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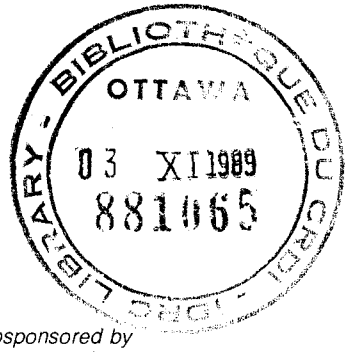
Editors: D. Alnwick, S. Moses,
and O.G. Schmidt



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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

FERMENTATION OF MAIZE-BASED "MAHEWU"

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Abstract *Studies were made on the production of lactic acid and pH changes during "mahewu" fermentation. The following parameters were found to affect these changes: varying quantities of sorghum malt, incubation temperature, ingredient type added to the porridge, solids content of the porridge, and cooking time. The quantity of sorghum malt added to cooked porridge significantly ($P \leq 0.01$) influenced the amount of lactic acid produced. Incubation of "mahewu" (12% solids) at 45°C for 16 h produced the most acceptable product. The addition of wheat bran to the cooked porridge before fermentation resulted in the highest amount of lactic acid (0.450%) produced. The addition, however, of rapoko/ sorghum malt produced the most acceptable "mahewu," with 0.575% lactic acid. "Mahewu" with 14% solids content was judged the most acceptable. The amount of lactic acid produced was not significantly affected by cooking time.*

"Mahewu" is a nonalcoholic beverage popular among the indigenous people of southern Africa. The consumption of "mahewu" is highest among farmers, school children, and junior members of staff of mining companies and industrial firms. Because of the improved nutritional value of the fermented product, nongovernmental organizations (NGOs) in Zimbabwe, such as the Red Cross and Christian Care, have used "mahewu" in supplementary feeding programs.

Even though some degree of success has been reported in the commercial production of "mahewu" in South Africa (van Noort and Spence 1976), the basic knowledge of the principles involved in "mahewu" fermentation cannot support present industrial enthusiasm. Commercial "mahewu" production in Zimbabwe has met with limited success. Two companies - Nutresco (Pvt) Ltd and Food and Industrial (Pvt) Ltd - are currently involved in large-scale production of "mahewu". Nutresco's "mahewu," made from precooked maize meal, sorghum flour, and barley malt enriched with minerals, vitamins, and fortified with soy protein, is claimed to be high in protein (15-19%) and in energy (330-402 kcal/100 g).

Food and Industrial (Pvt) Ltd produces two forms of "mahewu" - standard and instant. Standard "mahewu" is made from precooked maize meal, sorghum malt, sodium benzoate (as a preservative), and

saccharin. Instant "mahewu" powder is made from precooked maize meal, milled roasted maize grains, lactic acid (to impart the characteristic "mahewu" flavour), brown sugar, and saccharin. Both mixtures are enriched with minerals and vitamins and are fortified with full fat and defatted soy meal. The continued use of saccharin is, however, disturbing: there is concern over evidence from animal experiments, linking saccharin to certain carcinomas (Newell 1981; Waddell and Lachance 1981; Jensen 1985; Schoenig and Anderson 1985). The method of production and the ingredients used vary from place to place.

Different methods of producing "mahewu" have been described by different workers (Van der Merwe et al. 1965; van Noort and Spence 1976; Steinkraus 1983). Steinkraus (1983) notes that wheat flour provides the inoculum and is the source of growth for the spontaneous fermentation. The fermentation of maize meal to produce "mahewu" is a spontaneous process in which the natural flora of sorghum malt or wheat flour carry out the fermentation. The traditional souring process is not ideal for large-scale industrial production. First, the initial inoculum of the desirable lactic acid producing bacteria is very low, resulting in low acid production in the early phase of fermentation - an extended competitive phase, during which aerobic microorganisms survive and produce undesirable end products. Second, uncontrolled ambient fermentation temperatures favour the growth of undesirable microorganisms and can result in a secondary fermentation that produces acetic acid, butyric acid, or both - acids that detrimentally affect the taste of the product.

Schweigart and de Wit (1960) demonstrated that the fermentation process of maize porridge could be reduced from 36 h to 3 h using a starter of Lactobacillus bulgaricus and L. delbrueckii. This enhancement of the fermentation process has been used in the preparation of "ogi" and "ting" (Banigo et al. 1974; Mpuchane 1985).

