Effect of extrusion cooking and amylase addition to gruels to increase energy density and nutrient intakes by Vietnamese infants

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Title: Effect of the processes (extrusion cooking and/or amylase addition) used to increase energy density of gruels on energy and nutrient intakes of 7 to 10-month-old Vietnamese infants

Short running title: *Effect of processes on intakes of young children…*

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ABSTRACT

Extrusion cooking and α-amylase addition are two processing methods used for the preparation of high energy density (ED) gruels of suitable consistency. A quantitative study of energy and nutrient intakes of 67 infants aged 6 to 10 months in rural areas in Vietnam was carried out to compare the effects of these processes used alone or in combination. Twice a day, for a period of four days each, infants successively ate four gruels prepared from different flours based on a blend of rice, sesame and soybean: an instant flour obtained by extrusion cooking (gruel A), a ready-to-cook flour obtained by extrusion cooking plus α-amylase addition (gruel B), a flour produced by milling crude rice, sesame and roasted soybean plus α-amylase addition (gruel C) and without amylase (control gruel D). Gruels A, B and C had a high ED of respectively 94, 122 and 124 kcal/100 g while the control gruel D had a low ED (59 kcal/100 g). The intakes of the four gruels were inversely linked to their ED. However, despite the fact that gruels B and C had similar ED, larger intakes were obtained with gruel B, which was attributed to better acceptability. The average energy intakes of high ED gruels A, B and C, respectively 112, 134 and 117 kcal/meal, were significantly higher than that of gruel D (81 kcal/meal). Of the three processing methods, the one combining extrusion cooking and amylase addition gave the best results in terms of gruel acceptability and energy intake.

Key Words: Instant flour, ready-to-cook flour, α-amylase, energy density, energy intake.

INTRODUCTION

In the developing world, 32% (178 million) of children under five (WHO standards) still suffer from stunting.[1] In Vietnam remarkable progress has been made in reducing child undernutrition in the last two decades, and, as a consequence, the prevalence of stunting decreased from 59.7% in 1985 to 27.9% in 2006 (NCHS standard). However, malnutrition is still a major public health concern in Vietnam, and the government has implemented a national plan of action to accelerate the reduction of stunting.[2] One of the necessary conditions to protect young children from malnutrition is that households have access to affordable complementary foods of appropriate energy and nutrient densities in addition to breast milk. Studies conducted in the framework of the Fasevie programme demonstrated that it is possible to produce nutritious infant flours from local raw materials using different processes: extrusion cooking with a very low cost extruder (VLCE) designed in collaboration with a Vietnamese institute (Centre of Technological Transfer and Consultancy-CTC) or the addition of amylase.[3,4] By enabling partial starch hydrolysis, these processing methods enable the preparation of high energy density gruels.

The effects on quantity and energy intake of feeding children with high energy density gruels have been described in many studies in different countries.[5-9] However, the effect of the type of processing methods used to produce the infant flours that enable the preparation of high energy dense gruels has not been investigated.

The objective of this study was to measure the intakes (in quantity, energy and nutrients) of gruels prepared from flours produced by three processing methods: extrusion cooking, amylase addition, or a combination of the two, compared to those of a minimally-processed gruel prepared from a flour made of crude or roasted raw materials without extrusion cooking or amylase addition.

SUBJECTS, MATERIALS AND METHODS

Recruitment of participants

The study was conducted in two villages in the vicinity of Tam Ky town in Quang Nam province. Before launching the study, a meeting was organized by the coordinator to inform local authorities (village chiefs, health workers, and a representative of the women's union) about the objectives and activities of the study.

All infants aged from six to 10 months during the period planned for the study in the two villages were invited to participate in a general health examination at the municipal health center. A total of 82 infants were eligible, i.e. were still breastfed, were not severely malnourished (weight-for-height and height-for-age z-scores>-3) and their parents were willing to bring them to the canteen located nearest their home twice a day throughout the study period. A letter explaining the objectives and the organization of the study was sent to parents who had to give their written consent. The parents were then invited to come to a meeting during which the objectives and the activities of the study were presented. Written consent was obtained from the mother (or father) of each infant. Nine canteens were set up that could receive around eight infants each day. They were open every day from 7 to 10 a.m. and from 3 to 6 p.m.

