Improving Young Child Feeding in Eastern and Southern Africa

Household-Level Food Technology

Proceedings of a workshop held in Nairobi, Kenya, 12-16 October 1987
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Editors: D. Alnwick, S. Moses, and O.G. Schmidt

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Abstract

The weaning period, that is the period in a young child’s life when supplementary foods are introduced to complement breast milk, poses great nutritional risk to children in developing countries. By the end of the second year of life, one-third of children in eastern and southern Africa are chronically malnourished. The following factors contribute to the growth faltering commonly observed in weaning-age children: low nutrient intake, high incidence of diarrheal disease (often caused by contaminated weaning foods), and recent declines in duration and intensity of breastfeeding.

Food scientists, nutritionists, and health planners working in Africa and South Asia met in an international workshop to examine household-level food technologies that hold promise for improving nutrition of infants and young children. After reviewing current knowledge of breastfeeding and weaning practices in eastern and southern Africa, participants discussed the use in weaning diets of fermented foods and germinated flour, for both improved nutrient intake by young children and decreased risk of food contamination. Research that should be conducted into the effectiveness of the food technology was identified and its diffusion at the community level discussed.

This publication contains the proceedings, conclusions, and recommendations of the workshop. It is directed at scientists and health planners who are involved in nutrition research and developing programs to improve feeding of infants and young children in developing countries.

Résumé

Le sevrage, c’est-à-dire la période où l’on commence à donner des aliments solides à un jeune enfant en complément du lait maternel, présente de graves risques nutritionnels pour les enfants dans les pays en développement. Dès la fin de leur deuxième année, le tiers des enfants en Afrique orientale et australe souffrent de malnutrition chronique. Les facteurs suivants sont à l’origine du retard de croissance que l’on retrouve couramment chez les enfants en âge d’être sevrés : carence nutritionnelle, forte prévalence des maladies diarhéniques (qui s’expliquent souvent par la contamination des aliments) et diminution récente de la durée et de l’intensité de l’allaitement maternel.

Cette publication fait un compte rendu des discussions de l'atelier et présente ses conclusions et ses recommandations. Elle s'adresse aux scientifiques et aux planificateurs de la santé qui participent à des recherches en matière de nutrition et à l'élaboration de programmes visant à améliorer l'alimentation des nourrissons et des jeunes enfants dans les pays en développement.

Rezumen

El período de destete, es decir, aquel periodo en la vida de un niño en que se introducen en su dieta alimentos suplementarios para complementar la leche materna, representa un gran riesgo nutricional para los niños de países en vías de desarrollo. Hacia el final de su segundo año de vida, un tercio de los niños en África Oriental y el sur muestran síntomas de malnutrición crónica. Los siguientes factores contribuyen al crecimiento vacilante que se observa comúnmente en los niños que se encuentran en edad de dejar la lactancia materna: baja ingestión de nutrientes, alta incidencia de diarrea (a menudo causada por alimentos para el destete contaminados), y nuevas disminuciones en la duración e intensidad de la alimentación proveniente del pecho de la madre.

Científicos del campo de los alimentos, especialistas en nutrición y planificadores de la salud que trabajan en África y en el Sur de Asia se reunieron en un taller internacional para examinar las tecnologías de alimentos que se utilizan en el hogar y que prometen buenos resultados en el mejoramiento de la nutrición de lactantes y niños pequeños. Después de analizar el conocimiento que existe actualmente sobre la alimentación recibida a través del pecho de la madre y las prácticas que se utilizan para el destete en el oriente y sur de África, los participantes discutieron el uso en dietas para el destete de alimentos fermentados y harina germenada para que los niños pudieran ingerir nutrientes mejorados y haya una disminución en el riesgo causado por la contaminación de los alimentos. Se identificó la investigación que se debe realizar sobre la efectividad de las tecnologías de alimentos y se discutió su difusión en el seno de la comunidad.

