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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,
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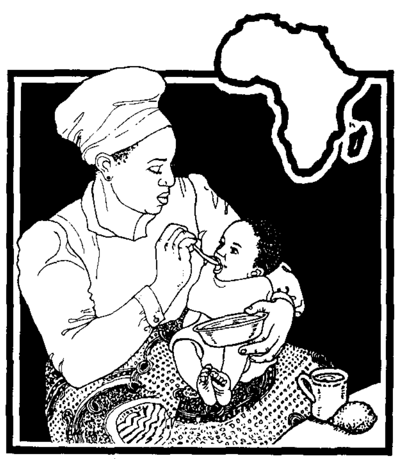

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Abstract

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 duré 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 ni o en que se introducen en su dieta alimentos suplementarios para complementar la leche materna, representa un gran riesgo nutricional para los nin os de países en vías de desarrollo. Hacia el final de su segundo a o de vida, un tercio de los ni os en Africa oriental y del sur muestran se ales de malnutrición crónica. Los siguientes factores contribuyen al crecimiento vacilante que se observa comúnmente en los ni os 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 bunos resultados en el mejoramiento de la nutrición de lactantes y ni os peque os. 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 ni os 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 ni os en los países en desarrollo.

CONTENTS

CYANIDE CONTENT OF GERMINATED CEREALS AND INFLUENCE OF PROCESSING TECHNIQUES

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Abstract *A recent paper stated that dried products from germinated sorghum contained hydrocyanic acid and were, therefore, potentially hazardous to the consumer. Work at the Overseas Development Natural Resources Institute (ODNRI) has refuted this statement (Dada and Dendy 1987). Germinated feterita sorghum, containing an average of 454 ppm cyanide as HCN, was used as a substrate. When this was dried at 50°C, little effect was had on the HCN level. It was found, however, that when the sorghum was toasted at 100 or 180°C for 15 min, and then dried at 50°C, the hydrocyanic acid (HCN) level was lowered by 83 and 96.5%, respectively. Fermentation of either a paste or a slurry of germinated sorghum for 24 h resulted in a loss of HCN in excess of 70%. Boiling the slurry or steaming the paste eliminated the HCN completely. Frying or hot-grilling the paste removed slightly more than 90% of the HCN. The Tanzanian infant food "kimea" was also studied. It was shown that during the normal process of making this food, there was a lowering to a safe level of the cyanide in the sprouted sorghum. There was no cyanide in sprouted pearl millet. In a preliminary study, no correlation was found between the tannin content of the grain and the HCN content after germination.*

Sorghum is a major source of human food in semi-arid regions that include much of eastern and southern Africa. Sorghum can be converted into excellent foods, both traditional and new, by suitable processing; this processing can also be industrialized, and the food sold in convenient retail packs. Products such as "uji" (thin porridge) and "supa mtama" (polished sorghum) are already available across the counter.

The sprouting of cereal grains results in increased enzyme activity that in turn causes the following: loss of total dry matter; change in amino acid composition; conversion of some starch to soluble sugars; slight increase in crude fat and crude fibre; and slightly higher amounts of certain vitamins and minerals (Morard and Rubenthaler 1983). Wang and Fields' (1978) suggestion that sorghum be germinated in the home was opposed by Panasiuk and Bills (1984): they considered the potential for cyanide poisoning and noted that both germinated sorghum and young sorghum plants contain appreciable amounts of the cyanogenic glycoside 'dhurrin' - a substance that, upon hydrolysis, yields hydrocyanic acid (HCN); ungerminated sorghum grain contains little or no dhurrin.

The lethal dose for HCN is 0.25-3.5 mg/kg body weight, depending on the individual; the median dose would be approximately 1 mg/kg. If a sorghum product contains 400 ppm of HCN, then the lethal ingestion would be 25 g (dwb) for a 10-kg infant. Neither should we overlook the goitrogenic effects of the ingestion of sublethal doses of HCN over a long period.

Traditional processes generally include the drying and milling of germinated sorghum to produce a sorghum malt. This malt can be used as an ingredient for the production of foods such as porridge, alcoholic or nonalcoholic beverages, and unleavened bread. Germinated sorghum can also be wet-milled into a paste or a slurry that can be further fermented before it is boiled, steamed, fried, or baked. Several authors have published accounts of traditional methods of processing sorghum in a number of countries; examples of such studies are those of Subramanian and Jambunathan (1980) and of Rooney (1984).

