Title:

MICRONUTRIENT ENHANCEMENT IN MAIZE-BASED STAPLE FOODS IN GHANA

338.19
PLA

Institution:

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Principal Investigator:

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Accra, Ghana.

Estimated Duration:

Two Years

Date of Submission:

May, 2000.

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MICRONUTRIENT ENHANCEMENT IN MAIZE-BASED STAPLE FOODS IN GHANA

SUMMARY

This proposal seeks support under the Miconutrient Initiative Programme of Canada through the OAU/STRC - SAFGRAD (funds in the amount of US$56,920.00 over a period of two years) to undertake a programme of activities at the Food Research Institute of the CSIR on micronutrient fortification of maize foods through the major intermediate product, the fermented maize meal. The project will make available effective techniques for fortification of commonly used intermediate maize based staple food in Ghana with essential micronutrients both at the commercial and traditional levels of processing. This action has been spurred by the urgency to combat the problems of micronutrient deficiency in the country as a result of inadequate intake of foods rich in micronutrients. The goal of the proposed project is to improve the nutritional status and livelihoods of the rural and urban population in Ghana by reducing diseases caused by micronutrient deficiencies. Specific objectives will include: developing a technology for the fortification of the dehydrated fermented maize meal with iron, vitamin A and zinc at both the commercial and village levels; investigating the effect of processing on the micronutrient content of the fortified dehydrated fermented maize meal; determining the bio-availability, acceptability and shelf life of the fortified fermented maize meal; transfer of the developed technology to selected local food processors to promote the production and distribution of the fortified fermented maize meal; and assessing the market demand and affordability for the fortified fermented maize meal. Children and women will be the main beneficiaries. In the short term various entrepreneurs involved in maize processing and women using the fermented maize meal for commercial preparation of traditional staple foods will be empowered economically through commercial activities involving small-scale processing of value-added products, and thousands of children in the country should enjoy better health through micro-nutrient enriched diets.

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I. BACKGROUND INFORMATION

a. Statement of the Problem

In sub-Saharan Africa, deficiencies in micronutrients such as vitamin A, iodine, iron and zinc are known to be highly prevalent and are in turn responsible for the grave socio-economic and health situation in the area. The main cause of micronutrient deficiency is inadequate intake of animal and other sources of foods rich in micronutrients. For the poor in sub-Saharan Africa, the major sources of essential micronutrients are vegetables (especially the green leafy vegetables) and cereal and legume-based diets. The main problem with the green leafy vegetables however is that they are not only seasonal but highly perishable. In addition, it has been observed that most children are often reluctant to consume green leafy vegetables. The cereal and legumes-based diets also do not provide enough quantities of micronutrients. Additionally, cereals and legume usually contain phytate, an anti-nutritional factor, which reduces the bioavailability of micronutrients such as iron and zinc.

According to available survey data, the average prevalence of clinical and sub-clinical vitamin A deficiency in Ghana is 0.5 and 20% respectively. The prevalence of iron deficiency is 10.5% for pre-school children, 7.5% for school-age children, 13.5% for pregnant women and 12.5% for nursing mothers (Quarshie and Agbley, 1999). Diets deficient in sufficient amounts of iron, zinc, iodine and vitamin A always cause adverse health defects in all human beings. These include impairing the learning abilities and intellectual performance of the people, decreasing the resistance of children to infection and reducing the working capacities in adults. In particular insufficient uptake of vitamin A causes blindness, increases mortality, gastrointestinal disease and suppresses immune systems and hence pre-disposes children to common diseases like respiratory tract infection, measles and diarrhea (Hamilton et al, 1988). Iron deficiency is responsible for anemia, learning disability, mental retardation, poor physical development and diminished ability to fight infectious diseases, reduced capacity to do physical work and premature death (Bouis, 1995; Lotfi *et al.*, 1996).

Food fortification, which involves the addition of one or more nutrients to staple foods, has been considered as the most effective means of improving the micronutrient intake. In this strategy the main objective is to increase the level of consumption of added nutrients by taking advantage of the importance of such staples in the food culture of the target people. By selecting the right food ingredients to act as the carrier (food vehicle) of the specific micronutrients (fortificants) the need for encouraging individual compliance or changes in the customary diet will be minimised (Lofti et al, 1996).

The challenge of this project is therefore, to develop and transfer to commercial maize processors both in the rural and urban centers, a simple but sustainable technology for improving the vitamin A, iron and zinc contents of the traditional fermented maize dough and the commercial version, the dehydrated fermented maize meal developed by the Food Research Institute.

1.2. Goal, Objectives and Rationale

1.2.1 Goal

The goal of this project is to improve the nutritional status and livelihoods of the rural and urban population in Ghana by reducing diseases caused by micronutrient deficiencies.

