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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

Proceedings

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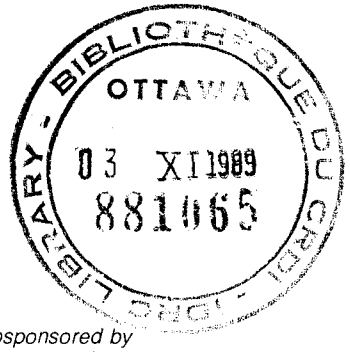
Editors: D. Alnwick, S. Moses,
and O.G. Schmidt



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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 diarrhéiques (qui s'expliquent souvent par la contamination des aliments) et diminution récente de la durée et de l'intensité de l'allaitement maternel.

Des spécialistes des sciences de l'alimentation, des nutritionnistes et des planificateurs de la santé travaillant en Afrique et en Asie du Sud se sont réunis dans le cadre d'un atelier international afin d'examiner des technologies alimentaires applicables au niveau des ménages qui semblent prometteuses pour améliorer la nutrition des nourrissons et des jeunes enfants. Après avoir examiné les connaissances actuelles en matière d'allaitement au sein et les pratiques de sevrage en Afrique orientale et australe, les participants ont discuté de l'utilisation, au cours du sevrage, d'aliments fermentés et de farine germée, tant pour améliorer l'apport nutritionnel chez les jeunes enfants que pour diminuer les risques de contamination des aliments. Ils ont également discuté des recherches qu'il y aurait lieu d'entreprendre sur l'efficacité des technologies alimentaires et sur leur diffusion dans la collectivité.

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.

Resumen

El período de destete, es decir, aquel período 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 Africa oriental y del sur muestran señales 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 Africa 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 Africa, los participantes discutieron el uso en dietas para el destete de alimentos fermentados y harina germinada para que los niños pudan 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 lainvestigación nutricional y en programas de desarrollo para mejorar la alimentación de lactantes y niños en los países en desarrollo.

CONTENTS

HIGH-ENERGY, LOW-BULK WEANING FOOD DEVELOPMENT IN ZAMBIA

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Abstract *This paper presents a rationale for weaning-food development, giving background information on sprouting of cereal grains such as millet, sorghum, and maize. This practice of sprouting is shown to be a traditional one, not only in Zambia but in other African countries. A case study was undertaken by the National Food and Nutrition Commission (NFNC); this study evaluated germinated and ungerminated staple cereals for dietary bulk, protein digestibility, and iron availability. The results showed that germination could be used to alter the consistency of high-viscosity gruels, while increasing their energy and other nutrient density. A nutritional study has therefore been proposed on the acceptability and use of germinated cereal flour in weaning foods and on the problems of low food intake among preschool children; this study is to take place in Solwezi District, in the Northwestern Province of Zambia. The project will run for 1 year, after which a seminar will be held to discuss and evaluate the results.*

In Zambia, mortality among preschool children (4 years of age and under) is very high, caused mainly by protein energy malnutrition (PEM) combined with infection. PEM poses a major health threat to the nation: recent estimates (1986) based on hospital records indicate that malnutrition is either a direct cause of, or a major contributing factor in, 70% of child deaths in Zambia. Inadequate food intake has been found to be largely responsible for the prevalence of PEM (FAO/NFNC 1974). With the initiation of weaning, a child enters a very delicate stage of its life. The traditional foods usually introduced to a child during weaning have bulk properties that limit energy and other nutrient intake. A possible solution to this bulk problem has, in recent years, been seen to lie in concentrated energy sources. Such products are, however, costly and therefore rarely available to low-income families. A more practical solution to the dietary bulk problem lies in the use of traditional methods of fermentation and germination - methods that have been shown to reduce the dietary bulk of cereal-based weaning foods.

UNICEF (1986) reveals that in 1980, 6.4% of admissions of children to hospitals throughout Zambia were attributed to PEM and

other nutritional disorders. In 1978, these disorders were responsible for about 13% of deaths in children under 5 years of age, as compared with 18% in 1980. This deteriorating situation is the result of a complexity of factors, the major one being the lack of cheap, high-energy, low-bulk local weaning foods. Such foods, if available, could assist mothers in providing an adequate diet during the weaning period.

Breastfeeding in Zambia continues until the child is 2-3 years of age (Dirorimwe 1980). To meet the child's increasing nutrient requirements, however, foods supplementary to breast milk must be introduced when the child is 4 months of age. It is at this stage that food problems emerge, of which dietary bulk is one of the most important.