Fermentation has been proposed by several investigators as a way of improving the nutritional quality of cereals (Hamad 1978; Hamad and Fields 1979; Kazanas and Fields 1981). Cameron and Hofvander (1971) reported an increase in the riboflavin and niacin content of fermented maize. Kazanas and Fields (1981) observed that natural lactic fermentation of ground grain sorghum increased significantly the availability of the following: lysine, leucine, isoleucine, methionine, niacin, thiamin, and riboflavin. As well as improving the nutritional value of foods, lactic acid producing bacteria are also reported to produce antimicrobial agents that inhibit the growth of undesirable microorganisms (Shahani et al. 1976, 1977). To gain a better understanding of "mahewu" fermentation, experiments were therefore designed to study the effects of the following parameters: variations in the quantity of sorghum malt, optimum incubation temperature, type of ingredient added to the porridge, solids content of the porridge, and cooking time, with respect to the production of lactic acid and pH change.

Materials and Methods

Tap water (500 mL) was added to a mixture of 30 g of maize meal and 30 g of sorghum malt. The resultant broth was boiled for 10 min. The porridge (12% solids) was cooled rapidly (by immersing pot in cold tap water) to ambient temperature (average 20°C). The 500 mL of porridge was then poured into fermentation jars. An appropriate

quantity of sorghum malt (0-60% w/w) was added to each jar and the contents were thoroughly mixed by shaking; this mixture was then incubated at 25°C for 16 h, after which the percentage lactic acid and pH were determined.

Sorghum malt (30 g) was added to eight jars, each containing 500 mL of porridge (12% solids). The contents were thoroughly mixed by shaking and a sample taken of each and incubated at 20, 25, 30, 35, 40, 45, or 50°C for 16 h. To the porridge, 30 g of one of the following ingredients (National Foods (Pvt) Ltd, Harare) was added: wholemeal wheat flour, plain wheat flour, sorghum malt, barley malt, rapoko/sorghum malt (1/3 rapoko, 2/3 sorghum malt), maize meal (No. 1 Roller meal), and wheat bran (Red Seal). A control batch of porridge was made, to which no ingredient was added after cooking. A sample of each of the above treatments was incubated at 25°C for 16 h. Porridge samples of 500 mL were prepared as discussed but containing 8, 10, 12, 14, 16, and 20% solids. The samples were incubated at 25°C for 16 h.

Seven porridge samples (12% solids) of 500 mL were prepared and heated to boiling for different periods of time. The porridge samples were boiled for 0, 10, 20, 30, 40, or 50 min. After cooling the porridge to ambient temperature, 30 g of sorghum malt was added to each and the contents were thoroughly mixed. The resulting broth was then incubated at 25°C for 16 h.

To a weighed sample of "mahewu" filtrate in a 250-mL flask, three drops of phenolphthalein indicator were added. The mixture was titrated against 0.1 N NaOH.

$$\% \text{ lactic acid} = \frac{N \times V \times \text{milliequivalent (ME) of lactic acid} \times 100}{\text{weight of sample (g)}}$$

where N is the normality of NaOH, V is the volume of NaOH used (to end point), and ME is the $\frac{\text{molecular weight lactic acid}}{1000} = 0.09008$. The pH of "mahewu" was measured using a digital pH meter (PTI-15). A panel of four staff members, untrained but with experience of traditional foods, evaluated the "mahewu" using a simple preference test.

Results and Discussion

Fermentation of "mahewu" is dominated by lactic acid producing bacteria that convert sugars derived from the starch into mainly lactic acid, depending on the predominant microorganism. The sourness caused by this lactic acid has become a major organoleptic property in the traditional evaluation of "mahewu."

Effect of Adding Sorghum Malt to Porridge

The quantity of sorghum malt added to porridge significantly ($P \leq 0.01$) increased the amount of lactic acid produced (Table 1). Without any sorghum malt added to the porridge, only 0.20% lactic acid was produced after fermentation; 0.52% lactic acid was produced, however, when 30 g (5.49% w/w) of sorghum malt was added. This latter product had the most acceptable flavour. The addition of 60 g (10.70% w/w) of malt produced a product with 0.65% lactic acid, which was too "tangy" and of poorer body.

