process of encapsulation is believed to prevent some of the unwanted sensory changes related to food fortification. However, the iron used in original CSB may not be encapsulated as it is costly and not specified in the CSB protocols provided by WFP (Pee and Bloem, 2008; World Food Program, 2002, 2009b).

The sensory attributes ascribed to mineral fortification are less pronounced when a quantity of soya is substituted with skimmed milk powder and whey protein in CSB. However, for all four CSB porridges the perceived rancidity was of relatively low intensity (0.6-1.3 on a 0-15 scale).

Potential acceptance of CSB with milk protein

Recently, original CSB has been reformulated by WFP into a new porridge containing sugar, oil and dried skimmed milk (CSB plus plus) (World Food Program, 2009a). This new formulation of CSB increases the energy density and is used as a complement to breastfeeding in young children between 6-24 months of age. CSB plus plus is described by WFP to have a "pleasant smell, palatable taste and typical color which young children will like and enjoy" (World Food Program, 2009a). In relation to the present findings, the sweet taste and yellow color of CSB with milk proteins, especially of CSB with whey protein, could meet these porridge requirements. The sweet taste is suggested to have a positive effect in terms of acceptability in children. This is supported by the fact that humans are born with innate preferences for sweet taste and energy dense foods, whereas sour and bitter tastes are rejected (Steiner, 1974; Kern et al., 1993). Sensory attributes of foods are highly correlated with liking (the acceptance of foods) (Saba et al., 1998). Affective testing of CSB with milk protein is needed to determine whether CSB with milk proteins is sensory accepted and whether skimmed milk powder is preferred over whey protein.

Conclusion

The present study showed that CSB porridge was perceived as sweeter when soya flour was replaced by 15% (w/w) skimmed milk powder or whey protein. The sensory characteristics of CSB with milk proteins could be positive in terms of acceptability in children. Acceptance testing of this formulation with the target groups is recommended.

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