USE OF CEREALS IN COMPLEMENTARY FOOD FOR YOUNG CHILDREN IN AFRICA

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INTRODUCTION

One of the strategies to improve malnutrition in developing countries is development of better complementary foods (CF). CF are foods or non-milk fluids given in addition to breast milk. The period during which other foods are given together with breast milk is called the period of complementary feeding (WHO, 1998). The traditional CF in Tanzania are based on starchy staples, including cereals such as maize, sorghum, and finger millet (Mosha et al., 2000). Porridges made from these CF are usually low in energy density and very poor in providing fats, iron and vitamins (especially vitamin A) to infants. They can be contaminated from unclean water, unwashed hands and utensils, and lack of storage facilities. There is a need to develop and establish affordable blends/formulations with energy and other nutrient contents that meet the recommended daily intake of nutrients. These blends/formulations have to be made based on existing household food resources (Van Camp et al., 2007).

MATERIALS AND METHODS

To evaluate the use of an optimised complementary food on the growth and iron status of young children in a rural African community, a baseline survey was done by measuring food intake and nutritional status of six month old infants in Kilosa district, Morogoro region, Tanzania (Mamiro et al., 2005). Following the pilot study, a processed complementary food was produced containing finger millet, kidney beans, peanuts and mango. Optimisation was done based on the amino acid scores and energy value of the ingredients, and additional processing (soaking, germination) was done to reduce the level of anti-nutrients and improve the digestibility. The control CF contained the same ingredients as the processed CF, but no additional processing was done (Table 1). Both foods were solubilised in water and cooked prior to consumption. The optimisation of the production scheme and quality control of the CFs is described in more detail by Mamiro et al. (2001), Mbithi-Mwikya et al. (2002), and Kimanya et al. (2003). A detailed description of the trial protocol is given by Mamiro et al. (2004). The study was a randomized controlled trial, with the processed complementary food given to the intervention group and the non-processed food to the control group. Verbal consent was sought from mothers for their infants to participate in the trial. The ethics committee of the Tanzania Food and Nutrition Centre and University of Gent reviewed the protocol and gave approval for the trial.

Table 1. Composition of the field complementary food[1].

Variable	Processed	Non-processed	P value
Energy kJ/100 g DM)	1731 (11)	1731 (18)	0.89
Energy density porridge (kJ/mL)	6.1	1.7	-
Solids% (w/v) in porridge	35	10	-
Total iron (mg/100 g DM)	4.74 (0.41)	5.89 (0.87)	0.002
Soluble iron (%)	18.83 (0.72)	4.76 (0.80)	0.001
Phytates (% DM)	0.66 (0.02)	1.15 (0.03)	0.04

[1]redrafted from Mamiro et al. (2004) and Van Camp et al. (2007). Mean and sd of 12 production batches.

RESULTS AND DISCUSSION

Soaking, germination and fermentation are technologies that can reduce significantly the levels of phytates and tannins in cereal products (Mosha and Svanberg, 1990; Lorri and Svanberg, 1995; WHO, 1998). The *in vitro* iron solubility in soaked finger millet slightly increased compared to raw finger millet but was not enhanced by vitamin C and mango addition. Solubility increased significantly during germination, and was also influenced by extra addition of vitamin C and mango. This was accompanied by a significant reduction in phytate content. As a consequence, local processes like soaking and germination may have potential to reduce the level of phytates and can improve the solubility of iron in cereal products (Mamiro et al., 2001).

Although germination can improve the nutritional characteristics of cereals, the process is believed to favour outgrowth of pathogens and possible toxin production, rendering safety of the germinated products questionable. *Staphylococcus aureus*, contrary to *Bacillus Cereus,* does not increase in number during germination of finger millet (Kimanya et al., 2003). This suggests that finger millet is not a good substrate for growth of *S. aureus* and that the pathogen does not compete well with the natural flora of finger millet. Since *B. cereus* may have potential for toxin production during germination, it is recommended that proper safety control (HACCP) mechanisms including a procedure for observation of personal hygiene, selection of safe raw materials and water have to be followed in all food processing units where a germination stage for finger millet is involved (Kimanya et al., 2003).

Data from the pilot study indicate that underweight, wasting and stunting was present among children in the community. About 21% of the surveyed children were underweight based on FAO/WHO and the National Centre for Health Statistics (NCHS) scales. There were few (2.1%) cases of acute malnutrition (wasting). Results also indicated that 37.6% of the infants were stunted, giving height for age values below –2 z-scores. The CF taken were low in energy density, contained few amounts of fat and were too low in iron content to meet the dairy recommendations of iron for children of that age (Mamiro et al., 2005). This observation shows that nutritional problems start at very early age and that nutritional interventions focussing on optimisation of the nutritional value of CF should be carried out (Van Camp et al., 2007).

The project complementary food contributed more than 50% of the total daily energy intake. The remaining energy was obtained from other foods as well as from breast milk. At 12 months of age, no differences could be observed between the two groups in terms of weight gain, mean weight-for-length and length-for age z-scores. The majority of the infants (76%) were still anemic according to WHO standards at the end of the study. Zinc protoporphyrin ZP (a marker for iron status) declined significantly after six months intervention, but without differences between the two groups (Van Camp et al., 2007).

The fact that there was no additional effect of processed relative to the non-processed CF on nutritional status, supports the idea that processing does not necessarily matter to cover macro-nutrient needs, as long as nutrition guidance is appropriate and extra fat is added to the diet. Adequate amounts of CF were provided to each child and therefore the theoretical advantage of a higher energy dense food was neutralized (Mamiro et al., 2004). Increase of *in vitro* iron solubility accomplished by processing of plant based foods with low iron content, using locally adapted techniques, was not sufficient to demonstrate a significant improvement in iron status in the intervention group. This result suggests that the amount of soluble iron is not necessarily correlated with bioavailability, which has been confirmed in the study of Peynaert et al. (2006), using caco-2 cell lines instead of the *in vitro* iron solubility model. It may also be emphasized that degradation products from processing like phenolic acids may affect iron solubility and bioavailability (Andjekovic et al., 2007). Another, possibly more important explanation, is the rather low iron content in both processed and non-processed complementary food, which neutralised the beneficial effect on increased iron solubility in the processed CF (Van Camp et al., 2007).

CONCLUSIONS

The beneficial role of local processing in improving the nutritional value of complementary foods has been demonstrated in several studies, although more work is needed to evaluate their suitability to improve the nutritional status of infants and young children in real field situations. Local processing may not always be sufficient to cover the micro-nutrient needs of growing infants and young children, and addition of animal foods or supplementation may have to be considered simultaneously. Specific attention needs to be given to the safety of CF, including prevention of the outgrowth of pathogenic bacteria and avoiding the presence of bacterial toxins.

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