Because sorghum malt provides the initial inoculum, the higher the quantity of malt used, the greater the number of lactic acid producing bacteria present. Moreover, malted sorghum serves as a source of alpha- and beta-amylase enzymes for the saccharification of starch (Kneen 1944). These enzymes convert amylopectin and amylose (the constituent polysaccharides of starch) to dextrins and maltose, which are readily fermented by the lactic acid producing bacteria to lactic acid and other end products responsible for the final taste and flavour of the "mahewu." Steinkraus (1983) reported similar findings when wheat flour was used for spontaneous fermentation.

Effect of Incubation Temperature

The incubation temperature significantly affects the amount of lactic acid produced by the natural microflora in traditionally fermented "mahewu" (Table 2). Incubation of "mahewu" at 35, 40, and 45°C produced 0.55, 0.52, and 0.50% lactic acid, respectively. Although all three products were judged acceptable, the product incubated at 45°C was preferred. Increasing the incubation temperature to 50°C resulted in a decrease in the amount of lactic acid. This is because the optimum temperature of the natural microflora had been exceeded, resulting in loss of activity and

Table 1. The effect of varying sorghum malt quantity on lactic acid production by the natural microflora in traditionally fermented "mahewu."

	Sorghum malt treatment (g)						
	0	10	20	30	40	50	60
Lactic acid after 16 h incubation (%)	0.20	0.36	0.37	0.52	0.51	0.58	0.65[a]
pH after 16 h incubation	4.24	3.57	3.52	3.59	3.64	3.67	3.60

[a] Statistically significant at $P \leq 0.01$.

Table 2. The effect of incubation temperature on lactic acid production by the natural microflora in traditionally fermented "mahewu."

	Temperature (°C)						
	20	25	30	35	40	45	50
Lactic acid after 16 h incubation (%)	0.32	0.47	0.48	0.55	0.52	0.50	0.46
pH after 16 h incubation	4.07	3.55	3.41	3.18	3.23	3.29	3.39

possible inhibition of some of the lactic acid producing bacteria. Schweigart and de Wit (1960) observed an optimum temperature range of 30-35°C for South African "mahewu" incubated for 36 h. "Mahewu" incubated at 45°C has been found to be the preferred product: the optimum temperature for lactic acid producing bacteria is 45-50°C; at these temperatures, the growth of acetic and butyric acid producing bacteria is suppressed, resulting in a product of good quality.

Effect of Ingredient Type Added to Porridge

The amount of lactic acid produced and the pH of traditionally fermented "mahewu" varied with the ingredient added to the cooked porridge (Table 3). The addition of wheat bran to porridge produced the highest amount (0.450%) of lactic acid after fermentation, followed by barley malt (0.374%), rapoko/sorghum malt (0.373%), sorghum malt (0.350%), and maize meal (0.249%). Although Schweigart and de Wit (1960) found that the addition of wheat flour acted as a stimulant for bacterial growth, in the present study the addition of wheat flour and wholemeal flour did not exhibit any stimulatory properties on the growth of the desirable lactic bacteria.

Conditioning wheat before milling with different plants helps inactivate amylases and other enzymes that convert starch into soluble sugars. "Mahewu" prepared with rapoko/sorghum malt was the most acceptable, followed by products to which sorghum malt, maize meal, and barley malt were added.

Solids Content of Porridge

There was a general but nonlinear increase in percentage lactic acid produced with increasing solids content (Table 4). The differences were not significant between percentages of lactic acid produced

Table 3. The effect of ingredient type on lactic acid production by the natural microflora in traditionally fermented "mahewu."

Ingredient type	Lactic acid after 16 h incubation (%)	Lactic acid before incubation (%)	Lactic acid produced (%)	pH before incubation	pH after 16 h incubation
Wholemeal flour	0.251	0.123	0.128	5.56	4.36
Plain wheat flour	0.297	0.155	0.142	5.55	3.70
Sorghum malt	0.560	0.210	0.350	5.40	3.44
Barley malt	0.542	0.168	0.374	5.52	3.61
Rapoko/sorghum malt	0.575	0.202	0.373	5.48	3.57
Maize meal	0.411	0.162	0.249	5.54	3.65
Wheat bran	0.660	0.210	0.450	5.77	3.84
No additive	0.294	0.077	0.217	5.40	4.13

Table 4. The effect of solids content of porridge on lactic acid production by the natural microflora in traditionally fermented "mahewu."

