Development and processing of a novel food product for a school feeding project in South Africa.

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Abstract

Objectives
The aim of this project was to develop a nutritious novel food product that was acceptable to children, rich in energy, protein and micronutrients. This product had to be affordable, cost effective and easy to prepare by the caregivers, using locally available raw materials, with minimal waste and no need for specified fortification or enrichment.

Study design
This was an experimental study in which a novel food product was developed according to specific criteria.

Methods
The product developed was a nutritious vetkoek (a bread type cake fried in oil). A chemical food analysis was done to compare the theoretical and actual nutrient content. Acceptance testing and a shelf life analysis were conducted.

Results
In the sensory acceptance testing 65% of the consumers liked the vetkoek very much and 90% found it to be acceptable for inclusion in a school feeding program. The vetkoek was developed at a cost of R1.51 per day for a 120g portion and contributed to the nutrient intake of that group of children by 21.6% for energy, 14.4% for calcium, 141% for iron, 62.42% for zinc, 17.75% for vitamin A. The vetkoek stored at room temperature (25 °C) had a two day shelf life.

Conclusions
This study confirms that an affordable, safe and acceptable novel food product can be developed to be used as part of a school feeding scheme.

Keywords: novel food product, school feeding, product development, malnutrition, schoolchildren

INTRODUCTION

Malnutrition is a global problem. In developing countries, deficiencies in iron, iodine, vitamin A and zinc are the main manifestations of malnutrition (Muller & Krawinkel, 2005). Research has indicated that both acute and chronic hunger affect children’s access to school, their attention span, behaviour in class and educational outcomes. Furthermore, children suffering from short-term hunger, as a result of skipping breakfast, for example, have difficulty concentrating in class and performing complex tasks (DoH 2007; WFP 2006).

The malnutrition problem in South Africa...
SA) is a reality. The National Food Consumption Survey (NFCS) conducted in SA reported that the average dietary intake of energy, calcium, iron, zinc, selenium, as well as vitamins A, D, C, E, B2, B3, and B6 for children was less than 67%, and in some instances below 50% of the recommended daily allowance (RDA) (Kruger, Dhansay, Labadarios, Kotiah & Kullman, 2002; Roche, 2000). Vorster (2010) reported that 26.5% of South African children in rural areas and 16.7% in urban areas were stunted. These results indicate that many South African children are chronically hungry and thus food insecure. Results of international studies show that by improving the nutritional status of toddlers and schoolchildren, learning, behaviour and growth are beneficially affected. Well-fed children are stronger, brighter and more cooperative (Kruger et al., 2002; Roche 2000).

Schoolchildren are particularly vulnerable to short-term hunger, especially where diets of poor quality are consumed. Factors such as the long distances children walk to school, having to complete chores before going to school and poor quality and quantity of meals consumed at home, contribute to hunger in school children. Children who come to school hungry have diminished attentiveness, a greater likelihood of becoming distracted and a lack of interest in learning, resulting in failure, low achievement and repetition (DoH, 2005).

In 1994, President Nelson Mandela introduced the Primary School Nutrition Programme (PSNP) to establish school feeding on a national scale in SA. The aim of the PSNP was to improve the active capacity of primary school children by providing them with a nutritious snack. Fortified biscuits or bread and peanut butter was supplied to alleviate temporary hunger, thus contributing to pupils’ learning capacity, and improving school attendance and punctuality (DoH, 2004). An average of 5 million school children in SA have benefited annually since the programme started in 1994 (Labadarios, Steyn, Mgijima & Daldla, 2005). Initially the scope of the school feeding programme was: “The provision of an early snack, meeting 25 percent of the energy requirements of 3.8 million children (50% of primary school children) in areas targeted on the basis of the poverty criteria”. The aims in providing an early-morning snack are primarily to contribute to pupils’ active learning capacity, school attendance and punctuality, and to alleviate short-term hunger (Labadarios, 1997; Tomlinson, 2007; DoE, 2008). The Department of Health managed the PSNP from 1998 to 2004. In April 2004, the responsibility for school feeding in SA was passed on to the Department of Basic Education (DBE) and the programme was renamed the National School Nutrition Programme (NSNP) (van Stuijvenberg, 2005; DoE, 2008).

It is well known that school feeding can be costly and problematic. Problems of school feeding programmes across the world include: irregular delivery of supplies and culturally unacceptable food being served to name only two (Jamison & Leslie, 1999). Easy preparation is the key factor and most of the food products used should be instant or dry ingredients mixed with water. Where possible, cooking is limited and, if necessary, done by mothers or caregivers from the local community (Wentzel-Viljoen, 2003).

This project was undertaken in an informal settlement (n=1261 households) in the Vaal region, an industrial area situated approximately 70 km south of Johannesburg, South Africa, that has a population of 794 599. A baseline survey was undertaken in this community and poverty, household food insecurity and malnutrition, specifically stunting and micronutrient malnutrition, was observed in the children (Oldewage-Theron, Dicks, Napier & Rutengwe, 2005).