Esta publicación contiene las actas, conclusiones y recomendaciones del taller. Está dirigida a científicos y planificadores de la salud que participan en la investigación nutricional y en programas de desarrollo para mejorar la alimentación de lactantes y niños en los países en desarrollo.
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HIGH-NUTRIENT DENSITY WEANING FOODS FROM GERMINATED CEREALS

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Abstract Sorghum and maize were investigated for dietary bulk and food intake. Germinated and ungerminated flours were compared in the preparation of weaning gruels; using equal volumes of porridge, it was found that 3 times as much germinated flour (of the low-tannin sorghum varieties) could be used, while maintaining the same consistency of the gruel. Germinated flour of high-tannin sorghum varieties did not have this effect. The addition of 5% germinated low-tannin sorghum flour (enzyme rich) to thick ungerminated sorghum and maize gruels reduced the viscosity to acceptable weaning-food consistency. This method of reducing the dietary bulk of weaning food was accepted and used by mothers at the village level. Food intake by preschool children 12-48 months of age was significantly higher for bulk-reduced, low-viscosity gruel with 20% solids, than with untreated gruel. It was concluded that the use of bulk-reduced weaning foods of high nutrient density could eventually improve the nutritional status of young children and raise the nutrient intake of the infirm.

Observations of traditional child feeding practices in many developing countries reveal that the weaning period, defined as the period during which breast milk is being replaced by other foods, usually begins when the infant is 4-6 months old, and is extended to the age of 2-3 years (UNICEF 1985). During this time, the children must eat from the family pot. In our countries, these foods are mainly starchy tubers, such as cassava and sweet potato, or cereals such as maize, rice, sorghum, and millet. Small children are usually given gruels made from these staples. When prepared in this way, the starch structures bind large amounts of water; this results in gruels of high viscosity (Tanzania Food and Nutrition Centre, internal report). Such gruels need to be further diluted with water to give a consistency that is appropriate for child feeding. This dilution, however, decreases the energy and nutrient density of the gruel, and children must then eat large amounts to satisfy their requirements; consumption of the amounts in question is physiologically impossible. This high volume/viscosity characteristic of a diet is usually referred to as "dietary bulk," and the importance of this factor in relation to child feeding has already been investigated and reported elsewhere (Mosha 1984, 1985; Svanberg 1985).
In Tanzania, the diet in most households, particularly those in rural areas, consists of one staple food, supplemented with green leafy vegetables, beans, or peas; a few well-off families occasionally have meat as a supplement (UNICEF 1985). In a few areas, such as the lake zones, fish is abundant, and in the savanna areas of the central and northeastern parts of the country, milk is in plentiful supply; both these foods contribute substantially to the energy and protein content of the diets.

Although not the preferred food, the most common diet in the country is maize, followed by rice, bananas (plantain), cassava, sorghum, millet, sweet potatoes, and round potatoes. Cereals are normally prepared as a stiff porridge ("ugali") for adults, and as a thin gruel ("uji") for small children. Bananas and potatoes are boiled.

When comparing both the energy and the protein requirements for adults and children, it has been found that requirements for the latter are relatively high in relation to body size (Cameron and Hofvander 1983). In most cases, the amount of food that a child can eat per meal is very much influenced by the ability to chew and by stomach capacity, both of which increase with age. On the other hand, the amount of food a child actually eats depends on the consistency and potability of the food, and on the time and patience of the mother when feeding.

The period of a human being's development from the fetal stage to the preschool stage is critical to growth; during this period, adequate food intake (including that of weaning foods) is vital to good nutritional status.

Industrial manufacture of cereal-based weaning foods often includes operations intended to reduce dietary bulk; examples of such operations include enzyme (amylase) treatment, precooking, and extrusion. Although these processes result in lower water binding in the gruels, as sophisticated technologies, they make for rather expensive products (Anon. 1970); in poor countries, these products are usually available only to the urban children of higher income families.

