

STRATEGIES TO IMPROVE COMPLEMENTARY FEEDING: EXPERIENCES FROM OTHER COUNTRIES

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INTRODUCTION

In most countries malnutrition appears after the age of about 6 months when complementary foods has to be introduced. Prevalence of malnutrition reaches a maximum when children are about fifteen to twenty months old. Thus malnutrition seems to be strongly linked to the introduction of complementary foods.

This relation between complementary foods and malnutrition can be direct or indirect. The relation is direct when the main causes are insufficient energy or micronutrient absorption due to insufficient complementary food intakes or nutritional value. It can be indirect in some cases: first, when the introduction of complementary food is too early and reduces breast-milk intakes; secondly, when complementary foods are not safe and are responsible of foodborne diseases as diarrhoea or parasitic infections; third, when complementary foods reduce the nutrient bioavailability of the whole diet (Brown et al., 1997).

According to the physiological development of children at the age when malnutrition appears, an particular attention must be made to special transitional foods that is to say liquid or semi liquid foods as gruels. Consequently, strategies to improve complementary feeding must make accessible to infants safe foods with good nutritional value and also enhance a good utilisation of these foods.

1. WHAT SHOULD BE CONSIDERED ?

1.1. Quality of food

The qualities required for special transitional foods are safety, accessibility and nutritional value.

First, special transitional foods must be safe. Safety of complementary foods can be defined as assurance that they will not cause harm to infants and young children when they are prepared and given to infants according to their intended use. Special transitional foods must be free from biological, as bacteria, viruses and parasites, and chemical contaminants as heavy metals, pesticide, drug residues and mycotoxins.

Second, they must be accessible to infants and young children. Their accessibility depends mainly on three conditions:



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- their price must be sufficiently low to be purchased by mothers or the ingredients must be easily available if they are home prepared;
 - they must be easy to prepare into gruels because mothers are often very busy and do not accept to spend a lot of time for gruel preparation
 - they must have organoleptic characteristics well accepted by the children and their mothers.
- When complementary foods consist in gruels, the consistency of these gruels is of particular importance. In most contexts, infants are able to consume sufficient quantity of gruels only when they have a low viscosity. In addition as infants consume more rapidly liquid or semi-liquid gruels, mothers need less time to feed them which represents a considerable advantage.

Third, they must have a good nutritional value, that means (i) to have a sufficient energy density, (ii) to have sufficient nutrient contents, (iii) and these nutrients have to be bioavailable.

The importance of energy density had to be emphasised because low energy density can enable infants, who have limited gastric capacity, to ingest sufficient quantities of food, even if available, to satisfy their energy and nutrient requirements (Trèche, 1996). Energy requirement and breast milk intake of children of different groups of age are reported table 1. From these data it is possible to calculate the energy needed per day from complementary food and to estimate the minimum energy density at various frequencies taking into account the average gastric capacity of child evaluated to 30 ml per kg of body weight. When children with low breast-milk intake receive two meals per day which is the most frequent feature, energy density of meals should be above 94 kcal/100 ml for 6 to 9 month-old infant and 118 kcal/100 ml for 9 to 12 month-old infants. That means that gruels prepared from centrally produced infant flours should have an energy density of about 120 kcal/100 ml to permit to meet the energy requirement of most of the infants.

Desired nutrient density of complementary foods have been recently estimated in a state of art paper on complementary feeding (Brown et al., 1997) (table 2). Because breast milk provides less than a half of the corresponding infant needs after 6 months, complementary foods must have relatively high density for some vitamin as vitamin D, vitamin K, niacin, riboflavin and thiamine and some minerals as iron, zinc, phosphorus, manganese, magnesium, calcium and sodium. As the density of iron, Zinc and calcium in complementary foods are usually less than desired, it appears that they can be considered as the most important problem nutrients. In addition although vitamin A density is usually adequate, it should be also considered as nutrient problem because mothers with inadequate vitamin A intakes and stores secrete very low quantity of this vitamin in their breast milk.

Concerning nutrient bioavailability, the necessity to take into account the possible presence of antinutritional factors, as phytate which are often complexed with essential minerals, has to be underlined (Besançon, 1995).

1.2. Ways of utilisation

Beside the quality of foods, the ways with which they are utilised should be considered when elaborating strategies to improve complementary feeding. Two points are of particular importance: the age at introduction and feeding frequency.

It is now well established that complementary feeding introduction before the age of about 6 months is not useful and can have reverse effects as reduction of breast milk intake or apparition of foodborne diseases (Motarjemi et al., 1993). Consequently, strategies to improve

complementary feeding have to promote an appropriate age of introduction of complementary foods taking eventually into account specific constraints of each contexts.