1.2.2. Objectives

1. Develop a technology for the fortification of the dehydrated fermented maize meal with iron, vitamin A and zinc at both the commercial and village levels.

2. Investigate the effect of processing on the micronutrient content of the fortified dehydrated fermented maize meal.

3. Determine the bio-availability, acceptability and shelf life of the fortified fermented maize meal.

4. Transfer the developed technology to local food processors to promote the production and distribution of the fortified fermented maize meal.

5. Assess the market demand and affordability for the fortified fermented maize meal

1.2.3. Rationale

Maize (*Zea mays* L) is considered to be the most important staple food –grain in Ghana (Prempeh, 1971). This is because maize is a good source of carbohydrates. The percentage of carbohydrate in Ghanaian local varieties of maize is nearly 75 % w/w (Eyeson & Ankrah). In the last few years the Crop Research Institute of Ghana has developed a number new varieties of the Quality Protein Maize. An example is the *Obatanpa* variety that contains some important essential amino acids like lysine, methionine and tryptophan.

In Ghana maize is traditionally processed in most cases into fermented dough, before being subsequently cooked into various maize end-products like *kenkey, banku, koko* etc (Johnson & Halm, 1997). During the processing the whole maize grain is milled usually using a disc attrition mill. In the very rural areas, processing may be done using a large stone or pounded in a mortar until a fine powder is obtained. Invariably there are losses in the micronutrients during the milling and subsequent processing of the meal into the fermented dough. These lost micronutrients can, however, be replaced through enrichment or fortification. It is possible for this enrichment to be so undertaken as not to affect the quality and /or overall acceptability of the resulting maize product.

1.3. Justification

Maize production in Ghana has been increasing steadily over the past years from 1.2 MT/ha in the early 1990s to the present estimated level of 2.5 MT/ha. Indeed, but for adverse weather conditions in the latter part of the 1990s, the expectations were that the production would have peaked around 5 MT/ha by the end 1999 (Ministry of Food & Agriculture, Ghana, 1999). Maize is consumed in almost every part of Ghana. It is used to prepare a very popular weaning food for infants in Ghana called *koko*. The energy content of this porridge is estimated to be 98 KJ (Eyeson & Ankrah, 1975). Oracca-Tetteh (1972) also estimated that *koko* has 3.9 net dietary protein calories percent. Overall, it is estimated that nearly 52 % of the average energy intake of the average Ghanaian family is from maize.

Maize is generally a good source of some micronutrients like thiamine, phosphorus and pyridoxine. It also has a fair amount riboflavin, niacin, folate, biotin, iron and zinc. Micronutrients not present in maize include vitamin A and E and calcium. Eyeson & Ankrah (1975) found that the concentration of the iron in whole grain of the local Ghanaian maize variety decreases from 12.8 to 1.2 mg/100g during the preparation of fermented maize dough. This dough is what is cooked into traditional staple food like *kenkey, banku* and *koko*. In the majority of maize-based foods in Ghana, the maize grain is usually processed into fermented meal. The traditional wet dough has a relatively short shelf life and this was the main reason why the Food Research Institute of Ghana developed the Dehydrated Fermented Maize Meal which is gradually gaining acceptability amongst most urban dwellers in Ghana. Quite a number of food processors have acquired the technology and are producing extensively for the local as well as for the export market. Because of its growing popularity, the dehydrated fermented maize meal stands out as the most obvious choice for the micronutrient enrichment program in Ghana.

II. PROGRAM COMPONENTS

2.1. Develop a technology for the fortification of dehydrated fermented maize meal with vitamin A, iron and zinc at both the commercial and village levels.

2.1.1. Assessment of the prevalence and distribution of micronutrient deficiencies in Ghana

Agble (1991) and Quarshie and Agble, (1996) have estimated the prevalence and distribution of micronutrient deficiencies in Ghana. They found that 28 % of 12 – 23 months, 31% of 24 – 59 months old babies and about 30 % of all children below 5 years showed evidence of malnutrition resulting mainly from inadequate intake of micronutrients in the diets. They found the situation was more serious in the northern than in the forest and coastal parts of Ghana. Such secondary data and other primary data to be collected will be used to establish the prevalence and distribution of micronutrient deficiencies in Ghana. The micronutrient content of major staple foods in Ghana will be determined.

2.1.2. Traditional and commercial milling practices in Ghana and their effects on micronutrients

In most parts of Ghana, maize is first processed into fermented dough before subsequent use in the preparation of maize-based diets. In obtaining the dough, the maize is first washed and steeped in plentiful amounts of water for 1-3 days depending on the initial moisture content and hardness of the kernel. After steeping the water is drained and the maize is washed before taken for milling at a commercial milling centre. The type of mill found at almost all the milling centres is the disc attrition mill. The softened maize grain is milled into a fine meal. In the very rural areas, milling may be done using a big grinding stone and/ or by pounding.

