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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 África 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 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 germinada para que los niños puedan 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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FERMENTED "UJI" AS A NUTRITIONALLY SOUND WEANING FOOD

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Abstract Household-level food technologies involve preparation methods that can influence, positively or negatively, the nutritional quality of foods. Fermentation is a simple, low-cost technology that requires relatively little energy; this technology can be applied in rural areas to produce foods that are both nutritionally sound and safe. Fermentation is known to detoxify natural food antinutrient substances, to enrich foods with vital nutrients, and to render food more digestible. Fermented "uji" can be prepared from cassava, sorghum, millet, or maize flours, all of which are available in rural households. This food is said to stimulate milk production in lactating mothers. Although fermentation tends to increase levels of riboflavin and tryptophan in "uji," the process has no effect on niacin. Phytate is apparently hydrolyzed by fermentation, but amylolysis appears limited, thus having little effect on the bulkiness of the food. Some preliminary results show that the "uji" fermentation tends to eliminate coliforms. More investigations are, however, necessary to assess the effect of "uji" fermentation on the diarrhea-causing organisms that frequently contaminate weaning foods.

In the rural areas of developing countries, household-level food technologies are generally characterized by their simplicity, their low energy requirement, and their modest cost. These factors are important in areas of poverty and lack of essential facilities such as clean water and fuel. Moreover, these technologies have evolved over generations: experience has taught us to reject those techniques that are not safe and beneficial. Household-level food technologies make the best use of the locally, and therefore most abundantly, available raw materials. Despite these advantages, however, there is no doubt that when an innovative food or food preparation method is introduced without proper education and appropriate resources, problems are likely to occur: those weaning foods introduced by the developed world into the rural areas of developing countries have had a negative effect on nutritional status.

Porridges, whether fermented or not, have been used for a long time as weaning foods in Africa. A porridge such as "uji" can be simply prepared from raw materials ranging from root crop flours, such as cassava, to cereal flours, such as maize, sorghum, and millet

(Mbugua et al. 1983). Such gruels contain nutrients (carbohydrates and minerals) important to a growing child; supplemented with a good source of protein, such as breast milk, these gruels have for generations been used successfully as weaning foods in different parts of Africa.

Food-Processing Methods

Household food technologies are generally simple. They should be low in cost, relatively unsophisticated, and, most importantly, low in energy consumption. Table 1 shows the classification of various food preparation methods that are likely to be encountered at the household level.

Food preparation by means of biological modification in general means the use of that method which is least energy-intensive and lowest in cost. Such a method could involve simply placing the food in a container and storing it for some period at ambient temperature. During this period, spontaneous, natural biochemical changes set in through modification by microorganisms or enzymes. It is by sheer good luck, however, that some of these biochemical changes have produced certain foods that are nutritionally sound and safe for consumption. In most plant food materials, lactic acid fermentation tends to establish itself as long as water activity and redox potential are appropriate in the plant food system. This has proved to be extremely useful to humans and animals: the sour taste is highly acceptable, and the low pH inappropriate for the growth of pathogens.

The example of "uji" preparation by fermentation illustrates the simplicity with which the fermentation process can be applied. Slurries of flour in water are prepared and left to ferment spontaneously for some days. The metabolic associative growth of the microorganisms leads to a predominance of lactobacilli, which are tolerant to high acidity: the nonacid-tolerant organisms are sequentially eliminated (Mbugua et al. 1984). The spontaneous lactic fermentation of "uji" is attributed mainly to *Lactobacillus plantarum*, some coliforms, heterofermentative *Lactobacilli*, such as *Lactobacillus fermenti*, *Lactobacillus cellobiosus*, and *Pediococcus* (Mbugua et al. 1984). In food preparation, the 2 major objectives are usually safety and organoleptic acceptability; the nutritional implications of food preparation methods are usually of a lower priority, or are not considered at all.

Nutritional Implications for Household Food Technologies

A nutritionally sound food is characterized by factors of nutritional quality, and should be devoid of those factors creating nutritional stress. Factors of nutritional quality include the nutrients present in the food, and the antinutritive elements, the level of which should be zero. Nutritional stress factors are those that tend to increase nutritional requirements: these factors include deficiencies in diet, imbalance among nutrients, and the presence of deleterious substances such as chemicals and microorganisms that can cause diarrhea and other illnesses. Table 2 shows a list of nutritional stress factors and their properties.

Table 1. Organization of food preparation methods.

| Group/type of operation | Unit operation |
|-------------------------|--|
| Separation | |
| Physical | Extraction, sieving |
| Mechanical | Cleaning, grinding, dehulling, filtration, winnowing |
| Chemical | Hydrolysis |
| Biological | Fermentation, enzymatic modification |
| Preservation | |
| Physical | Dewatering, temperature modification, packaging |
| Mechanical | Washing, soaking |
| Chemical | Smoking, curing, salting, pH changes |
| Biological | Fermentation |
| Preparation | |
| Physical | Cooking, baking, frying |
| Mechanical | Mixing, mashing |
| Chemical | Aging |
| Biological | Sprouting, malting |

The various food preparation methods at the household and industrial levels can influence nutritional stress factors to the advantage and the disadvantage of consumers. Although preparations involving dehulling and milling lead to a decrease of tannins in dry beans and to the removal of phytates, this has its advantages; on the other hand, some protein, some minerals (such as iron, copper, and zinc), and some vitamins are lost. Soaking and other extraction methods are known to reduce thioglycosides and cyanogenic glucosides. Such has been the case in Nigerian "gari" preparation where, unfortunately, large quantities of Vitamin C are lost; thiamine, riboflavin, and niacin are also lost during the steeping processes of "ogi" preparation (Akinrele 1970). Alkali treatment of sorghum with wood ash in Burundi is said to reduce substantially the levels of tannins (Price et al. 1979); this treatment is likely, however, to reduce protein quality by forming artifactual amino acids.