During the study, of the 82 eligible infants, 15 (18.3 %) did not eat the gruel regularly because they were sick (5), or because the caregivers were too busy (7) or because the family had relocated far away from Tam Ky (3). Finally, data from 67 infants were used for analyses. For ethical reasons, children excluded for health reasons were allowed to continue to eat the gruels like the other infants.

The protocol of the study was approved by the ethical committee of the National Institute of Nutrition, in Vietnam.

Study protocol

Infants were fed four types of gruels -one type twice a day- for four consecutive periods of four days (Table 1). The gruels were prepared by the canteen staffs who were previously trained for the purpose.

Composition and preparation of the infant flours

The composition on a dry basis of the four infant flours before adding sugar and amylase was based on the same blend of rice (62.2%), sesame (5.9%), soybean (18.5%), milk

powder (11.5%) and other ingredients, among which a mineral and vitamin premix (1.9%). The blend was designed to obtain gruels with nutrient densities that meet the latest international recommendations for young children (Table 2).[10,11] In order to obtain gruels of the same sweetness level, which is assumed to influence their acceptability[12], their sugar content on a dry basis was calculated so that the sugar content on a wet basis was 3.23 g/100 g of gruel using the targeted dry matter (DM) content of the gruel.
The four types of flour, A, B, C and D, were produced using same batches of rice, sesame and soybean. Flour A corresponded to the instant infant flour *Favina* (Fasevie programme), produced by extrusion cooking of a blend of rice and sesame with addition of roasted soybean and other ingredients. Gruel A was prepared using the instant procedure, i.e. by adding water at 75°C. Flour B was a ready-to-cook flour resulting from the extrusion cooking of the blend of rice, soybean and sesame, and addition of the other ingredients. An industrial powdered α-amylase (BAN 800MG, Novo) was added at a rate of 0.001% to obtain the partial starch hydrolysis required for the preparation of gruel of high ED and appropriate semi-liquid consistency. Flours C and D were prepared by blending crude rice, sesame and roasted soybean. BAN amylase was also added at a rate of 0.006% to flour C to enable the preparation of gruel of high ED. Gruels B, C and D were prepared by bringing the mix of water plus flour to the boil over gentle heat and then boiling it at 100°C for 5 min in the case of flour B, and for 10 min in the case of flours C and D. The slow increase in temperature enabled the action of amylase on gruel starch and boiling ensured the inactivation of the enzyme.[13] Gruel D corresponded to the minimally-processed gruel that was used as control.

Extrusion cooking of the rice-sesame mix (flour A) or rice-sesame-soybean mix (flour B) was performed using a VLCE EX-800, which is a simple single-screw autogenous extruder developed by the Fasevie programme[3,4] and manufactured by CTC in Vietnam. Soybean hulls were removed in a DH20 dehuller (CTC, Vietnam) and when necessary (flours A, C and D), the soybeans were roasted. Extrudates, roasted soybeans or blends of crude rice and sesame were ground and blended in adequate proportions (particle size < 0.5 mm). The resulting flours were then mixed with the other ingredients of the formula (i.e. sugar, milk powder, vitamin and mineral premix, $CaCO_3$, milk aroma, and when required, BAN amylase). The cost of the different flours was estimated taking into account raw materials and production costs (Table 2). The cost of flours A and B produced by extrusion cooking was slightly higher than that of flours C and D, but this additional cost remained limited thanks to the use of the VLCE produced in Vietnam. One batch of each type of flour was produced at the beginning of the study and packed in individual sachets containing the quantity required to prepare a bowl of gruel for one child (300 g). The sachets were then stored until use.

The four types of flours -along with their appropriate preparation procedure- enabled the production of the gruels A, B, C and D, with the targeted dry matter content, energy density and consistency shown in Table 3.

Preparation and distribution of gruels

In each of the nine canteens, the appropriate gruel was prepared by using the number of sachets equal to the number of children present and the corresponding quantity of water. The canteen staff poured about 300 g of gruel into a previously coded and weighed bowl, and the mothers were asked to spoon-feed the gruel to their child *ad libitum*. Clean pre-weighed serviettes were given to the mothers to collect any gruel their infant did not consume. Trained personnel, selected among local volunteers, weighed the child, the bowl and the serviette before and after the consumption of the gruel by the child (0.1 g precision), and were ready to intervene in case a child choked on the gruel.