The other important point is feeding frequency because it is not possible to develop estimates of adequate energy density of complementary foods without simultaneously considering the frequency of feeding. Some studies have demonstrated that energy intake increase both with energy density of gruels and their feeding frequency (Brown et al., 1995). Consequently, before elaborating a strategy for a given context, usual feeding frequency must be studied and taken into account.

1.3. The two possible type of strategies

In most situations, two types of strategy can be proposed. The first type consists in the central production and promotion of infant flours which are sold or distributed to children. During the past forty years all experiences of large scale production in developing countries have failed. Consequently, small scale production at cottage industry level is generally proposed by the organisations interested in infant flour production (Dijkhuizen and Würdemann, 1995). The second type of strategy consists in transferring at the household or community level simple technologies which enable mothers to prepare by themselves safe special transitional foods with good nutritional value.

The first type of strategy concerns children whose mothers have the possibility and the willingness to buy foods which is often the case in urban family. The second type concerns children living in poor, often rural families, where they are not enough money to buy special foods for them, even at a reasonable price.

However in both cases strategies must be completed by nutrition education in order to promote adequate complementary feeding practices and if possible health education to avoid that other limiting factors of the child development prevent any improvement of the infant nutritional status.

2. EXPERIENCES FROM OTHERS COUNTRIES

2.1. Efficacy trials

Efficacy trials are conducted according to randomised design in which there is an intervention group that receive specific foods under carefully controlled conditions whereas a concurrently evaluated group not receive these foods.

2.1.1. Previous trials (table 3)

The INCAP longitudinal study was carried out from 1969 to 1977 in Guatemala to assess differences in physical growth of children less than seven years of age who were offered either a cereal legume blend or a supplement containing a relatively small amount of energy. Both supplement were distributed daily through centralised, community based feeding stations. The mothers of the study infants were offered the same supplements during pregnancy and lactation.

Mean energy intakes for the supplemented group were 93 kcal/d more than for the control group. Children of the supplemented group grew approximately 25 mm more in length and 780g more in weight during the first three years of life than the control group. In addition it was observed that there was a greater positive relationship between supplementation and growth during the first year of life than during the second and third years. After three years of age, there was no further relationship between supplementation and growth.

In Columbia, a longitudinal study was carried out in low income communities of Bogota during the late 1970's. Pregnant mothers in the supplemented group and their family members received food rations weekly at the field station beginning with the third trimester of pregnancy and continuing up to 36 months after the birth of the infants. Infants received supplements, (milk + maize-soybean blend) directly at three months of age. The supplements were given in sufficient amounts to supply 670 kcal/d for 3 to 5 month-old infants and 428 kcal/d for the 5 to 12 month-old infants. Supplemented infants also received daily ferrous sulphate and vitamin A every 6 months. Consumption of the supplements resulted in a net increased in take of 200 kcal/D

By three months of age, the intervention children were significantly heavier by 197 g and were 9 mm greater. This suggests that maternal supplementation during pregnancy and lactation may have influenced the infants' post natal rate of growth. At 36 months there was a cumulative difference between groups of 476 g in weight and 22 mm in length. Subsequent analyses found that the greatest relative difference in both rates occurred from 9 to 12 months.

In one Thailand trial a high energy micronutrient fortified supplemental biscuit was distributed through day-care centres to children less than 36 months of age. Consumption of the biscuits provided approximately 300 kcal/d in addition to a broad range of micronutrients but the net increase in energy consumed was not recorded. There was no detectable additional impact of the food intervention on the children's length or weight increments during the 22 months of observation. The authors concluded that nutrition may not have been the primary factor limiting the growth of children.

An other trial performed in Indonesia examined the impact of high energy snacks consumption on the growth of 113 children from 6 to 20 months of age who were cared for in day care centres. The snack food were provided twice daily six days per week. Supplemented children consumed about 317 kcal/d more than unsupplemented children and gained 0.29 standard deviation in weight for age Z-score during three months of observation whereas the weight for age Z-score of control children diminished by 0.01 standard deviation during the same period. These differences were highly statistically significant but there were no differences between groups in length for age Z-score.

The Orstom four country study was aimed to measure the effect of early food supplementation on the growth of infants from four to seven months of age in four countries: Congo, Senegal, Bolivia and New Caledonia (Simondon et al., 1996) (table 4). A total of 90 to 127 infants in each site were randomly assigned to receive the supplement or not. The centrally prepared pre-cooked supplement was composed of several cereals, soybean flour, milk powder, vegetable oils and sugar and was fortified with vitamins and minerals. The food was delivered to infants' homes twice daily, seven days per week by field workers who mixed the dry blend with an appropriate amount of water to form a semi-liquid porridge and then observed the feeding. A maximum of about 200 kcal/d was offered to four month old infants and twice that amount to older ones. All infants in each site were breast-fed during the course of the study except in New Caledonia. Mean consumption of the study supplement ranged from 70 to 161 kcal/d in the four sites. Compared with control infants, supplemented infants in Senegal grew significantly more in length from 4 to 7 months. Those in Bolivia had significantly greater length increments only from 5 to 6 months. There were no significant impacts of supplementation on weight gain in any age period except for a small negative effect from 5 to 6 months of age in the Congo. The lack of significant effect on growth of infants in New Caledonia was not surprising given that their nutritional status was similar to that of the

reference population. In other site, supplements had probably simply displaced intake of breast-milk or others foods.