Dietary bulk may be the limiting factor in energy and nutrient intake in early childhood: it is a problem both of low energy and nutrient density (amount per volume of food) and of consistency.

In rural communities, the most common staple food is maize, followed by cassava, sorghum, and millet. The cereal is made into a flour that is usually prepared as a stiff porridge ("nshima"). The amount of flour in such a porridge is about 30%; this gives an energy density of 1 kcal/g. Although "nshima" is consumed mainly by adults, children, when they reach the age of about 1 year, are introduced to this food. Although the energy density of "nshima" is acceptable, its sticky consistency limits the quantity that can be consumed by children.

To overcome this bulkiness, mothers often dilute the porridge or prepare it with less flour; in both cases, a thin, soft porridge is attained that has a consistency suitable for child feeding (a thin porridge, containing 5% dry matter and giving 0.2 kcal/g, and a softer, thicker porridge with a semiliquid character, containing about 10% dry matter). Food-intake studies have shown that whereas weaning-age children can eat only about 150-200 g of the thick "nshima," they are able to eat 300-400 g per meal of the thin, semifluid porridge. The nutrient density per volume of food in the thin porridge is, however, reduced; to meet his or her nutrient requirements, a child would have to consume about 3-5 L over one or two meals, and that is clearly impossible. The only alternative would be to feed the child at least 6-7 times per day; only in this way would energy and other nutrient requirements be met, especially during illness (Mosha and Svanberg 1983). The heavy work load of women, particularly during the farming season, makes this frequency of feeding impracticable.

Rationale

The energy and nutrient density of weaning foods can be increased by the addition of oil, fats, or sugar (Wilfart 1983). These concentrated energy sources increase the energy density and reduce viscosity; they are, however, too expensive for the poor. An alternative solution to the dietary bulk problem is the increased use of improved traditional food preparation methods, such as fermentation and germination.

Fermentation of cereals breaks the starch structure and reduces the water-binding capacity of the porridge. The fermented products

are usually used for alcoholic beverages. Studies conducted in Zambia on fermented products have thus far been limited; further studies are needed, firstly to develop products of adequate energy density, and subsequently to test these products for their acceptability.

Germination, on the other hand, is a traditional process that is used in the brewing of local beer. In germinating seeds, amylolytic enzymes are developed in cereal varieties. The alpha-amylases are synthesized within the cells of the aleurone layer; from here, they migrate to the starchy endosperm, where hydrolysis of the starch granules begins (Mosha 1984; Svanberg 1985). This means that upon cooking, the starch granules will not swell to the same extent, and the amylase chains (which form the gel network) will be broken down. Studies carried out by Mosha and Svanberg (1983) also show that when a small amount of germinated flour is added to thick porridge, the porridge is liquefied within minutes.

Practice of Germination

The practice of sprouting seeds of various cereal grains (such as millet, sorghum, and maize) is an old tradition in Zambia (Richards 1939; Thompson 1954). The practice of sprouting has also been reported in South Africa, Botswana, and Swaziland (Novellie 1977), and in Tanzania (Mosha and Svanberg 1983). In all these reports, germination of cereals was used in the brewing of beer: this involves a twofold process of fermentation - with bacteria that produce lactic acid, and with yeasts that produce alcohol. In Zambia, sprouted cereal flour is also used to prepare, on a small scale, a nonalcoholic sweet beer called "munkoyo." This beverage is based on the roots of Rhynchosia insignis. Research is underway to enable its production on a commercial scale.

For germination, seeds are soaked in water and sprouted for 1-4 days, depending on the product one wishes to make. Banana leaves are traditionally used to sprout the seeds. After sprouting, the seeds are dried on mats and milled to obtain flour. During this process, there are many changes that occur in chemical composition (Lorenz 1980), including changes in dry matter and in total protein. Of particular importance to the study under consideration were the antinutritional factors associated with germinated foods: these include aflatoxins, cyanide development, tannins, phytates, and fecal coliforms.