The main objective of this investigation was to determine the effect of traditional processing on the cyanide content of germinated sorghum. An opportunity later arose to cooperate with the United Nations Children's Fund (UNICEF) in Tanzania on the examination of an indigenous infant food, "kimea," made by adding a sprouted grain (sorghum, finger millet, or pearl millet) to a maize porridge.

Materials and Methods

Grain

The work was done in the ODNRI laboratories. Feterita sorghum was obtained commercially in the U.K. Through the offices of UNICEF in Dar es Salaam (Tanzania), ungerminated samples of white sorghum, "Serena" variety sorghum, and pearl (bulrush, pennisetum) millet were obtained from Dodoma, and finger millet (ragi, eleusine) from Sumbawanga. UNICEF also supplied sprouted samples of these grains as used in "kimea." To destroy a minor infestation of weevils, the samples were held at -30°C from arrival to use - about 12 days. Commercial maize meal was obtained by UNICEF. The grains are listed in Table 1.

Germinated Grain

Cleaned, whole grain was soaked in four times its volume of water at ambient temperature (20°C) for 24 h; it was then sprouted on a sprouting tray at 30°C in a humidity oven (RH 95%) for 2 days. The grain was washed twice daily with water during sprouting to prevent mould growth. This was considered the laboratory equivalent of the traditional germinating of grain. The laboratory samples were divided and further processed into three groups: malt meal, wet-milled products, and dry-milled products.

Table 1. HCN content of grains and malts.

	ppm HCN[a]
Grains (unsprouted)	
White sorghum ex Dodoma	ND[b]
Serena sorghum ex Dodoma	Trace[c]
Pearl millet ex Dodoma	ND
Finger millet ex Sumbawanga	ND
Sprouted grains	
Sprouted at ODNRI	
Feterita	454
White CV sorghum ex Dodoma	413
Serena CV sorghum ex Dodoma	122
Pearl millet ex Dodoma	ND
Finger millet ex Sumbawanga	ND
Sprouted in Tanzania, analyzed at ODNRI	
White sorghum ex Dodoma	12
Serena sorghum ex Dodoma	41
Bulrush millet ex Dodoma	ND
Finger millet ex Sumbawanga	ND

[a]Average of duplicates.
[b]Not detectable.
[c]Below 5 ppm.

Malt Meal

Malt meal was prepared by drying the germinated grain in an air oven at 50°C for 24 h. A form of toasting was carried out to enhance the flavour of the meal: air heated to temperatures of 100 and 180°C was passed through thin layers of the grain for 15 min. (Various combinations of drying and toasting were used (see Table 2).) After the grain had been rubbed on a sieve and the shoots and roots (growth) either retained or removed, the hammer-milling was done.

Wet-Milled Products

Wet-milled products were prepared using a mortar and pestle to grind the germinated grain with varying amounts of water; this produced either a paste or a slurry. Some of these products were fermented for 24 h at room temperature. The fermented slurry was boiled for 15 min, and the paste either steamed or fried in oil for the same length of time.

Dry-Milled Products

Dry-milled products were prepared by drying and milling the germinated grains. Samples of malt were made into a dough and toasted or boiled with water. The boiled malt was cooled, then fermented (mainly lactic acid fermentation).

"Kimea" Infant Food

To prepare the infant food, a stiff maize meal porridge was made by adding 100 g maize meal to 400 g water. This was brought to a boil and cooked for 30 s before stirring in 10 g of the germinated, dried

Table 2. HCN content of food products.