An alternative to these industrial processes could be an increased use of improved traditional food preparation procedures that will modify starch structures. One such procedure that is widely known and used is germination. Although germination of cereals is mainly associated with the preparation of local alcoholic beverages, there are a few examples of this procedure being used to prepare local weaning foods with low dietary bulk (Hellström et al. 1981).

**Background**

The most common weaning food is a thin "uji" or porridge of maize or sorghum. Depending on season and area, a variety of beans, peas, and vegetables are added; most of the time, however, the early weaning diet is composed of single foods. With the exception of diets prepared in some pastoral communities, the fat content is very low, especially in the diets of the Masai, the Wasukuma, and the Wakuria. Generally, we can classify weaning foods in Tanzania into four groups:
Weaning foods composed of single foods, usually cereal flours made into thin porridges or gruels ("uji");

Double mixes, i.e., a mixture of cereal or root/tuber flour or bananas prepared as a mash, mixed usually with a little milk or animal fat;

Triple mixtures of starch cereal, fruit, and vegetable mash; and

Multimixes, including all the varieties mentioned, plus any other food that the mother finds suitable and that makes the food palatable and attractive.

As mentioned earlier, the majority of mothers in the country use weaning foods composed of a single type. Limited surveys in the country show that many children suffer from protein energy malnutrition (PEM). About 6-7% of children suffer from extreme PEM. This figure is very high. The normal average of severe PEM in those areas where malnutrition is said to be moderate is between 1 and 2% (TFNC 1987). PEM exists at these levels for several reasons: the diets of children as well as of adults are, on the whole, based on cereal staples, and have only limited supplementation with protein, vitamins, and mineral sources; this situation is exacerbated by inadequacies in the frequency of feeding, in the amount of food given per meal, and by the presence of disease.

Because of ecological, geographical, and other variables, there exist many weaning practices. The "uji" feeding method is used in almost every part of the country. Some children are fed only once or twice a day - a feeding frequency that is inadequate for young, growing children. We must make it a priority to discover ways of increasing the number of times a child is fed.

The timing of the initiation of weaning is extremely important. According to the population census of 1978 in Tanzania, the child mortality rate is around 231/1000. Those children whose resistance to disease is lowered not only suffer loss of strength, but also have difficulty performing well at school. The issue of energy density must also be addressed in this workshop: it is one of the major constraints in child feeding for most of the developing world. Most foods given to children have low energy density (dietary bulk). The problem of dietary bulk in children's meals is discussed in the following section.

Use of Additives

The addition of fats, oils, or sugar has some influence on the consistency of the food. Fats and oils have been found to have a double effect on the bulkiness of a diet. First, they lower the viscosity of a gel by interfering with the formation of the gel network. Second, fat has a higher energy density: 1 g of fat produces 9 kcal, whereas carbohydrates produce about 4.2 kcal/g (Cameron and Hofvander 1983). Furthermore, fats, unlike starch, do not bind with water when prepared in a porridge. With regard to a prepared porridge, fat is 10-15 times denser than starch (Svanberg 1985). Sugar has also been proven to decrease the gel (viscosity) strength. Although fats and sugar are excellent in reducing dietary bulk, the prices of these two commodities are extremely high in Tanzania.
Fermentation

Because of their heavy workload, most mothers lack the time to feed their children as frequently as is required. These mothers are able to feed their children, at most, three times a day. Fermentation of food can, however, make it possible to increase feeding frequency: fermentation of cereals breaks down the starch structure and reduces the water-binding capacity of the gruel or "uji"; as a result, fermented foods have a relatively long shelf life, do not require recooking, and can be served anywhere. The Waarusha, Wamasai, and Wameru of northern Tanzania feed their children with a fermented food known as "loshoro" - a liquid food mixture made from well-cooked dehulled maize, fresh milk, bananas, and a small amount of fermented milk. "Loshoro" can last for 2-3 days without spoilage and does not need recooking; mothers can therefore feed their children as many times per day as they wish. Such good examples need to be emulated and improved upon.