Research has revealed that during germination, mycotoxins such as aflatoxins produced from Aspergillus flavus, Pasticus, and Penicillium moulds are developed (Frazier and Westhoff 1978). After the germinated seeds have been washed, cooked, or dried at high temperatures, however, these mycotoxins are destroyed. It is also reported that germinated sorghum seeds contain detectable amounts of dhurrin - a cyanogenic gycoside that yields hydrocyanic acid upon hydrolysis (Akazawa et al. 1960). This cyanide exists in the form of heat-stable, nonvolatile cyanogenic glycoside; it cannot be destroyed, either by drying or by cooking. The amount intended for use in the porridge to reduce dietary bulk is, however, very small (5-10 g/100-125 mL). This constitutes 18.6-37.23 ppm/100-250 mL of hydrocyanic acid, which is less than the average permissible consumption level of 200 ppm/day of hydrocyanic acid (Conn 1973). Nevertheless, to ensure

safety in the use of sorghum sprouts, studies are required to measure the hydrocyanic acid levels in porridge prepared in the household.

Tannins and phytates are naturally occurring substances in sorghum and millet. Tannins are reported to inhibit protein digestibility; phytates have been shown to bind minerals such as iron and zinc. One advantage of the germination procedure is that it considerably reduces the levels of tannins and phytates (Mosha and Svanberg 1983).

Untreated water used in the rural areas for soaking seeds has been shown to be contaminated with fecal coliforms that are likely to cause diarrhea (Svanberg 1985). This water should be reboiled to get rid of the coliforms and other bacteria.

Case Study

A laboratory-based case study was undertaken by the NFNC; this study evaluated germinated and ungerminated staple cereals for dietary bulk, protein digestibility, and iron availability (Luhila 1986). The study had two aims: the first was to determine whether the use of germinated cereal flour in sorghum- and millet-based porridge reduces dietary bulk; the second was to determine whether protein digestibility and iron availability can be improved through germination.

Methodology

The seeds of sorghum and millet were first washed in 0.2 hydrochloric acid. Half the seeds were soaked for 16 h and germinated for 48 h; they were then dried and milled. Both germinated and ungerminated samples were analyzed for nitrogen content, using the method described by Hambraeus et al. (1976). Crude protein levels were obtained by multiplication by the factor 6.25. In vitro protein digestibility was analyzed by the method described by Mertz et al. (1984). Total iron was determined by atomic absorption spectrophotometry after wet-washing in nitric acid. In vitro iron availability was analyzed by the method described by Narasinga and Prabharathi (1978). The viscosity of sorghum (Zambia Sorghum Variety 1 (ZSV1)) was measured using a Haske Rotovisco model RU1, with an SC 11 profile measuring system and a shear rate of 54 rounds per minute.

Results and Discussion

Total nitrogen increased in germinated sorghum varieties (local and ZSV1) and in germinated millet (local variety). Total iron also increased in germinated sorghum and in germinated millet (local varieties). These increases are attributable to dry-matter losses through respiration. In vitro protein digestibility increased in germinated sorghum (ZSV1) and decreased in germinated millet (local variety). The increase, according to Mosha and Svanberg (1983), could have been due to a decrease in tannin content. In vitro iron availability increased in germinated millet but not in sorghum (ZSV1). Here again, the increase could have been the result of a decrease of inhibitors such as phytates.

The viscosity measurements of ungerminated and germinated sorghum at a consistency of 3000 cP (the suitable eating consistency for

children) indicated that the concentration of ungerminated flour was 13%. In order that a similar consistency be attained before the viscosity became high and unsuitable for child feeding, a double amount of germinated flour was required. Moreover, when 10% germinated cereal flour was added to thick porridges prepared from ungerminated flour, the dietary bulk was reduced.

Conclusions

The study showed that germination - a traditional method known not only in Zambia but in the SADCC region as well (Vogel and Graham 1979) - could be used to reduce the consistency of high-viscosity gruels, and at the same time increase energy and other nutrient density. As a result, further research on the acceptance and use of germinated cereal flour is underway.

Future Research

A project has recently been undertaken by NFNC to investigate the following: weaning food practices, nutritional status of preschool children, frequency of feeding, beer-brewing practices, and the provision of sanitary services, of water supply, and of food.

In light of the potential of germinated cereals for use in weaning foods, and because of the problem of PEM among preschool children, we shall test the hypothesis that "the use of germinated cereal flour in weaning foods would lead to improved food intake in children and, consequently, improve the nutritional status of the children." Other variables in the study will include: acceptance and adoption of the use of germinated cereal flour in weaning foods, existing methods of germination, storage of malted flour, and general handling of malted flour. If sprouted sorghum or millet is used, the hydrocyanic acid will be measured in the dietary bulk-reduced porridge. The long-term objective of this project is to determine the impact of the intake of bulk-reduced porridge on the nutritional status of preschool children.