	ppm HCN
Malt meal	
Dried at 50°C and milled	446
Dried at 50°C minus growth and milled	45
Dried at 50°C, toasted at 100°C, and milled	321
Dried at 50°C, toasted at 100°C minus growth, and milled	43
Dried at 50°C, toasted at 180°C, and milled	46
Dried at 50°C, toasted at 180°C minus growth, and milled	16
Toasted at 100°C, dried at 50°C, and milled	77
Toasted at 100°C, dried at 50°C minus growth, and milled	16
Toasted at 180°C, dried at 50°C, and milled	16
Toasted at 180°C, dried at 50°C minus growth, and milled	0
Wet-milled products from germinated grains including growth	
Wet-milled into a paste and steamed	0
Wet-milled into a paste and fermented for 24 h	119
Wet-milled into a paste, fermented for 24 h, and steamed	0
Wet-milled into a paste and fried in oil	30
Wet-milled into a paste, fermented for 24 h, and fried in oil	0
Wet-milled, sieved, and slurry fermented for 24 h	122
Wet-milled, sieved, and slurry fermented for 24 h, and boiled	0
Dry-milled products from germinated grains including growth	
Dried at 50°C, milled, and boiled in water	0
Dried at 50°C, toasted at 180°C, milled, and boiled in water	0
Dried at 50°C, milled, kneaded into dough, and hot-grilled	30
Dried at 50°C, milled, boiled with water, sieved, wort-boiled and inoculated with yeast, and fermented for 24 h	0
Dried at 50°C, milled, boiled with water, and fermented for 24 h	0
"Kimea" (UNICEF samples)	
White sorghum after cooking	ND
White sorghum after cooling to 60°C	ND
White sorghum after cooling to 40°C	ND
Serena sorghum after cooking	ND
Serena sorghum after cooling to 60°C	ND
Serena sorghum after cooling to 40°C	ND
"Kimea" (ODNRI-sprouted samples)	
White sorghum after cooking	Trace
White sorghum after cooling to 60°C	Trace
White sorghum after cooling to 40°C	Trace
Serena sorghum after cooking	ND
Serena sorghum after cooling to 60°C	ND
Serena sorghum after cooling to 40°C	Trace

ground grains ("kimea"). Samples were taken at once and during natural cooling at 60 and 40°C.

Hydrocyanic Acid (HCN)

HCN was determined by the AACC method (1983), with minor modifications for distilling the homogenate. A Kjeltec Distilling Unit 1002 was used to ensure that HCN from the sample was not liberated into the atmosphere. The products from the original 10 g dry sorghum grain were blended with 100 mL water and transferred into a distillation tube that was then sealed. After standing for 2 h, 20 mL of 10% tartaric acid was added, and the steam switched on. The liberated HCN was collected quantitatively in 50 mL of 2.5% NaOH. When 400 mL of the distillate had collected in the receiver flask, it was titrated with 0.2% silver nitrate by the AACC approved method (60-20). Blank determinations were also carried out.

Results and Discussion

Table 1 summarizes the data on HCN recoveries from the various grains, and Table 2 summarizes that recovered from the food products. These data show that millet grain and sprouts supplied by UNICEF did not contain any trace of cyanide. The same result was obtained when the millet grain was sprouted at ODNRI. This is a clear indication of the likely absence of cyanogenic glycoside in millet. Although Serena CV sorghum grain did contain cyanide, the amounts were very small. No cyanide was detected in the white sorghum grain.

Germinated sorghum, dried at 50°C and milled to make a malt meal that could be used as a food ingredient, did not lower significantly the dangerously high level of HCN. This endorses the conclusions of Panasiuk and Bills (1984). Toasting the malt at 100°C lowered the HCN content only slightly; toasting at 180°C, however,lowered the HCN content by 90%. Toasting wet-germinated sorghum for 15 min at 100°C, or at 180°C, resulted in a loss of 83 and 96.5%, respectively. The removal of the shoots and roots lowered the HCN content by more than 90% (Tables 1 and 2). This would indicate the presence of limited amounts of dhurrin in the seed, as compared with the very high level in the shoots and roots of the germinated grain. The shoots and roots were not removed before preparation either of the wet-milled or of the dry-milled products. The levels of HCN were reduced by more than 70 and 90%, by a fermentation of the paste and the slurry, or by a drying and toasting of the paste, respectively.

All the processes used (with the exception of the drying at 50°C and the drying at 50°C followed by toasting at 100°C) reduced the levels of HCN by at least 70% and frequently by 100%; the remaining HCN was therefore always well below 200 ppm - the maximum level recommended in several countries for HCN in lima beans (Panasiuk and Bills 1984).

Wang and Fields (1978) suggested that germinated sorghum could and should be used to produce more nutritious foods. This brief investigation strongly suggests that foods produced from germinated sorghum, either by dry heating to 180°C, by moist heating to 100°C, or by lactic acid or alcoholic fermentation, offer little or no risk of cyanide poisoning.