Micronutrient malnutrition can be addressed by supplementation and fortification of food, and by implementing programmes designed to educate people
to diversify their diets (Venkatesh Mannar & Sankar, 2004). Food diversification aims to increase dietary availability, regular access and consumption of vitamin- and mineral-rich foods in at-risk micronutrient deficient groups. It involves the changes in dietary behaviour of the group (DoH, 2004). Food modification is primarily a strategy to improve either the amount of food in the diet or its bioavailability (Venkatesh Mannar, 1999).

Vetkoek (bread dough fried in oil) was one of the food items most commonly consumed in this community and was chosen as the product to be developed for this study. This article thus reports on the development and processing of a novel food product, vetkoek, that was developed as a nutrient-dense product that could be implemented in the existing school feeding programme in the only primary school present in the informal settlement (n=580 children).

AIMS OF THE PROJECT

The specific aim of this project was to develop a novel food product, vetkoek, based on the following criteria:

- The product should provide 25% of the Estimated Average Requirement (EAR) for children aged 6-13 years old for vitamin A, iron, zinc, calcium and energy as identified in the baseline study (Oldewage-Theron, Napier, Dicks & Rutengwe, 2005);
- The product should be easy to prepare (the baseline survey indicated 18.9% of the caregivers were illiterate, and only 17% of the households had access to electrical stoves, 8.8% to coal stoves and 75.6% to paraffin stoves).
- Ingredients for the product should be available in the households (ingredients formed part of food items most commonly purchased), with minimal waste.
- The product should be cost-effective (<R 2.00 per person per day). was consumed by the majority of households in this study as it was inexpensive and easy to prepare with ingredients readily available in the households. Thus, it was decided to develop a nutritious vetkoek that met all the criteria.

The second aim was to develop the infrastructure at the school where the school feeding programme, incorporating the vetkoek, would be implemented.

OUTLINE OF THE PROCEDURES AND METHODS

This experimental project was undertaken in two phases. Phase one was the development of the vetkoek (novel food product) and phase two was the development of the infrastructure for implementing the vetkoek in a school feeding programme.

Phase 1: Product development and analysis

Initially five different vetkoek recipes were chosen from South African recipe books. The recipes chosen were theoretically analysed by using the FoodFinder software program, based on the South African Food Composition tables (Langenhoven, Kruger, Gouws, & Faber, 1991) and developed by the SA Medical Research Council for food analyses. The nutritional content of each recipe was compared to the EAR of children aged 6-13. Different ingredients from the top 20 consumed foods, as indicated in the baseline survey, were added and after inclusion of an ingredient or ingredients, the recipe was analysed once more to determine the influence of a single ingredient on the nutritional value of the recipe. The three recipes with nutritional values closest to 25% of the EAR for energy, calcium and iron of children aged 6-13, were selected.

The cost-effectiveness of each recipe was determined. Three different vetkoek
recipes were prepared by the researcher in a food laboratory under recommended food safety and hygiene standards according to the specific recipes. A paired preference testing was conducted to determine the most popular of the three products. The preference test forces a choice of one item over another. A sensory panel of 60 children, aged six to 13 years, was composed by random selection from the primary school in order to evaluate the three types of vetkoek (A, B and C) presented to them. The general appearance, taste and overall acceptability were evaluated and the most popular product chosen.

The Agricultural Research Council, an accredited food analysis laboratory in Pretoria, did the chemical analyses to compare the theoretical and actual nutrient content of the following: ash, moisture, fat, protein, folic acid, carbohydrates, vitamins A, B1, B2, B6, B12 and C, as well as energy, calcium, magnesium, copper, iron and zinc. The results indicated a shortfall in energy of 429 kJ, 156.4 mg of calcium, and 40 retinol equivalents (RE) of vitamin A to meet 25% of EAR. The shortages were addressed by adding 20 g of milk powder. The final adjustment to the recipe was made to address an average of 25% of the estimated average requirements for energy, iron, zinc, calcium, and vitamin A for children 6-13 years of age.

Directly after preparation, the prepared vetkoek were couriered to the Agricultural Research Council for shelf life testing. Shelf life testing was conducted under controlled test conditions to evaluate the growth of harmful bacteria and micro-organisms after selected time periods to determine shelf life.

During testing, the food was periodically examined for changes in appearance, aroma, texture and taste until it became unacceptable. For the shelf life testing, one tray was set aside at 4ºC and the other tray at room temperature (±25ºC). The vetkoek were plated out on day 0 (day of arrival), day 2, 4 and day 7. A 10 g sample was removed aseptically from the inside of the vetkoek. The samples were homogenised in a Stomacher 400 (DHK Pty Ltd) with 90 ml of diluted buffered peptone water. The sample was plated out for a total aerobic plate count on Tryptone soy agar and incubated at 25ºC for 72 hours and for testing on yeast and moulds on Rose Bengal agar and incubated at 25ºC for 72 hours.

Sensory acceptance testing was done by using a hedonic scale questionnaire, which is a suitable method for measuring children’s responses to products. The Sensory acceptance testing was conducted on three different occasions by three target groups consisting of 30 random chosen boys and girls, aged 6-13 from the primary school.