Samples of each prepared gruel were collected for the determination of DM content (by dehydration in an oven until constant weight) and Bostwick flow measurements at 45°C, according to the method described by Mouquet et al.[14]

Nutritional value of infant flours

Samples of each of the four infant flours were collected for biochemical analyses. Protein content (N x 6.25) was determined by the method of Kjeldahl (standard NF. V03-050).[15] Lipids were extracted with ether oil using the HT6 Soxtec system (Tecator, Höganäs, Sweden) according to the official AOAC method 2003.06.[16] Insoluble fibre (Acid Detergent Fibre, ADF) contents were determined by the method of Van Soest[17] using a Dosi-fiber (Selecta, Barcelona, Spain). Ash contents were determined by calcination in a furnace at 530°C. Available carbohydrates were calculated by difference (100 - proteins - lipids - ADF - ash). Energy contents of the infant flours were then calculated using Atwater coefficients: 4 kcal/g DM (16.7 kJ/g DM) for proteins and available carbohydrates and 9 kcal/g DM (37.6 kJ/g DM) for lipids. Mineral (calcium, iron and zinc) contents were determined by atomic absorption spectrophotometry (SpectrAA 200, Varian, Victoria, Australia). All analyses were made in duplicate and the two values averaged. The energy content and main nutrient composition of each study infant flours are listed in Table 2.

Data management and statistical analysis

Data management and statistical analyses were carried out using SAS software (version 9.1; SAS Institute, Cary, NC, USA). The association between the canteen (from 1 to 9) and the characteristics of the gruels (DM content and Bostwick flow) was assessed by analysis of variance. Concerning intakes, linear mixed models (the MIXED procedure of SAS) were used to evaluate the effect of the type of gruel (A, B, C or D), the day rank of the diet period (from day 1 to day 4), the age of children (in months), the number of the canteen (from 1 to 9) and the time of day the meal was eaten (morning or afternoon) - the last variable was included only for the outcomes expressed per meal. Each model was adjusted for the number of the period (1 to 4) and for all other factors studied. Interactions between the type of gruel and the day rank of diet, the period, the age, and the time of day of the meal were also included. The primary response variables were the amount of gruel consumed and the energy intake (EI) expressed in g or kcal per kg of body weight (BW) and per meal or per day. Different nutrient intakes were also calculated and analyzed. When appropriate, Tukey's test was performed to examine the pairwise levels of significance. In all comparisons, differences were considered significant when $p < 0.05$.

RESULTS

Characteristics of infants

Among the 67 study subjects, 32 were male and 35 female. The mean age of the study subjects was 7.84 ± 1.33 months and their mean body weight was 7.79 ± 1.22 kg. All children were still breastfed during the study as this was a criterion for inclusion.

Characteristics of study gruels prepared in the canteens

The mean DM content and corresponding ED of the study gruels as well as the mean Bostwick flow as an indicator of the consistency are listed in Table 3. All values were close to those obtained in the laboratory (targets). Thus, as expected, the dry matter content and the Bostwick flow of gruels B and C did not differ significantly. For dry matter content, the standard deviation was low, indicating a relatively good control of the methods of preparation of gruels by the canteen staff. Concerning Bostwick flow, its variability was remarkably low for gruel D, but higher for the three high ED gruels A, B and C. Indeed, the increase in ED is based on partial starch hydrolysis during processing, and the extent of starch hydrolysis obtained through extrusion cooking or amylase action depends greatly on the processing conditions. It may also have been difficult to thoroughly control the temperature of gruel during the measurements made at the canteens and it is known that the consistency of highly concentrated gruels is highly dependent on temperature.[14]

Despite satisfactory control of the preparation of the different types of gruel, there was a significant effect of the canteen on both DM content and Bostwick flow for the three high ED gruels. In most cases, a higher Bostwick flow was linked to a lower DM content. The effect of the canteen can possibly be explained by the know-how of the canteen staff or the environmental conditions when water was being heated for the preparation of the instant flour A, or during cooking of gruels B and C, which may have had an effect on the quantity of water that evaporated.

Amounts of gruel consumed and energy intakes

Influence of the day of the period

Neither the effect of the day ($p = 0.46$), nor the interaction of day with the type of gruel ($p = 0.64$) were significant. As a result, this variable was removed from the models.

Influence of the canteen

The effects of the canteen on the amount of gruel consumed and energy intake were both highly significant. This can be partially explained by differences in the characteristics of gruels due to the way the canteen staff prepared them, but also by the atmosphere of each canteen (from whether the canteen staff smiled or not, or the layout of the canteen facilities).