Methodology

The northwestern province has been chosen as the first for implementation of the project. This province is one of the few in which nutrition surveys have recently been conducted; these studies found malnutrition to be prevalent. A second reason for this choice of province is the fact that its institutional infrastructure for training and for nutritional work is comparatively well developed: there is a "Nutrition Mobile Team Program" in the northwestern province, covering the three districts of Solwezi, Kasempa, and Mwinilunga; it is sponsored by the Area Development Project.

Because their funds are limited, however, the NFNC project will be confined to the Solwezi District. Using the same sample points as those used by the Nutrition Mobile Team Program, all the children between the ages of 3 and 36 months will undergo preliminary assessment for malnutrition. Data on frequency of feeding, weaning practices, health status, sanitation, brewing practices, and food availability will be collected. Using stratified, random sampling, a

total of 300 households will be selected from the Solwezi nutritional status survey for the study. The anthropometric study will include growth and physical development in relation to height and weight. The nutritional indicators that will be used to screen for chronic and present malnutrition are weight/age and weight/height. All other factors to be included in this study will be reflected in a questionnaire. After the preliminary assessment study, the households selected will be categorized according to the experiments that will be carried out in each area; the children will be grouped for feeding as follows:

- Group 1 - Children will be fed porridge made with germinated cereal flour that has been supplemented with groundnuts or beans;
- Group 2 - Children will be fed porridge made with ungerminated cereal flour that has been supplemented with groundnuts or beans; and
- Group 3 - Children will be fed porridge made with unsupplemented, ungerminated cereal flour.

Group 1 will receive bulk-reduced porridge as well as supplementation with other nutrients; group 2, although supplemented, will retain the problem of bulk; and group 3 will act as a control. Respondents (mothers) in groups 1 and 2 will be taught how to prepare groundnuts or beans for use as a supplement in weaning foods. Those in group 1 will also be taught how to select cereal seeds, germinate them in hygienic conditions for 2 days, and store them properly.

The study will test the willingness of the mothers to use germinated cereal flour, supplemented with groundnuts or beans, in weaning foods. In this experiment, demonstrations will be made of the effects of germinated cereal flour. The mothers will be asked to observe the consistency of plain porridge and that of porridge made with germinated flour and a supplement. The porridges will then be served to the mothers, and their reactions recorded on a hedonic scale as shown by Mosha (1984). Parameters used in this study will include smell, colour, taste, texture, and general willingness on the part of the mothers to use the product. In addition, the preparation of protein-supplemented porridge will be demonstrated and organoleptically tested by respondents in group 2.

The study will then test the willingness of the children to eat supplemented, bulk-reduced porridge and supplemented, untreated porridge. To determine the amount of porridge the children are able to consume, actual intake will be measured. These acceptability studies will be carried out for 2 months, for 5 days in each month. This period will allow the mothers experience in weighing or estimating food amounts, in preparation, and in feeding; they will then be ready to adopt the experimental germinated cereal supplements at the household level. Records of frequencies of feeding will also be kept.

Progress reports and monitoring data will be provided at the household, local, and district levels on a quarterly basis. Parents will be trained on the use of growth chart information; they will therefore be able to determine whether their child is underweight, and to seek advice from the health workers. The annual review will provide an effective tool with which to assess the implementation and

impact of the project. A seminar will also be held, in which the results of the research will be explained to the participants.

The participants will include nutritionists, health workers, community workers, and agricultural extension staff. Relevant organizations such as the University of Zambia and UNICEF will be invited. NFNC will cooperate with other groups in carrying out the project; these groups will include the district council, ward officials, social development officials, hospitals, clinics, the nutrition group, and women's clubs.

Conclusions

Porridges made with sorghum, millet, and maize are widely used as weaning foods in Zambia. Such porridges are not only low in energy but also bulky, making it difficult for small children to consume enough to meet their needs. Although bulk reduction can be achieved by the addition of sugar, oil, and fat to the porridge, these items are too expensive for the poor. A possible solution to the dietary bulk problem is the use of traditional methods of fermentation that have been shown to reduce the dietary bulk of cereal-based weaning foods.

The rationale for weaning food development has been given. It has also been shown that germination of cereals is a traditional practice. Although germinated cereals have been used mainly for brewing beer, the practice of germination can now be used for reducing dietary bulk and, at the same time, increasing the density of energy and of other nutrients. The project on the use of germinated cereal flour will take place in the Solwezi district of the northwestern province of Zambia. This project will run for 1 year; at the end of this year, a seminar will be held to discuss and evaluate the results.

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