Presently there is no available information on the amount of micronutrient loss during the process of steeping and subsequent milling. Eyeson & Ankrah (1975) however, found that the iron content of maize decreased by over 70% during the preparation of maize dough with the local Ghanaian variety of maize. Since there are new varieties of maize on the market presently, there will be the need, in this project, to evaluate the effect of the milling on the iron content, taking into consideration process and varietal differences.

2.1.3. Development of simple micronutrient fortication techniques

Appropriate techniques will be developed for the fortification of both the traditional fermented maize dough and the commercial dehydrated fermented maize meal with vitamin A, iron and zinc. This phase of the project will involve the use of premixes purchased through chemical supply agencies. Subsequently, however, local sources of the micronutrients will be identified and appropriate isolation and fortification techniques developed

Outputs for Program Component 2.1

i. Baseline information on the micronutrient content of various major staple foods in Ghana.

ii. Loss of micronutrient that occur during processing of maize into fermented maize meal and during subsequent cooking of the meal established.

ii. The form and quantities of vitamin A, iron and zinc that can be incorporated into fermented maize meal without changing the appearance and/or taste of the cooked form of fermented maize meal identified.

iii. Techniques for uniform mixing of the micronutrients (vitamin A, iron and zinc.) with fermented maize meal established.

iv. A standard quality assurance and Hazard Analysis Critical Control Point (HACCP) systems for the industrial production of fortified fermented maize meal established.

Activities planned for the Outputs for Program Component 2.1

Activity 2.1.1: Undertake survey of micronutrient content of major staple foods in Ghana

Activity 2.1.2: Determine the amount of micronutrients lost in maize during processing into fermented maize dough or dehydrated fermented maize meal.

Activity 2.1.3: Determine the effect of traditional cooking on amount of micronutrients content in fermented maize meal.

Activity 2.1.4: Determine the form and amounts of vitamin A, iron and zinc that can be used to fortify fermented maize meal. Information collected from secondary sources as well as results from output 1 will be used.

Activity 2.1.5: Carry out the sensory evaluation of the uncooked and cooked forms of the fortified fermented maize meal.

Activity 2.1.6: Design and fabricate an appropriate dry-mixer.

Activity 2.1.7: Determine the optimum time required for achieving 100% degree of mixing of micronutrient(s) and the fermented maize meal.

Activity 2.1.8: Establish procedures, methods and frequency for periodic testing to ensure content and level of micronutrient in the fortified fermented maize meal are according to established standard.

Activity 2.1.9: Develop quality assurance control as well as HACCP (Hazard Analysis Critical Control Points) systems for industrial production of fortified fermented maize meal.

a. Investigate the effects of processing on micronutrient contents of fortified traditional maize fermented dough and the commercial dehydrated fermented maize meal.

Outputs for Program Components 2.2

i. The effect of processing and cooking on the micronutrient contents of the fortified dehydrated fermented maize meal established.

ii. The compatibility of the different micronutrients in the fortified traditional fermented maize dough and dehydrated fermented maize meal established and/or improved.

Activities Planned for Outputs for Program Component 2.2

Activity 2.2.1: Carry out sensory evaluation on the uncooked and cooked forms of fortified fermented maize meal.

Activity 2.2.2: Investigate the relative stability of or interaction between iron and vitamin A (or between zinc and vitamin A) during processing of fortified fermented maize meal.

Activity 2.2.3: Develop technologies to improve stability of vitamin A, iron and zinc or the interactions between these micronutrients in the fortified fermented maize meal.

Note: Activity 2.2.3 will only be undertaken if results from Activity 2.2.2 prove positive.

2.3. Determine the bio-availability, acceptability and shelf life of the fortified fermented maize meal

Outputs for Program Component 2.3:

i. The bioavailability of the added micronutrients (iron, zinc and vitamin A) established.

ii. The consumer acceptability profiles of the cooked maize-products from the fortified traditional dough and the commercial dehydrated fermented maize meal established sensory evaluated.

iii. Storage stability of fortified fermented maize meal established.

Activities for Outputs for Program Component 2.3

Activity 2.3.1: Investigate the bioavailability of the added micronutrients using studies on rats

Activity 2.3.2: Conduct consumer sensory profile testing to assess the acceptability of the cooked maize product of the fortified fermented maize meal

Activity 2.3.3: Determine the effect of light, temperature and humidity on the stability of micro-nutrients added to the fermented maize meal.

Activity 2.3.4: Determine the moisture adsorption characteristics of the fortified fermented maize meal.

Activity 2.3.5: Investigate the physico-chemical and microbiological changes during storage at ambient and accelerated temperatures of the fortified fermented maize meal.

Activity 2.3.6: Investigate the packaging requirements of the fortified fermented meal.