Cereal fermentation for child feeding is becoming less common among many tribes in Tanzania. Traditionally, a number of these tribes prepared "togwa" - a fermented porridge made from cereal flour and served as a drink to children and to adults. This good practice is gradually disappearing; there is a need to revive it before it disappears altogether. At present, fermentation of cereals in Tanzania is used mainly for the brewing of local beverages.

Material and Methods

Because sorghum is drought-resistant and is already widely used for germination (primarily for the preparation of locally brewed beer), it is the main cereal included in this study. The study used one of the traditional and one of the improved varieties of the white (low tannin) type of sorghum; the others were brown (high tannin) types. Their respective generic names are traditional (local) white "Lugugu" and brown "Udo Msonga," and improved white "ET-35" and brown "5DX 125/13/3/1." In addition to the sorghum varieties, one type of maize (Ilonga white composite) - a white "flint" maize variety - was also studied.

In this study, all the sorghum and maize flour used for preparing the gruels had been milled (whole grains) in a laboratory plate mill (80% passing a 60-mesh sieve), either with or without prior germination.

Germination

The traditional germination procedures at the village level in Tanzania were adapted to laboratory conditions as follows: the seeds were soaked in 70% ethanol for 2 min to prevent the growth of microorganisms. The seeds were then soaked in the same amount of water and kept in the dark for 12-20 h. After being washed in distilled water, the seeds were spread in a layer 1-cm thick between wet cotton cloths, and left to germinate for 48 h at room temperature (20°C). The sprouted seeds were dried on a plate in an air stream at 50°C, and the dried seeds with their vegetative portion were milled in the laboratory mill.
With traditional germination, the grain was thoroughly washed, soaked in the excess water overnight, and washed again. The soaked grain was thinly spread in a gunny bag, placed flat on a clean floor in the house, and covered with grass to maintain darkness. The bag was sprinkled with water daily and germination was allowed to continue for 2 days. The germinated cereal flour was termed "power flour" (P.F.) by the author.

**Preparation of Gruels and Viscosity Measurement**

Flour and distilled water were mixed in a glass beaker and heated in a boiling water bath to reach a cooking temperature of 95°C within 7-10 min; the mixture was then left at room temperature to cool. Gruels were prepared either from ungerminated or germinated flours, or from ungerminated flour mixed with 5-10% germinated flour (added before or after cooking).

The viscosity of the gruels was measured using a Haake Rotovisco model RV1 with an SCII profiled measuring system and a shear rate of 54 rpm. The measuring temperature was kept at 40°C to allow comparisons of different types of gruels. Lower temperatures are commonly used for feeding infants, and this usually means higher viscosities. Household viscosity measurements were carried out using a Brookfield Viscometer.

**Germinated Cereal Flour Adoption**

In 1983, a group of scientists led by Dr Alexander Mosha at the Tanzania Food and Nutrition Centre (TFNC) conducted a study on germinated cereal flour in Luganga village in the Iringa region. Many tribes in Tanzania use the germination of cereals for brewing the local beer; as far as brewing was concerned, therefore, the process (germination) was not a new one for many mothers. It was, however, a new concept as it related to the germination of cereals for porridge-making.

The objective of the study, as expressed by Mosha (1985), was to determine the acceptability for mothers of bulk-reduced "uji," their readiness to use the technique, and the actual intake of this porridge by young children. This paper highlights the general methodology used during the study, and the promotion of the use of P.F. in other parts of the country. In conducting the exercise, 40 households were selected randomly. These households represented all the village administrative cells. From each of the selected households, young children were chosen and their weights recorded monthly for 10 months.

Before the P.F.-treated porridge was fed to the children, it was served to the mothers: young children will usually eat what their mothers will eat. Porridge containing 20% flour was cooked for 30 min, cooled to 40°C, reduced in bulk by the addition of germinated flour, and served to the mothers. The mothers were asked to score their reactions on a hedonic scale score sheet. The parameters considered were smell, colour, taste, texture, and readiness to feed this type of food to their children. The scale ranged from 5 (very good) to 1 (very bad), as described in the Indian Standard of 1972 (Mosha 1985). The research team interviewed mothers who couldn't read
and write, and helped in marking the scores. The acceptance and use of P.F. in the household was recorded by mothers who participated in the food intake study; this study continued for 3 months.