	Solids content of porridge (%)					
	8	10	12	14	16	20
Lactic acid after 16 h incubation (%)	0.374	0.429	0.418	0.445	0.548	0.660
pH	3.37	3.46	3.49	3.47	3.68	3.68

with solids contents of 10, 12, and 14% (0.429, 0.418, and 0.445%, respectively). There was an increase in the percentage of lactic acid (0.548 to 0.660%) for samples with 16 and 20% solids content. The increased solids (maize meal and sorghum malt) increased the source of sugars for conversion to lactic acid and also the initial population of lactic acid producing bacteria. "Mahewu" made from porridge containing 14% was judged most acceptable.

Cooking Time of Porridge

The cooking time of porridge has not been shown to bear any relationship to the amount of lactic acid produced during spontaneous fermentation of "mahewu." Boiling (cooking) porridge is not, therefore, necessary for the production of lactic acid during fermentation. The presence of the appropriate natural microflora and enzymes appears to be enough to cause fermentation. The organoleptic properties of the uncooked broth (slurry) were, however, unacceptable to the taste panel. This demonstrates that the amount of lactic acid in the final product is not the only factor that determines the quality and acceptability of "mahewu."

References

Banigo, E.O.I., de Man, J.M., Duitschaever, C.L. 1974. Utilization of high-lysine corn for the manufacture of ogi using a new, improved processing system. Cereal Chemistry, 51(5), 559-572.

Cameron, M., Hofvander, Y. 1971. Manual on feeding infants and young children. United Nations, New York, NY, USA. p. 73.

Hamad, A.M. 1978. Evaluation of natural fermentation and germination to improve the nutritive value of cereal grains. University of Missouri, Columbia, MO, USA. PhD thesis.

Hamad, A.M., Fields, M.L. 1979. Evaluation of the protein quality and available lysine of germinated and fermented cereals. Journal of Food Science, 44, 456-459.

Jensen, O.M. 1985. Saccharin and the human cancer hazard. Statens Levnedsmiddelinstitut, Soborg, Denmark. Publikation No. 110, DK-2860. 48 pp.

Kazanas, N., Fields, M.L. 1981. Nutritional improvement of sorghum by fermentation. Journal of Food Science, 46, 819-821.

Kneen, E. 1944. A comparative study of the development of α and β-amylase in germinating cereals. Cereal Chemistry, 21, 304-314.

Mpuchane, S. 1985. Variability in the properties of "ting," a maize meal fermented product. Botswana Notes and Records, 10, 97-106.

Newell, G.R. 1981. Artificial sweeteners and cancer. Progress in Cancer Research and Therapy, 17, 273-278.

Schoenig, G.P., Anderson, R.L. 1985. The effect of high dietary levels of sodium saccharin on mineral and water balance and related parameters in rats. Food and Chemical Toxicology, 23, 465-474.

Schweigart, F., de Wit, J.P. 1960. Preparing and drying mahewu and its nutritional value. Food Industries of South Africa, May-June 1960.

Shahani, K.M., Vakil, J.R., Kilara, A. 1976. Natural antibiotic activity of Lactobacillus acidophilus and bulgaricus. I. Cultural conditions for the production of antibiotics. Cult. Dairy Product Journal, 11(4), 14-17.

_____ 1977. Natural antibiotic activity of Lactobacillus acidophilus and bulgaricus. II. Isolation of acidophilin from L. acidophilus. Cult. Dairy Product Journal, 12(12), 8-11.

Steinkraus, K.H., ed. 1983. Handbook of indigenous fermented foods. Marcel Dekker Inc., New York, NY, USA.

Van der Merwe, A.R., Schweigart, F., Cachia, V.A. 1965. Mahewu - its industrial production and its value as a nutrient. Sonderdruck ans den Heften, 6/984 and 1/1265.

van Noort, G., Spence, C. 1976. The mahewu industry. South African Food Review, Oct. 1976, 129-133.

Waddell, W.J., Lachance, M.P. 1981. Saccharin and bladder tumors. Science (Washington, DC), 214, 134.