Results of efficacy trials in Guatemala, Colombia, Thailand, Indonesia and of the Orstom four country study have been quite variable and the reasons of the results are not always evident. It is well recognised that a positive impact of food supplements would be expected to occur only when the nutritional status of the target population is impaired and feeding practices are suboptimal. This may explain the lack of responses in New Caledonia where children's nutritional status was similar to international reference data and in Thailand where children received their meals in the day care centres where food consumption may have already been adequate. In addition it is likely that food interventions that were delivered before 6 months of age may have simply displaced breast-milk. This may explain the negative results in the Congo and in Bolivia. Thus the critical target age range for supplementation appears to be within the period from 6-12 months, with possible additional benefit for growth during the next two years.

2.1.2. Preliminary results of a Congo trial

This trial was carried out in 1995-1996 in the Congo to test the effect of the use of amylase-containing flour on energy intake and growth of infants in an anciently urbanised district of Brazzaville (Trèche et al., 1997).

Two randomised groups of 40 mothers of free-living infants were supplied with maize/soybean flour with amylase or without amylase when their infant was 17 week of age, until 32 week. The period of distribution was chosen considering the early introduction and cessation of gruel consumption in Brazzaville. Mothers were given the amylase treated or the control flour. They were instructed how to prepare the gruel, but they were free to use it at their convenience. At 24 week of age, a 24-hour quantitative food consumption study was done. Anthropometry was measured at 10, 16, 24 and 32 weeks.

The mean energy density per 100 g of prepared gruel was 115 kcal with the amylase-containing flour vs 63 kcal with the control flour.

The infants' energy intake from gruels was 68% higher per meal and 58% higher per day in the amylase containing flour group than in the control flour group.

The mean 24 to 32 week length increment was significantly higher in the amylase containing flour group (1.84 vs 1.36 centimetre by month). Additional treatments of data will allow to know if the consumption of amylase containing flour is responsible of a higher displacement of breast-milk than the consumption of control flour. But now, it appears that, in the context of Brazzaville, the use of amylase-containing flour improved the energy intake from gruels at the age of 6 month and the infants' growth during the 6-8 month period.

2.2. Implementation of strategies at pilot scale level

Examples of nutrition intervention mainly axed on improving complementary feeding are very few. Three of them will be examined here.

2.2.1. The Dietary Management of diarrhoea (DMD) project (Peru and Nigeria)

The DMD project, consisting in the community-based development of improved home-prepared food recipes to complement breast feeding both during diarrhoea and between

episodes of illness, was carried in the highlands of Peru and in the Kwara state, Nigeria, from 1986-1988.

Specific attention was devoted to energy density, frequency of feeding, protein adequacy, density of selected nutrients and food hygiene. Information on the preparation of these improved recipes was disseminated through interpersonal and mass media channels. Professional training was included as part of the pilot intervention.

Evaluation of the project in Peru consisted mainly in collection of representative data on reported knowledge, and adoption of the recommended recipe. Within five months of initiating the intervention, 82% of mothers were aware of the recipe, 16% had prepared it at least once at home and 12% intended to continue using it.

In Nigeria in addition to collecting information on the reach of the nutritional message within height weeks of the pilot intervention, the evaluation team measured children's intake before and after introduction of the project in both intervention and control communities. Of the mothers participating in the intervention, 57% knew the recipe, 48% tried it and 17% intended to continue using it in the future. The mothers' level of education was significantly associated with adoption of the recommended diet and their perception of the cost of the recipe and its preparation time were negatively associated with its adoption. There was little impact of the intervention on mean total energy intakes by children in the intervention communities, largely because the recipe replaced other complementary foods but there was no evidence that the complementary foods displaced breast-milk.

2.2.2. The Bangladesh rural advancement committee's child survival program

This program was carried out in the Bangladesh in the late 1980's to encourage better complementary feeding practices for infants greater than 5 months of age. Messages on specific recipes for snack foods and other meals, appropriate feeding behaviours and improved food hygiene were disseminated to child caregivers by village workers who provided home demonstrations. Specific advice was given on enriching meals with energy protein and micronutrients by adding oil, molasses, milk, fish and lentil flour to existing diets and by increasing intakes of local vegetables and fruits.

The impact of the intervention was evaluated by recording reported dietary intakes of non-breast milk foods and assessing anthropometric indicators of children aged 4 to 18 months in program and control communities at baseline and five months later.