Results and Discussion

Figure 1 shows the viscosities of gruels prepared from different amounts of ungerminated and germinated flours (5-25% counted as dry matter). All the ungerminated flours had very similar concentration viscosity relationships: a suitable eating consistency for small children (1000-3000 cP) is obtained with gruels containing about 10% flour.

With germinated flours, large differences were observed among the varieties studied. For the improved white sorghum variety and for the maize, the amount of flour in the gruels can be increased considerably (2-3 times) before the viscosity becomes unacceptably high. This is evidently a result of starch degradation caused by the action of the alpha- and beta-amylases that develop during germination.

For the improved brown sorghum variety, however, germination for 48 h had no observed effect on the concentration/viscosity relationship. The amylolytic activity obviously developed more slowly in the high-tannin sorghum variety. The explanation for this may be the inhibitory effect exerted by the tannins on the activity of amylolytic enzymes in the seed (Ljungqvist et al. 1981).

Figure 2 shows how, when the thick gruels were cooled to 40°C after cooking, their viscosities were affected by the addition of germinated flour. Before this addition, the flour gruels prepared from

![Graph showing viscosity changes](image)

**Fig. 1. Viscosity curves of various gruel concentrations of ungerminated and germinated grains.** (□) 5DX, ungerminated; (■) 5DX, germinated; (○) ET-35, ungerminated; and (●) ET-35, germinated.
Fig. 2. Viscosity of gruels with ungerminated flour, concentration 15% at 40°C (□); after addition of germinated flour at 40°C and viscosity measured after 10 min (■). A, acceptable eating consistency for children of approximately 1-3 years. A, local, ungerminated white sorghum; B, improved, ungerminated white sorghum; C, local, ungerminated brown sorghum + local, germinated white sorghum; D, improved, ungerminated brown sorghum + local, germinated white sorghum; E, local, ungerminated maize; F, sun-dried, ungerminated cassava + germinated maize.

Ungerminated sorghums (15% dry matter) had viscosities ranging from 9000 to 16,000 cP at 40°C; these figures represent very thick consistencies. With the addition of a small amount of germinated flour of the white (low-tannin) sorghum varieties, the viscosity decreased within 5 min to below 1000 cP; this represents a semiliquid consistency, suitable for child feeding. Only about 5% addition (based on the total amount of flour) of germinated flour was required for this effect. The same effect was observed when germinated maize flour was added to ungerminated maize flour gruel.

To determine the heat sensitivity of the amylolytic enzymes in the germinated flours, additions were made at different temperatures. Figure 3 shows that the germinated flour can be added at any temperature between 20 and 70°C with the same viscosity-reducing effect as that described earlier for 40°C. Above 70°C, the enzymes seem to be inactivated by heat; some activity (40%) remained, however, even at 90°C.

Germinated flour of the white (low-tannin) sorghum varieties that had been prepared in the villages was also tested in this experiment, and gave the same results as the laboratory-germinated flour described earlier. In this case, however, some mouldy seeds were observed; in practical applications, these should be removed to avoid mycotoxin hazards. If the microbiological quality of the added germinated flour is questionable, the gruel can be reheated to boiling temperature after time has been allowed for enzyme activity. This will not affect the viscosity and will destroy cyanide activity (Brandtzaeg et al. 1981).
Fig. 3. Reduction of viscosity by adding germinated flour to gruels of ungerminated flour (15% concentration) at different temperatures.

Fig. 4. Viscosity of sorghum gruels with germinated flour added immediately before cooking (■) and after soaking overnight before cooking (□). □, acceptable eating consistency for children 1-3 years old.