Influence of the age of the child

The effect of the age of the child on the amount of gruel consumed per meal was not significant ($p = 0.67$) (interaction non significant $p = 0.57$).

Influence of the time of day of the meal

Children received two meals of gruel per day, the first in the morning, and the second in the afternoon. The analysis of the effect of the rank of the meal in the day revealed significant differences ($p = 0.018$) between the two meals, the mean amount of gruel consumed being slightly higher during the second meal of the day. This difference was approximately the same for each type of gruel (interaction between rank of the meal and type of gruel was non significant $p = 0.51$).

Influence of the type of gruel

Mean amounts of gruel consumed and energy intakes expressed per meal or per day are shown in Table 4. The effect of the type of gruel was highly significant ($p < 0.0001$) for all outcomes. The largest amount consumed was obtained with the low ED gruel (D) and the amount was significantly lower in the case of the three high ED gruels (A, B and C). Despite this reduction, energy intakes were significantly higher in the case of the three high ED gruels compared to that of the low ED gruel (Table 4). Thus, the energy intake from the two meals of gruel during the day increased by 38%, 66% and 44% for gruels A, B and C respectively, compared to that of gruel D. There were also some differences between the three high ED gruels: the mean amounts of gruels prepared from flours produced by extrusion cooking consumed were significantly higher than that of gruel C prepared from flour with addition of amylase but without any extrusion cooking. And this was true even in the case of gruel B which had the same ED as gruel C. Consequently, the energy intake of gruel B was significantly higher than that of the other two high ED gruels, A and C.

The mean percentages of recommended energy intake were calculated for each type of gruel taking into account the latest figures for total energy requirements[18] and low and average energy intake from breast milk[19] (Table 5). Considering average breast milk intake, the consumption of gruels A, B or C provided on average more than 100% and at least 72% of the total energy requirements, respectively, for infants aged 6-8 months and 9-11 months, but only 79% and 56% in the case of gruel D. These figures were much lower when low breast milk intake was taken into account, in this case suggesting the need to increase the frequency of meals. By looking at individuals, only a few children among the 67 in our study were able to cover 100% of the recommended energy intake from complementary foods when only consuming the gruel twice a day. Among the 6 to 8-month-old children, nearly half managed when consuming high ED gruels A, B, C and considering average breast milk intake, but very few children in the 9 to 11-month-old group did. When children get older, the contribution of breast milk decreases, and more than two meals of gruel per day are needed in addition to other foods such as snacks. The increase in DM content by using processing that partially hydrolyses starch in order to obtain high ED gruel has also the considerable advantage of increasing the intake of all the nutrients contained in the infant flour. Thus, in our study, as shown in table 4 for a few examples of nutrients, the nutrient intakes from the high ED gruels A, B and C were substantially higher than those from gruel D. With two meals of gruel D, only the protein requirements were fully satisfied whereas the mean calcium intake only just reached the minimum of the range of recommended daily intake, which means that about half the children did not have sufficient calcium intake. With the high ED gruels, the highest mean nutrient intakes were obtained with gruel B prepared from the flour produced by extrusion cooking and the addition of amylase, values for protein and calcium intakes being significantly higher than those of the three other gruels. Compared to the recommendations for daily nutrient intakes from complementary foods, on average, two meals of gruel A, B or C provide enough nutrients to cover 100% of lipid, protein, calcium and iron requirements.

DISCUSSION

The main objective of this study was to compare energy and nutrient intakes from gruels whose ED was increased using three processing methods (extrusion cooking, addition of amylase or both) and against a low ED gruel as control. Before we comment on the differences between the intakes of the four types of gruel, it should be noted that the mean amount of gruel consumed per meal ranged from 11.8 to 17.7 g/kg of BW and was consequently much lower than the assumed functional gastric capacity of children estimated at 30 g/kg of BW, which is the value most calculations are based on when recommendations for complementary feeding are established.[19,20] However, even lower values have been reported in other contexts.[7,12,21] In these studies as well as in ours, children were fed *ad libitum* and decided by themselves when to stop eating. This suggests that filling the gastric capacity may not be the only factor that determines satiety in children.