Program children consumed approximately 8 kcal/kg/d more from complementary foods than the control children but it is unknown whether there were any simultaneous changes in breast milk consumption. It appears from the adjusted weight for age data that program children gained several hundred grams more body weight than control children during the interval of observation. The decrement in weight for age Z-score of program children of - 0.19 SD was significantly less than the change of - 0.65 SD of the comparison group.

2.2.3. The PAAN project (Congo)

Two strategies were developed from 1991 to 1995 in the Congo within the frame of the PAAN project (*Projet d'appui aux activités de Nutrition*) realised by the Ministry of health assisted by ORSTOM and Congolese researchers and supported by UNICEF/Congo and the French Ministry for Co-operation. Concerning the improvement of complementary feeding, this project comprised three stages: (i) Situation analysis and identification of needs for improvement, (ii) Development and testing of food processes, (iii) Implementation and evaluation of strategies.

The situation analysis was performed in two pilot zones: one district of Brazzaville and an isolated rural zone named the Kukuya Plateau. Studies were carried out to characterise the feeding practices and nutritional status, the traditionally used special transitional foods, the quantitative food consumption of infants (table 5).

It was observed that the prevalence of stunting was very high in the Plateau area and moderate in Brazzaville. In both rural and urban areas, the main features of complementary feeding were: early introduction of gruels and of family foods; preparation of gruels mainly from a fermented maize paste called *poto-poto* in Brazzaville and from cassava on the Kukuya plateau; low feeding frequency (Cornu et al., 1993).

The main characteristics of traditional gruels were a low energy density in regard to the feeding frequency and a protein content relatively low in Brazzaville and extremely low on the plateau. In Brazzaville gruels were prepared by mothers at a low viscosity (in average 1500 centipoises at 6 months) (Trèche et al., 1993; Trèche, 1995). In the other hand, we observed that mothers incorporated very high amount of sugar in the gruels. This high sugar content of gruels explains that energy density of gruels was higher than in other countries but resulted in the low micronutrient content of the gruels as sugar only brings empty calories.

Energy intake from breast-milk and complementary foods was assessed only in the district of Brazzaville by means of a survey involving a random sample of 50 infants (Dop et al., 1995). The prevalence of breast feeding was high at 4 and 6 months but all infants were partially breastfed. Their mean Breastmilk intakes were already low at 4 months (429 ml/d). Total energy intakes were 80 kcal/kg/d at the age of 4 months and 74 kcal/kg/d 6 months. At 4 months the contribution of breast-milk to energy intakes was already low, 48% of total energy and it declined to 41% at 6 months. Gruels provided respectively 38% and 44% of the energy at 4 and 6 months.

The main conclusions of these descriptive studies were that feeding practices had to be improved, particularly the timing of complementary food introduction, the feeding frequency for infants older than 6 months, and the energy and nutrient density of gruels.

Consequently interventions in order to improve complementary feeding must include promotion of educational messages and technological innovations to provide children with nutritionally adequate gruels. This could be achieved by the production of infant flour mix at the level of small-scale production units and by transferring at household level simple home-based technologies for preparing improved gruel.

Hence, the second stage of the programme consisted in development of processes to improve complementary foods. It consisted mainly in (i) definition of conditions for using various amylase sources, in particular malted maize flour and industrially produced amylases, (ii) use of a computer program (ALICOM developed by ORSTOM) to formulate nutritionally adequate mixes and (iii) selection of different processes in particular for maize grain germination, roasting of leguminous seeds, blending of gruels ingredients.

These studies led to the development of a small scale pilot unit producing Vitafort, an infant flour mix containing maize, soybean, sugar, industrial amylase and a mineral and vitamin supplement and of recipes for the preparation of an improved gruels by mixing cassava flour, peanut or pumpkin butter, malted maize flour, reasonable amount of sugar, and water in adequate proportion (Tchibindat et Trèche, 1995).

The third stage of the programme consisted in implementation and evaluation of strategies. Two community-level strategies were implemented taking into account the characteristics of urban and rural contexts.

In an anciently urbanised district of Brazzaville, Vitafort was made available in neighbourhood shops at a reasonable price. A programme of nutrition education promoting an appropriate use of Vitafort through the Integrated Health Care Centres was planned but could not be implemented because of socio-political troubles. Consequently the evaluation could not be realised so far.