Figure 4 shows that when germinated flour was added to ungerminated flour immediately before cooking the gruel, no viscosity-reducing effect could be observed. In this case, a 10% addition of germinated white sorghum flour was used.

Figure 4 also shows the effect of leaving the mixtures of ungerminated and germinated flours (90:10) to soak in water overnight before cooking. Here the amylolytic activity of the germinated sorghums was evidently effective. The gruels prepared from these soaked flour mixtures had markedly reduced viscosities, measured at
40°C. If this approach to producing low-density gruels is considered, it becomes important to select varieties that will give the desired effect. When only ungerminated flour was left to soak overnight before cooking under ordinary laboratory conditions, no viscosity reduction was observed.

The mothers readily accepted the bulk-reduced porridge. On average, about 30% of the mothers indicated that they were using P.F. almost every time weaning food was prepared; the rest were using P.F. 25-50% of the time.

In the studies comparing children's intake of porridge with and without P.F., the following procedure was followed once each month: on the 1st day, the children were given porridge with 5% flour; the 2nd day, they were fed porridge with 20% flour but without P.F.; and on the 3rd day, they received porridge with 20% flour, treated with P.F.

On the whole, there was a wide variation in individual food intake within age groups. Children between 12 and 24 months (the critical age during weaning) had a range of 277 ± 93 g mean porridge intake per meal for 20% solids porridge without P.F., to 347 ± 94 g for the bulk-reduced porridge (Mosha 1985). In other words, the intake of P.F.-treated porridge was more by 25% than the intake of stiff porridge of the same concentration. There was no significant variation between intake of porridge with 5% solids (liquid) and that with 20% solids treated with P.F.

Fieldwork

The acceptability of bulk-reduced white maize porridge, thinned by the addition of P.F., was tested with eight mothers. The parameters used included colour, smell, taste, texture, and readiness to feed the porridge to their children. The scores averaged “very good,” indicating favourable acceptability.

The adoption of P.F. by mothers in 40 households over a test period of 3 months is summarized in Table 1. The group using P.F. “every time weaning food was prepared” doubled. The proportion of those using it 25% or more of the time increased from 48 to 86%. These findings were later used as a basis for a regional campaign to promote bulk-reduced gruels.

<table>
<thead>
<tr>
<th>Use of P.F.</th>
<th>April</th>
<th>May</th>
<th>July</th>
</tr>
</thead>
<tbody>
<tr>
<td>Almost every time</td>
<td>12.5</td>
<td>17.5</td>
<td>27.5</td>
</tr>
<tr>
<td>50% of the time</td>
<td>15.0</td>
<td>15.0</td>
<td>22.5</td>
</tr>
<tr>
<td>25% of the time</td>
<td>20.0</td>
<td>25.0</td>
<td>35.0</td>
</tr>
<tr>
<td>Several times</td>
<td>35.0</td>
<td>30.0</td>
<td>10.0</td>
</tr>
<tr>
<td>Do not remember</td>
<td>17.5</td>
<td>12.5</td>
<td>5.0</td>
</tr>
<tr>
<td>Total</td>
<td>100.0</td>
<td>100.0</td>
<td>100.0</td>
</tr>
</tbody>
</table>
Table 2. Effect of added power flour (P.F.) on the viscosity of gruels prepared by mothers at home (maize gruel plus 5% groundnuts).

<table>
<thead>
<tr>
<th>Household number</th>
<th>Viscosity of household gruels (cP x 1000) Without P.F.</th>
<th>With P.F.</th>
<th>Temperature (°C)</th>
<th>Solids (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>120.0</td>
<td>10.0</td>
<td>38</td>
<td>18</td>
</tr>
<tr>
<td>2</td>
<td>240.0</td>
<td>5.0</td>
<td>50</td>
<td>23</td>
</tr>
<tr>
<td>3</td>
<td>280.0</td>
<td>7.0</td>
<td>43</td>
<td>25</td>
</tr>
<tr>
<td>4</td>
<td>170.0</td>
<td>4.0</td>
<td>42</td>
<td>18</td>
</tr>
<tr>
<td>5</td>
<td>80.0</td>
<td>1.5</td>
<td>38</td>
<td>15</td>
</tr>
</tbody>
</table>

aViscosity for the samples with P.F. was read at a temperature of about 2°C below the sample without P.F. A spindle speed of 2 rpm was used for all the determinations.