Germinated sorghum, therefore, has good potential for use in traditional foods or in new, industrialized products. Shortly after the principal part of the program had been completed, there was an opportunity to examine a traditional food, "kimea," provided by UNICEF. The results from this examination are included in the tables. It will be noted that the method for making infant porridge from maize meal, whereby 10% sorghum malt is added, eliminates almost all the HCN present.

Although the addition of high cyanide sorghum sprouts (413 ppm) to hot maize porridge did not totally eliminate the cyanide, the latter was reduced to a reasonably safe level. Adding the sprouted sorghum at a lower temperature would increase the risk of cyanide poisoning. To prevent this, the flour from sorghum sprouts should be added just at the boiling point of the porridge. Assuming that the germinated sorghum obtained in Tanzania had, initially, a similar proportion of HCN to that germinated in the U.K., the HCN level must have been lowered by 90% during the transport period of 2-3 weeks. (In this context, it is worth noting that during the processing of germinating sorghum, dhurrin is hydrolyzed, thus liberating HCN. Care should therefore be taken during processing by, for example, providing good ventilation of the processing area and thus allowing the HCN to be removed without danger.)

Table 3. Relationship between tannin content of sorghum grain and the HCN content of the 2-day sprout (30°C).

Variety	% germination	Sprout length (mm)		% tannin	HCN (ppm)
		Range	Average		
M-35-1	95.4	1-60	29.6	0.04	200
ET-3491	98.8	1-80	50.3	0.05	643
NES 7360	68.3	1-40	24.0	0.05	145
2KX 17	70.0	1-40	19.2	0.06	197
IS 76	94.0	1-55	41.3	0.06	564
SPV-472	98.5	1-60	40.3	0.06	562
Lulu Dwarf	95.3	1-60	41.3	0.06	594
IS 8595	91.8	1-50	20.2	0.07	286
USA Yellow (old stock)	70.9	1-30	7.2	0.08	74
Local White (Kenya)	95.1	1-30	20.7	0.08	494
WS 1297	90.5	1-40	20.1	0.08	271
Feterita	90.5	1-70	45.2	0.09	454
CO-4	97.6	1-60	42.4	0.20	548
Local Red (Botswana)	81.5	1-50	19.5	0.50	286
Serena	81.0	1-65	24.8	1.65	387
Seredo	95.0	1-65	34.1	2.90	658
Dobbs	99.1	1-70	44.0	3.40	826
Local Red (Kenya)	90.0	1-40	25.0	7.70	200
BJ 28	90.8	1-15	4.9	9.00	308

The study attempted to draw a correlation between the ability of the sorghum variety to generate HCN on sprouting, and the tannin content of that sorghum; the results in Table 3 show that there is no such correlation. These results also show that of the 19 varieties examined, all produce dangerously high levels of HCN on germination. These concentrations of HCN can, however, be lowered to safe levels by the careful use of indigenous methods of processing and cooking.

References

AACC (American Association of Cereal Chemists). 1983. AACC approved methods (8th ed.). AACC, St Paul, MN, USA. Method 60-20.

Dada, L.O., Dendy, D.A.V. 1987. Preliminary study of effect of various processing techniques on the cyanide content of germinated sorghum. Tropical Sciences, 27, 101-104.

Morard, M.M., Rubenthaler, G.L. 1983. Germination of soft white wheat and its effect on flour fractions, breadmaking and crumb firmness. Cereal Chemistry, 6, 411-417.

Panasiuk, O., Bills, D.D. 1984. Cyanide content of sorghum sprouts. Journal of Food Science, 49, 791-793.

Rooney, I.W. 1984. Sorghum utilization in traditional foods. In Proceedings of a symposium on sorghum and millets: criteria for quality of grains and products for human food. 11th Congress of the International Association for Cereal Science and Technology, June 1984. International Association for Cereal Chemistry, Schwechat, Austria. p. 6-9.

Subramanian, V., Jambunathan, R. 1980. Traditional methods of processing of sorghum (sorghum bicolor) and pearl millet (Pennisetum americanum) grains in India. In Proceedings of a symposium on sorghum and millets processing. 10th Congress of the International Association for Cereal Science and Technology, June 1980. International Association for Cereal Chemistry, Schwechat, Austria. p. 115-118.

Wang, Y.Y.D., Fields, M.L. 1978. Germination of corn and sorghum in the home to improve nutritive value. Journal of Food Science, 43, 113-115.