For the rural pilot zone, the intervention was a package comprising nutrition education and the transfer to mothers of a simple processing technique to prepare the above mentioned improved gruel. The intervention was performed on the Kukuya plateau which had about 16000 inhabitants (Moukolo et al., 1995). Simultaneously, surveys were also carried out on a similar other area, the Djambala plateau which was considered as a reference zone without intervention. The target population was initially all women off the Kukuya plateau but afterwards was restricted to mothers having a young child. Twelve female local field-workers were trained to visit the villages and teach the mothers the most appropriate ways of feeding infants and young children, and how to prepare the energy dense gruel. The design of evaluation comprised the evaluation of process and the evaluation of impact. Three surveys were performed 8, 17 and 27 months after the beginning of the intervention to control evolution of the knowledge of mothers and the utilisation frequency of the improved gruel. The evaluation of impact on nutritional status was carried out using a quasi experimental model which permitted to make a comparison between situations before and after 27 months of intervention taking into account evolution in the reference zone. The main results of the evaluation were:

- a high level of participation of the mothers having a young child during the time of the intervention
- an improvement of their knowledge of appropriate complementary feeding practices.
- a significant delay of introduction of gruel and of family foods
- the regular use of improved gruels by a significant proportion of the infants depending on the period of evaluation
- the ability of the mothers to prepare improved gruels and to confer them a high energy and protein content
- but evaluation of the infant nutritional status by comparison to a control area failed to demonstrate a significant positive impact on the target children 27 months after the beginning of the intervention.

The main conclusions of evaluation of the strategy implemented in the rural pilot zone were that it was quite easy to develop nutrition education messages and technological processes able to improve mothers' knowledge of appropriate complementary feeding practices. But, influence of socio-cultural constraints, in particular the lack of time of mothers, the role of witchcraft and mother in law's influence, were important limiting factors which prevented a large number of them to apply their new knowledge. Thus to obtain a significant effect on nutritional status, more attention must be devoted to socio-cultural constraints and others factors which determine it. In an other connection, improvement of complementary feeding seems to be necessary but not sufficient component of strategies able to reduce protein-energy malnutrition on remote African rural areas as the Kukuya plateau.

2.3. Experiences of central production of infant flours in Africa

In many African countries, infant flour production units have been implemented more or less recently (table 6). In most cases, national institutions were associated with non governmental organisations. The capacity of production varied within a large range from 1 to 250 tons per

months but the two units which produced more than 100 tons per month have ended their activities because of commercialisation problems. Some of these production units use sophisticated processes as drum-drying or extrusion cooking but most of them limits themselves to simple processes as grinding, roasting and blending. In most cases they use simple plastic bags for packaging (Trèche, 1995).

Concerning ingredients of these infant flours, cereals, mainly maize or wheat but also rice in some cases, were used as energy source (table 7). The more frequent protein source for complementation was soybean. In most cases sugar were incorporated. The incorporation of milk powder, and vitamin or mineral complements is less frequent.

The energy and nutrient contents of these flours are quite variable (table 8). On a dry weight basis, protein content varies between 9 and 20 g/100 g; lipid content varies between 2.2 and 11.5 g/100 g; fibre content varies between 0.9 and 7 g/100 g. Variation of calcium and iron contents is still higher depending on fortification.

The energy density of gruels made from some of these flours has been measured for two viscosities corresponding to the consistency at which gruels are generally consumed by 6 to 12 month old infants (table 9). Only two infant flours can be prepared into gruels with an energy density superior to 80 kcal/100 ml which is the minimum value recommended during the last meeting of the codex alimentarius commission for the processed cereal-based foods for infants and young children.

In conclusion of this rapid review of experiences of infant flour local production in Africa, the tendency to produce at a small scale level in regard to commercialisation problems has to be underline. But most of production units lack of technological knowledge to produce flours with good nutritional value, in particular flours which can be prepared into gruels with sufficient energy density. Thus there is a need for developing and transferring to them some simple processes which enable them to prepare infant flour with good nutritional value.

3. POSSIBLE STRATEGIES FOR VIETNAM

What are the possible strategies to improve complementary feeding in Vietnam ? Taking into account young child nutritional status and technological development in Vietnam, and in regard of the experiences in other countries and the present knowledge about infant requirement, it seems than, like in most other developing country, the priority is to provide to the greatest number of 6 to 12 months old infants special transitional foods of good nutritional value and to teach mothers to use them in an appropriate way. For this, two types of strategies should be developed like in most other countries.

The first type consists in low cost infant flour production in small decentralised units. But this kind of production units needs to be assisted and controlled by national institutions or non governmental associations which can transfer them the necessary knowledge relative to processing and management and simultaneously inform mothers of good complementary feeding practices.

In regard to the available foods and the technological development, extrusion cooking of rice, green bean or soybean, peanut or sesame blend enriched with appropriate vitamin and mineral complements appears to be realisable.

The second type of strategy, reserved to very low income families, consists in transferring at the household or community level simple technologies which enable mothers to prepare by themselves safe special transitional foods with good nutritional value. This transfer, which

must be accompanied by nutrition education messages, can be realised only after training of field agents belonging to health services or organisations having a permanent contact with mothers. But in a first step appropriate processes and nutrition education messages have to be elaborated at a central level taking into account characteristics available foods and nutrient requirements.