The reducing effect of the increase in gruel ED on the amount consumed observed in our study has often been reported and authors also all observed a consecutive increase in energy intakes.[6,7,9] Generally, the amount consumed is inversely linked to the concentration (and therefore to the ED) of the gruel, as was the case with gruels D, A and C in our study. However, the amount of gruel B consumed was higher than that of gruel C although there was no significant difference between the characteristics of the two gruels, either in DM content or in Bostwick flow. Consequently, the difference in the amounts consumed can be attributed to better acceptability or appetence of gruel B, produced by extrusion cooking. During the study, canteen staff also reported that gruel C was not accepted by the children or their mothers as well as the other types of gruel. Indeed, the many biochemical reactions that occur during the extrusion cooking step have been reported to improve the palatability of cereal and soybean based products.[22,23] Finally, energy intakes from gruel B prepared by extrusion cooking and addition of amylase were significantly higher than that of gruel A prepared only by extrusion cooking, due the lower ED of the latter (94 vs. 122 kcal/100 g for gruel B), and also slightly higher than that of gruel C prepared only by addition of amylase, due to lower acceptability.

Despite the fact that the infant flour B is not instant and requires a short cooking time that may be perceived as a little more constraining by caregivers, the addition of amylase enables the preparation of a very high ED gruel, significantly higher than the gruel prepared with the instant flour (A). In addition, in contexts where the good hygienic quality of the water is not always ensured, which is the case in many developing countries, the short cooking time needed is a guarantee that the children will receive a safe gruel. Compared to gruel C with only amylase added, the required cooking time for gruel B was shorter, which led us to qualify this type of flour of “ready-to-cook”. The additional production cost due to the use of extrusion cooking (+ 9.5 % compared to flour C) remains reasonable thanks to the use of a VLCE. But it could be higher if other types of single screw extruders are used.

In conclusion, the three different processing methods (extrusion cooking using a VLCE, addition of amylases, or both) used for the preparation of high energy density gruels from a fortified rice-sesame-soybean blend proved to be efficient in increasing energy and nutrient intakes by children, compared to a simpler processing method without an extrusion cooking step or the addition of amylase. Among the three processing methods tested, the one that combined extrusion cooking and the addition of amylase resulted in the highest intakes due to higher ED associated with better acceptability. Thus the preparation of ready-to-cook infant flour by combining extrusion cooking and amylase addition is a new way of using the VLCE that may extend its use for the production of nutritious infant flours beyond Vietnam to other developing countries.

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AUTHOR DISCLOSURES

Nguyen Van Hoan, Claire Mouquet-Rivier, Sabrina Eymard-Duvernay, Serge Trèche, no conflicts of interest.

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Table 1. Study design

		Period 1				Period 2				Period 3				Period 4			
	Day of consumption†	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4
Canteens 1, 2	19 infants	Gruel A				Gruel C				Gruel B				Gruel D			
Canteens 3, 4	13 infants	Gruel B				Gruel A				Gruel D				Gruel C			
Canteens 5, 6	13 infants	Gruel C				Gruel D				Gruel A				Gruel B			
Canteens 7, 8, 9	22 infants	Gruel D				Gruel B				Gruel C				Gruel A			

†Two meals of gruel per day, one in the morning, one in the afternoon

Table 2. Nutritional value and estimated cost of flours used in the studyafter adjusting sugar content

	Type of gruel			
	A Instant	**B** Extruded + BAN	**C** Raw + BAN	**D** Raw
Nutritional value (per 100 g DM†)				
Energy value (kcal)	425	423	429	423
Protein (g)	14.6	14.4	15.2	13.5
Lipid (g)	8.5	8.1	9.3	7.7
Calcium (mg)	259.3	282.6	276.2	242.3
Iron (mg)	20.6	22.0	26.0	23.3
Zinc (mg)	7.7	8.4	9.8	8.6
Cost of flour including raw material and production cost (US $ per kg)	1.27	1.27	1.16	1.07

†DM = dry matter

Table 3. Characteristics of the gruels distributed to the infants

			Type of gruel			
			A Instant *n = 72*	**B** Extruded + BAN *n = 72*	**C** Raw flour + BAN *n = 72*	**D** Raw flour *n = 72*
Dry matter content (g/100 g of gruel) †	*targeted*		*22.0*	*29.0*	*29.0*	*14*
	measured	Mean ± SD	$22.2^{b} \pm 1.1$	$28.8^{c} \pm 1.7$	$29.0^{c} \pm 1.9$	$13.9^{a} \pm 0.8$
Energy density (kcal/100 g of gruel)	*targeted*		*93.5*	*124*	*124*	*59*
	measured	Mean	94.4^{b}	121.8^{c}	124.4^{c}	58.8^{a}
Bostwick flow (mm/30 s)	*targeted*		*65*	*95*	*95*	*65*
	measured	Mean ± SD	$68^{a} \pm 21$	$96^{b} \pm 13$	$94^{b} \pm 20$	$65^{a} \pm 3$