Table 2 summarizes the effect of maize P.F. on the viscosity of gruels prepared by mothers, using ordinary maize flour and 5% groundnut flour. The treated gruel was, on average, 40 times rheologically thinner than the control; this promises easier ingestion and greater nutrient intake, and accords with other investigations using sorghum and finger millet (Hellström et al. 1981; Mosha and Svanberg 1983; Mosha 1984).

Food intake by preschool children was considered for only 18 children, aged 12-48 months (the period when malnutrition is usually at its worst). On average, 50% of the children ate 440 g of the thin 5% solids porridge during one meal. The liquid bulk-reduced 20% solids porridge averaged 390 g/child per meal for 50% of the group; the 20% solids untreated thick porridge averaged only 220 g/child per meal. This indicates that in real terms, nutrient ingestion was four times greater with the bulk-reduced porridge than with the untreated thin gruel, and twice as much as with the thick untreated porridge. The amounts are within the range of results reported by other investigations on young children (Ljungqvist et al. 1981; Mosha and Svanberg 1983).

After 10 months of the Luganga study, in December 1983, a Joint Nutrition Support Programme (JNSP) was launched in Iringa by UNICEF and the World Health Organization (WHO), in collaboration with the Tanzanian government. The JNSP program was preceded by a mass campaign that covered 168 villages; about 60,000 children under 5 years of age were reached. The campaign centred around four important aspects of child survival and development: growth monitoring, oral rehydration therapy, breastfeeding and weaning foods, and immunization. The four aspects were known by the acronym GOBI. Under the aspect of breastfeeding and weaning foods, six practices were advocated:

* Breastfeeding the child for a long period (at least 1.5 years);
* Increasing the frequency of feeding;
* Preparing high-density food (thick porridge) whose thickness is then reduced by the use of P.F.;
• Using multimixes to achieve nutrient complementarity;
• Providing enough food per meal; and
• Maintaining hygienic conditions during preparation as well as during feeding.

The response in terms of a willingness to use P.F. was very positive. As was mentioned earlier, although most mothers knew how to prepare germinated cereals for brewing purposes, they did not know how to use P.F. to thin down the thick porridge. Because the procedure is not difficult, however, they easily adopted the technique.

During the campaign in each of the 168 villages, those children who were seriously malnourished were identified; their parents were then asked to take them to established feeding centres daily. At the feeding centres, the children were fed thick porridges, thinned down by P.F. The feeding was carried out by the mothers, with daily assistance from village health workers.

For the Iringa region, the application of P.F., together with other nutrition programs, had a significant effect: the child mortality rate was reduced from 152/1000 to 107/1000 by 1986. The project has also reached Mtwara, Ruvuma, Morogoro, Singida, Kilimanjaro, Arusha, and Kagera - 7 out of 20 regions, and still in progress. Over 20 radio programs have been broadcast on the use of germinated cereal flour.

Conclusions

Other researchers have reported the viscosity-reducing effect of germinated cereals in the preparation of gruels for infants and small children (Hellström et al. 1981; Mosha 1984); this effect is also recognized in a number of traditional communities. Considering the fact that the technology and raw materials are common in most village situations, one might ask why this beneficial practice is not more widely used. An answer may lie in the time-consuming nature of the operation; given the already heavy work load of the women, new and lengthy tasks may not be readily accepted. The proposed method of using germinated flour as an additive to liquefy weaning gruel may, however, still be a viable option: germinated flour requires less frequent preparation, and small portions can be set aside when the local beer is produced.

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