The main ingredients of these gruels could be, like for the centrally produced infant flours, rice, green bean or soybean, and sesame or peanut incorporated with dry germinated green bean flour to bring amylases necessary to improve energy density of the gruels.

CONCLUSION

The improvement of complementary feeding is a world wide problem at least in developing countries but this problem has not an unique solution.

If energy and nutrient infant requirements and physiological constraints are probably the same all around the world, strategies must be adapted to each situations. Nevertheless, experiences in various situations are helpful and some informations provided above can be taken into account for elaborating successful strategies to improve complementary feeding and young child nutritional status in Vietnam.

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Table 1: Estimated minimum energy density to attain different levels of total daily energy intakes at various feeding frequencies

Age			6-8 months	9-11 months	12-23 months
Energy requirement			682 kcal	830 kcal	1092 kcal
Breast milk intake		Average ⁽¹⁾	413 kcal/d	379 kcal/d	346 kcal/d
		Low ⁽¹⁾	217 kcal/d	157 kcal/d	90 kcal/d
Energy needed from CF		Average ⁽¹⁾	269 kcal/d	451 kcal/d	740 kcal/d
		Low ⁽¹⁾	465 kcal/d	673 kcal/d	996 kcal/d
Average gastric capacity ⁽²⁾			249 ml	285 ml	343 ml
Estimated minimum energy density at various feeding frequencies	2 meals / day	Average ⁽¹⁾	54 kcal/100ml	79 kcal/100ml	108 kcal/100ml
		Low ⁽¹⁾	94 kcal/100ml	118 kcal/100ml	145 kcal/100ml
	3 meals / day	Average ⁽¹⁾	36 kcal/100ml	53 kcal/100 ml	72 kcal/100ml
		Low ⁽¹⁾	62 kcal/100 ml	79 kcal/100ml	97 kcal/100ml

(1) The categories low and average correspond to energy intake from breast milk being low (mean - 2SD) and average (mean)

(2) Gastric capacity is evaluated to 30 ml/kg body weight

Sources: Brown et al., 1997. State of the art paper on complementary feeding. Paper prepared for the UNICEF/WHO joint consultation, 28-30/11/95, Montpellier, France

Table 2: Desired nutrient density of complementary foods by level of usual breast milk intake

			6 - 8 months			9 - 11 months			12-23 months		
			Level of breast milk intake								
			Low	Av.	high	Low	Av.	high	Low	Av.	high
Protein		g/100kcal	1,1	0,7	0	1,0	0,7	0	0,9	0,7	0,2
Calcium		mg/100kcal	91	125	345	67	78	112	30	26	19
Chloride		mg/100kcal	74	81	123	57	53	42	73	76	84
Copper		mg/100kcal	0,04	0,04	0,14	0,03	0,02	0,04	0,04	0,04	0,04
Iron (1)	Low	mg/100kcal	4,5	7,7	28,3	3,1	4,6	9,0	1,2	1,6	2,4
	Av.	mg/100kcal	2,3	4,0	14,7	1,6	2,4	4,7	0,6	0,8	1,2
	high	mg/100kcal	1,5	2,5	9,2	1,0	1,5	2,9	0,4	0,5	0,8
Fluoride		µg/100kcal	0	0	0	0	0	0	0	0	0
Iodine		µg/100kcal	4	0	0	4	0	0	5	1	0
Magnesium		mg/100kcal	13	19	56	10	13	20	8	9	11
Manganese		µg/100kcal	3	4	14	2	3	4	1	2	2
Phosphorus		mg/100kcal	75	114	360	54	70	116	25	26	29
Potassium		mg/100kcal	109	129	258	83	84	86	71	69	64
Selenium		µg/100kcal	0,6	0	0	0,7	0	0	1,1	0,5	0
Sodium		mg/100kcal	54	74	197	45	53	77	47	54	68
Zinc		mg/100kcal	1,0	1,6	5,2	0,7	1,0	1,7	0,6	0,8	1,1
Folate		µg/100kcal	0	0	0	1	0	0	3	0	0
Niacin		mg/100kcal	0,6	1,1	4,1	0,7	0,9	1,7	0,8	0,9	1,4
Pantoth. ac		mg/100kcal	0,2	0,2	0	0,2	0,1	0	0,1	0,1	0
Riboflavin		mg/100kcal	0,06	0,07	0,14	0,04	0,04	0,04	0,05	0,05	0,06
Thiamine		mg/100kcal	0,02	0,04	0	0,03	0,04	0,04	0,05	0,05	0,06
Vit. A		µgRE/100kcal	35	5	0	32	9	0	31	17	0
Vit. B6		µg/100kcal	0	0	0	0	0	0	0	0	0
Vit. B12		µg/100kcal	0	0	0	0,01	0	0	0,03	0	0
Vit. C		mg/100kcal	2,2	0	0	2,1	0	0	2,3	1,1	0
Vit. D		µg/100kcal	1,5	2,5	8,9	1,0	1,5	2,8	0,7	0,9	1,3
Vit. K		µg/100kcal	2,0	3,3	11,0	1,4	2,0	3,5	1,0	1,2	1,6