The fermentation process is known to be extremely effective in eliminating a number of nutritional stress factors. In "uji" fermentation, hydrolysis of phytate is reported (Mbugua et al. 1983). Because of the subsequent acidification, however, amylolysis during "uji" fermentation is extremely limited (Mbugua et al. 1983); a reduction in bulk for infant feeding cannot, therefore, be achieved in this way. The natural lactic acid fermentation is also said to detoxify sunflower meal by reducing the chlorogenic acid (Knorr 1987). The lactic acid-producing bacteria and other organisms with alpha-galactosidase enzymes are important in reducing oligosaccharides, such as raffinose, stachyose, and verbascose, that cause flatulence and diarrhea in humans. Those with beta-galactosidase activity can be useful in hydrolyzing lactose in milk products, thus enabling people who are lactose-intolerant to consume milk-based products.

Table 2. Nutritional stress factors in some common food materials.

| Stress factor | Chemical nature | Occurrence | Action | Dietary effect |
|----------------------|------------------------|-------------------|-----------------------------|---|
| Phytates | Organic acid | Cereals, legumes | Chelates metals | Decreases mineral availability |
| Oxates | Organic acid | Spinach, amaranth | Chelates cations | Decreases Ca and Fe availability |
| Gossypols | Polyphenol | Cotton seed | Chelates metals Reactive | Anemia Potential poisoning |
| Tannins | Polyphenol | Beans, sorghum | Binds proteins | Protein made insoluble Enzyme inactivated Decreases Fe and B12 availability |
| Avidin | Protein | Egg white | Binds biotin | Biotin made available |
| Trypsin inhibitors | Protein | Legumes, cereals | Inhibits proteolysis | Decreases protein availability |
| Solanine | Alkaloid | Potato | Inhibits choline esterase | Gastrointestinal or neurological disorders Potential poisoning |
| Linamarin | Cyanogenic glycoside | Cassava | Releases cyanide | Potential poisoning |
| Thiaminases | Protein | Fish | Destroys thiamine | Possible thiamine deficiency |
| Goitrogen | Glucosinolate | Rapeseed, cabbage | Goitrogenic | Decreases iodine intake |

It has been noted that sunflower meal can be detoxified by lactic acid fermentation. Detoxification of gossypol by *Diploida* fungus has been observed in cottonseed meal (Knorr 1987). Cassava is detoxified by use of corynebacterium organisms (Akinrele 1970). Fermented peanuts with *Aspergillus oryzae* are said to contain no aflatoxins, and *Rhizopus* moulds are even said to degrade aflatoxin (Knorr 1987). The high intake of fermented milk has been reported to result in decreased cholesteremia (Spoerry 1974). Even the omnivorous rats fed with *Lactobacillus acidophilus* organisms produced decreased activities of beta-glucuronidase, nitroreductase, and azoreductase, the bacterial enzymes in the gut believed to convert procarcinogens to proximal carcinogens (Knorr 1987). The bacterial organisms are said to produce similar effects in humans.

Because it is believed to stimulate milk production, fermented "uji" is sometimes prescribed for lactating mothers who are short of milk. This belief needs to be investigated; it is known, however, that lactic acid, a major organic acid in fermented "uji," stimulates the absorption of calcium, a major mineral in milk formation. The fermentation of "uji" has been shown to be efficient in inhibiting and eliminating coliforms (Mbugua et al. 1984). This would imply that the process can be effective in eliminating diarrhea-causing organisms, particularly those from the enterobacteriaceae group; also indicated is the potential for "uji" as a weaning food, especially under relatively unsanitary conditions. More work, however, needs to be done in this area. Studies with diarrhea-causing organisms, such as salmonella, staphylococci, and enteropathogenic *Escherichia coli* have shown that they can be inhibited in milk by different lactic acid-producing bacteria (Minor and Marth 1972; Park and Marth 1972; and Frank and Marth 1977). Further studies with "uji" have shown that during fermentation, levels of riboflavin and tryptophan increase significantly (Mbugua 1986). Increases in lysine, leucine, isoleucine, methionine, and relative nutritive value have been reported in various fermented cereals (Hamad and Fields 1979; Kazanas and Fields 1981).

Conclusions

The advantages of fermented foods as described in the literature far outweigh the disadvantages. Examining the nutritional benefits, the convenience, the low cost, and the safety of fermented foods, it appears that such foods could be extremely useful in weaning. It is not clear, however, why in many societies these foods have not been widely used; there is a need for research and for promotion, especially in those areas whose local conditions call for the particular advantages provided by fermentation.

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