† Values in a row with different superscript letters are significantly different, $p < 0.05$

Table 4: Mean amounts of gruel, energy and nutrient intakes as a function of the type of gruel†

	Type of gruel				Recommended daily intake from complementary foods§
	A	B	C	D	
	Instant	Extruded + Ban	Raw flour + Ban	Raw flour	
Amount of gruel‡					
(g/meal)	118.4 ± 2.5^{b}	110.0 ± 2.6^{b}	93.4 ± 2.6^{c}	140.8 ± 2.5^{a}	
(g/kg BW/meal)	15.1 ± 0.3^{b}	13.8 ± 0.3^{c}	11.8 ± 0.3^{d}	17.7 ± 0.3^{a}	
(g/day)	238.1 ± 6.5^{b}	220.7 ± 6.6^{b}	186.7 ± 7.0^{c}	283.2 ± 6.5^{a}	
Energy intake‡					
(kcal/meal)	111.8± 2.6^{b}	134.3 ± 2.6^{a}	116.7 ± 2.7^{b}	80.8 ± 2.6^{c}	
(kcal/kg BW/meal)	14.1 ± 0.3^{b}	16.8 ± 0.4^{a}	14.7 ± 0.4^{b}	10.1 ± 0.3^{c}	
(kcal/day)	224.8 ± 6.7^{b}	269.5 ± 6.8^{a}	233.5 ± 7.1^{b}	162.7 ± 6.6^{c}	*176*
Lipid (g/day)§	4.5 ± 0.1^{b}	5.1 ± 0.1^{a}	5.1 ± 0.1^{a}	2.9 ± 0.1^{c}	*4.8*
Protein (g/day)	7.7 ± 0.2^{b}	9.2 ± 0.2^{a}	8.3 ± 0.2^{b}	5.2 ± 0.2^{c}	*3.0 - 4.5*
Calcium (mg/day)	139.1 ± 4.2^{b}	178.9 ± 4.3^{a}	142.7± 4.6^{b}	100.7 ± 4.2^{c}	*100 – 200*
Iron (mg/day)	11.0 ± 0.4^{b}	14.6 ± 0.4^{a}	13.6 ± 0.4^{a}	9.0 ± 0.4^{c}	*11*

† $p < 0.0001$ for all outcomes. All values are mean ± std error, adjusted for canteen, period, and meal (only in the case of data expressed /meal).
‡ Values in a row with different superscript letters are significantly different, $p < 0.05$ (Tukey's test).
§ For infants aged 6-11 months with average breast milk intakes (Lutter and Dewey[11]).

Table 5. Energy requirements from complementary foods and mean percentage of recommended energy intake as a function of the type of gruel (taking into account 2 meals/day)

Age group		6-8 months		9-11 months	
Total daily energy requirements (kcal/day) †		**615**		**686**	
		Low BME	*Average BME*	*Low BME*	*Average BME*
BME intake (kcal/day) ‡		217	413	157	379
Energy required from CF§ (kcal/day)		**398**	**202**	**529**	**307**
gruel A	*n*	*47*		*20*	
	Mean % of REI-CF§	57	113	42	72
	Number of children whose intake ≥ 100% of REI-CF§¶	3	24	1	4
gruel B	*n*	*44*		*20*	
	Mean % of REI-CF§	65	128	53	92
	Number of children whose intake ≥ 100% of REI-CF§¶	8	25	1	8
gruel C	*n*	*43*		*20*	
	Mean % of REI-CF§	58	115	45	77
	Number of children whose intake ≥ 100% of REI-CF§¶	3	23	0	6
gruel D	*n*	*45*		*20*	
	Mean % of REI-CF§	40	79	32	56
	Number of children whose intake ≥ 100% of REI-CF§¶	0	10	0	1

† Butte et al.[18]; ‡ WHO[19]
§recommended energy intake from complementary foods (REI-CF)
¶ taking into account the mean intake for the four days of consumption