(1) depending on the low (5%), intermediate (10%) or high (15%) bioavailability of iron

Sources: Brown et al., 1997. State of the art paper on complementary feeding. Paper prepared for the UNICEF/WHO consultation, 28-30/11/95, Montpellier, France

Table 3: Summary of selected efficacy trials of complementary foods

Location	Guatemala	Columbia	Thailand	Indonesia
Authors	<i>Martorell, 1995</i>	<i>Mora, 1981</i>	<i>Gershoff, 1988</i>	<i>Husaini, 1991</i>
Type of intervention	Food supply to mother during pregnancy and to children	Food supply to mother and to children after 3 months	Food supply to children only	Food supply to children only
Nb of subject	330	172	205	113
Age range (months)	3-36	3-36	< 36	6-20
Duration of BF	not specified	median age 6.6 mo	not specified	not specified
Type of supplement	cereal-legume blend	milk+maize-soybean blend	high fat biscuit + vit. and minerals	high energy snacks
Method of distribution	Twice daily at field station	weekly pick up of ration at field station	Once daily in day care centre	Twice daily at day care centre
Duration of participation	36 months	3rd trimester of pregnancy + 36 months	12 months per age group	3 months
Est. net increase in energy consumed	93 kcal	200 kcal	not recorded	317 kcal
Difference in weight gain	+ 780 g	+ 476 g	+ 100 g (ns)	+ 0,30 Z-score
Difference in length gain	+ 25 mm	+ 22 mm	+ 1 mm (ns)	+ 0,04 Z-score (ns)

Sources: Brown et al., 1997. State of the art paper on complementary feeding. Paper prepared for the UNICEF/WHO consultation, 28-30/11/95, Montpellier, France

Table 4: Summary of ORSTOM four country study

Location	Congo	Senegal	Bolivia	New Caledonia
Type of intervention	Food supply to children only			
Number of subject	120	110	127	90
Age range	4 to 7 months			
% of breast-feed	100%	100%	100%	47%
Type of supplement	gruels prepared with blend of cereals, soybean, milk power, oil sugar, vitamins and minerals			
Method of distribution	delivered twice daily to infants' home seven days per week			
Duration of participation	3 months			
Energy consumed from supply	189 kcal	133 kcal	161 kcal	160 kcal
Difference in weight gain	- 250 g (ns)	- 10 g (ns)	- 70 g (ns)	- 60 g (ns)
Difference in length gain	- 1.5 mm (ns)	+ 4.8 mm	+ 2.5 mm (ns)	+ 0.5 mm (ns)

Sources: Simondon K, Gartner A, Berger J et al., *Am J Clin Nutr*, 1996, 64: 537-545

Table 5: Feeding practices and nutritional status in Congo

	Brazzaville	Kukuya Plateau
Stunting (12-23 mo; < - 2 ET)	14%	41%
Median age at CF introduction	15 weeks	10 weeks
Main gruel ingredient	70% fermented maize (poto-poto)	95% cassava products
Feeding frequency (6-11 mo; < 3/day)	85%	95%
Median age at FF introduction	7 months	5 months

**Table 6: General characteristics of infant flour
production units in Africa**

Country and name of the flour	Since	Assistance	Capacity of production	Special processes	Packaging	Observations
Algeria Supéramine	1966	Public + Private	250t/month	drum-drying	plastic bags	stopped in 1984
Benin Ouando Ouando factory	1977 1992	Public + Coop. Public + NGO	10t/month 100t/month	extrusion-cooking	plastic bags	Industry
Burkina Faso Misola	1981	Public + NGO	variable		plastic bags	dispatching
Burundi Musalac	1984	Public + Coop.	42t/month		plastic bags	dispatching
Cabo verde Micaf	Project since 1986	Public + Private				
Congo Vitafort	1992	Public + Res. org.	2 t/month	Amylases	plastic bags	dispatching
Guinea Yéolac	1988	NGO	20t/month			stopped
Marocco Actamine	1972	Public + Private	50 t/month	?	plastic bags	
Niger Bitamin	1991	Public + NGO	4 t/month		plastic bags	
Rwanda Sosoma	1985	NGO	60 t/month			stopped
Chad Vitafort	1993	Public + NGO	10 t/month			
Togo Nutrimix Viten	1985 1991	Public NGO	1 t/month 20 t/month	?	plastic bags plastic bags	
Ex-Zaire Cérévap	1983	Private	250 t/month	extrusion cooking	aluminium bags	stopped