Phase 2: Infrastructure development

The school in which the school feeding programme would be implemented had no kitchen or food preparation area and a production kitchen had to be erected on the school premises. Permission was obtained from the principal and the school governing body to erect a wooden hut for this purpose. An engineer from the Vaal University of Technology Engineering Faculty was consulted to draw up the plans and build the production kitchen.

Furthermore, a portioning frame was designed and made of stainless steel to be used by the community workers to portion each batch of vetkoek into 20 x 120 g portions. The frame was 2 cm high, 40 cm long and 25 cm wide. The vetkoek dough had to be rolled in the same size as the portioning frame. The frame was placed on the dough and pressed down, and this produced 20 vetkoek portions of 120 g each.

Training conducted

The school principal identified five caregivers in the community, and training
was provided on personal hygiene, basic kitchen hygiene, safety, basic food preparation, cooking methods and the use of electrical equipment. An illustrated recipe pamphlet containing different recipes for vetkoek was developed and printed for illiterate people. It was used in training the caregivers who were responsible for preparing the vetkoek. These trained caregivers would be responsible for the preparation and portioning of the vetkoek on a daily basis during the implementation of the school feeding programme.

RESULTS

Results for phase 1: Product development and analyses

The results showed that for the paired preference testing, 56% of the consumers preferred sample C, 31% preferred sample A and 23% sample B. In the sensory acceptance testing 65% of the consumers liked the vetkoek very much and 90% found it to be acceptable for inclusion in a school feeding program. The vetkoek was developed at a cost of R1.51 per day for a 120g vetkoek. This fell close to the cost margin of R1.50 per learner per day for 2004/5, as stated by Wildeman & Mbebetho (2005), which was utilised for the PSNP in SA.

The vetkoek contributed to the nutrient intake of the targeted group by 21.6% for energy, 14.4% for calcium, 141% for iron, 62.42% for zinc, and 17.75% for vitamin A for the group of children.

Shelf life testing results indicated that the vetkoek stored at 4 °C had a seven day shelf life period, whereas the vetkoek stored at 25 °C had only a two day shelf life. Although moulds were visible on day 4 on the vetkoek stored at 25 °C, the counts were very low throughout the trial.

Results for phase 2: Infrastructure development

A wooden hut measuring 4x4 m² with a veranda and a corrugated iron roof was built. Part of the researcher's student grant from the National Research Foundation (NRF) was used to fund the building of the kitchen. Insulation panels were installed inside for the walls and ceiling and were painted white. The kitchen had one door and one window, which opened to the outside. The window was used as a serving hatch. A safety door was installed as a security measure. A square cement slab was laid in front of the kitchen, so that the children did not have to stand in mud during the rainy seasons, and to keep dust from entering the kitchen. Water and electricity were connected via the adjacent building. The kitchen was equipped with all the necessary equipment and small utensils required for production. These included: a serving trolley, stainless steel table and washbasin, a deep fat fryer, mixing bowls and a portioning frame.

CONCLUSIONS AND RECOMMENDATIONS

Malnutrition amongst children remains a problem to be addressed not only in SA, but worldwide. Various strategies are implemented to address the persistent malnutrition problem and all of these have their own advantages and disadvantages. School feeding programmes are a strategy that is adopted globally to alleviate hunger and thus increase concentration and learning capacity. This research project provided the opportunity to develop a novel food item that is affordable, acceptable, safe for consumption, nutritious and easy to prepare from ingredients usually available in the households in the community as proposed by the New Partnership for Africa's Development (NEPAD) and the Comprehensive Agricultural Development Programme (CAADP).

This study confirms that an affordable, safe and acceptable novel food product, meeting 25% EAR for certain identified micronutrients, can be developed and prepared with minimum effort.
The vetkoek was subsequently implemented in an intervention study in this community (Napier, Oldewage-Theron & Kearney, 2009) and the impact of the vetkoek consumption on the nutritional status of the children in this community was investigated over a period of six months. More research is needed to test compliance of consumption over a long term (at least 12 months). Similar products could be developed for other circumstances, for e.g. HIV/AIDS children and micro-enterprises could flow forth from such studies. However, further research is needed on market needs, packaging materials, product lines and distribution.

To sustain this initiative, it is recommended that the recipe leaflet be made available to the parents and caregivers of the primary school children and that they are trained to prepare the vetkoek so that it can be included in the children’s lunch boxes. No special equipment is needed for the preparation of the food product and ingredients available in the household can be used for preparation. The vetkoek that was developed in this project met all the criteria for the intended use in a school feeding programme for this particular community in the Vaal Region.

It is recommended that all products developed for school feeding programmes, be bio-chemically analysed for actual nutrient content and that researchers should not rely on theoretical calculations only. Further research on the bioavailability of the nutrients in the vetkoek is needed.

ACKNOWLEDGEMENTS

We hereby acknowledge the following for their co-operation in the project:
The National Research Foundation and the Vaal University of Technology for funding this project.
The caregivers and primary school children for participating.

References


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ABCommunications. Germany;