Table 7: Ingredient composition of infant flours produced in African production units

Country and name of the flour	Energy sources	Protein sources	Sugar	Milk power	min. Vit.
Algeria Superamine	Wheat : 28 %	Chickpea : 38 % Lentille : 18 %	5 %	10 %	Yes
Benin Ouando age 1 age 2	Maize: 37 %/Sorghum: 37 %/Rice :15 % Maize : 33 %/Sorghum :13 %	Soybean : 23 % or bean	11 % 11 %		
Burkina Faso Misola	Millet : 60 %	Soybean: 20 / Groundnut: 10%	9 %		Salt 1 %
Burundi Musalac	Maize : 48 %/Sorghum : 22 %	Soybean : 20 %	8 %	2 %	Yes
Cabo verde Micaf	Wheat : 40 %/Maize : 40 %	Bean : 20 %			
Congo Vitaforce 1 Vitaforce 2	Manioc : 43 %/Maize : 30 % Maize : 73,4 %	Soybean : 19 % Soybean : 14,1 %	8 % 11 %		Yes Yes
Guinea Yéolac	Maize, Sorghum	Soybean	Yes	Yes	
Marocco Actamine	Wheat : 48 %	Soybean : 16 %	15,4 %	20 %	Yes
Niger Bitamin	Mil : 67 %	Vigna: 20 %/Groundnut: 10 % Boabab fruit: 3 %			
Rwanda Sosoma	Sorghum, Maize	Soybean	no	no	no
Chad Vitaforce	Mil, Maize, Rice % or Sorghum 57 %	Vigna : 24 % Groundnut : 9,5 %	9,5 %		
Togo Nutrimix age 1 age 2 Viten age 1 age 2	Maize : 35 %/Rice : 20 %/Sorghum : 35 % Maize : 60 %/Rice : 10 % Maize, Rice, Sorghum Maize, Rice	Soybean : 25 % Soybean	10 % 5 % Yes Yes		
Ex-Zaire Cérévap	Maize, Wheat, Oil	Soybean	Yes	Yes	Yes

Table 8: Nutritional value of infant flour produced in African production units

Country and name of the flour	Energy kcal/100gMS	Protein g/100gMS	Lipids g/100gMS	Fibres g/100gMS	Calcium mg/100gMS	Iron mg/100gMS
Algeria						
Superamine	414	20,9	4,5	2,1	390	15
Benin						
Ouando age 1	401	9,9	3,1		6	13
age 2	366	16,0	4,0	7,0	29	9
Burkina Faso						
Misola	430	18,0	11,5			
Burundi						
Musalac	417	15,4	7,6	6,6	78	21
Cabo verde						
Micaf	434	16,3	5,5		850	54
Congo						
Vitafort		12,0	6,3	2,4	380	17
Guinea						
Yéolac		14,9	8,1	5,0	96	11
Marocco						
Actamine	357	21,3				
Niger						
Bitamin		16,2	8,9	2,2		
Rwanda						
Sosoma	400	16,5	7,7	2,2	6	7
Chad						
Vitafort		11 à 13	5,5 à 8,5	8 à 15	32 à 60	2 à 5
Togo						
Nutrimix age 1	426	8,2	2,8	0,9	40	
age 2	444	17,6	9,0	2,2	73	
Viten age 1		9,0	3,4	4,2	420	9
age 2		15,5	7,6	4,4	450	9
Ex-Zaire						
Cérévap	430	15,6	9,2	1,6	382	12

Table 9: Energy density (ED) of gruels

Country and name of the unit	ED of gruels corresponding to 1 PAs of viscosity	ED of gruels corresponding to 2 PAs of viscosity
Benin		
Superfarine Ouando age 1	41 kcal/100 ml	55 kcal/100 ml
Farine Ouando age 2	< 60 kcal/100 ml	70 kcal/100 ml
Burkina Faso		
Misola	62 kcal/100ml	71 kcal/100 ml
Burundi		
Musalac	53kcal/100 ml	66 kcal/100 ml
Congo		
Vitafort	100 kcal/100 ml	122 kcal/100 ml
Guinea		
Yéolac	60 kcal/100 ml	74 kcal/100 ml
Niger		
Bitamin	46 kcal/100ml	56 kcal/100 ml
Rwanda		
Sosoma	50 kcal/100 ml	72 kcal/100 ml
Chad		
Vitafort	50 kcal/100 ml	66 kcal /100 ml
Togo		
Viten age 1	44 kcal/100 ml	52 kcal/100 ml
age 2	54 kcal/100 ml	60 kcal/100 ml
Ex-Zaire		
Cérévap	97 kcal/100ml	110 kcal/100 ml
Control		
CSB flour from PAM	44 kcal/100 ml	58 kcal/100 ml