Activity 2.3.7: Establish shelf life for the appropriate packaging material and storage conditions using accelerated storage tests techniques.

2.4. Transfer the developed technology to selected local food processors and village food processes to promote the production and distribution of the fortified fermented maize meal

Output for Program Component 2.4

i. The technology of fortifying dehydrated fermented maize meal with iron, vitamin A and zinc transferred to local food processors both in the urban and village centers in Ghana.

Activities for Output for Program Component 2.4

Activity 2.4.1: Undertake a location testing of the developed technology for fortifying fermented maize meal at the Pilot Plant of the Food Research Institute of Ghana.

Activity 2.4.2: Undertake a location testing of the developed technology for fortifying fermented maize meal at the ELSA Foods, a local food processing company in Accra.

2.5. Assess the market demand and affordability for the fortified fermented maize meal

Outputs for Program Component 2.5

i. Market survey to test acceptability, demand and price for fortified fermented maize meal carried out.

ii. The packaging system for the fortified fermented maize meal determined.

iii. Distribution and marketing channels and the involvement of women groups, NGOs and small-scale producers of fortified fermented maize meal established.

Activities for the Outputs for Program Component 2.5

Activity 2.5.1: Assess market demand and affordability for the fortified fermented maize meal.

Activity 2.5.2: Determine efficient distribution and marketing strategies as well as pricing systems.

Activity 2.5.3: Assess the financial viability for the industrial production of fortified fermented maize meal.

Activity 2.5.4: Design a promotion strategy for the fortified fermented maize meal through workshops and seminars.

2.6. Establish a National Fortification Task Force

Output for Program Component 2.6

i. A National Fortification Task Force established to enhance legislation with regard to fortification and use of products in Ghana.

Activities for the Outputs for Program Component 2.6

Activity 2.6.1: Two meetings will be convened for the establishment of a national fortification task force involving representatives of food research institutions, food processing industry, Universities, consumer organizations, Ministry of health, policy makers etc.

Activity 2.6.2: The chances of enhancing legislation with regard to fortification and use of fortified foods will be assessed.

III PHASES OF THE PROJECT AND TIME SCALE

The components and activities outlined in section two above constitute the first phase of the project and will be undertaken within a maximum period of two years. Based on a successful outcome, a major phase will be proposed for the widespread diffusion of the fortification technologies developed and technical assistance to local entrepreneurs for the adoption of these technologies.

IV. PROJECT MANAGEMENT

Research Team

Dr. W. A. Plahar .... Food Technologist - Principal Investigator and leader

Dr. P-N. T. Johnson............ Food Technologist - Processing and storage stability studies

Mr. D. Blay .... Process Engineer - Design and fabrication of Mixers

Mrs. P. Larweh .... Home Scientist - Utilisation and sensory evaluation

Mrs. N. T. Annan .... Biochemist/Nutritionist - Micronutrient Analysis

Mrs. W. Quaye .... Agric. Economist/Socio-economic studies

Technical Staff

i. From Food Research Institute

ii. ELSA Foods, Accra, Ghana.

V. PARTNERSHIP OF STAKEHOLDERS

1. ELSA Foods

This is one of the food industries in Ghana presently producing dehydrated fermented maize meal. This company will assist with the location testing of the developed technology. Thus assist in the transfer of the technology to the food processing industries in Ghana.

2. National Board for Small-scale Industries in Ghana

This is the main Ghana Government agency which co-ordinates the activities of all small-scale industries in Ghana. It may be in a position to arrange credits/grants for interested food processors who would want to go into the commercial production of the fortified fermented maize meal.

3. Selected Supermarkets in Accra

A number of supermarkets are already involved in the sale of the fermented maize meal in Accra. Most of these supermarkets will readily be in the position to assist in the market studies as well as the consumer acceptability tests as explained in program component 2.5.

4. Non-Governmental Organisations (NGOs)

A number of NGOs such as Actionaid, ADRA and Catholic Relief Services (CRS) of Ghana, are involved in poverty alleviation projects in several areas including the northern parts of Ghana. Sometimes they offer free food donations to the very rural-poor. They will be in the position to help reach out to the very poor and malnourished inhabitants in Ghana.

V. BUDGET

Item	Cost ($'000)		
	Y. 1	Y. 2	Total
A. Research Inputs			
Chemicals, reagents and microbiological media	4.0	2.0	6.0
Vitamin and mineral premixes	2.0	1.0	3.0
Sensory preferences tests	0.3	0.2	0.5
Raw material supplies	0.5	0.2	0.7
Packaging materials	0.2	0.2	0.4
Fuel & maintenance cost	2.0	0.5	2.5
Processing costs	1.0	0.5	1.5
Travel, Transport and cordinating allowances	3.4	2.9	6.3
Labour costs	1.0	0.5	1.5
Stationery items	0.5	0.5	1.0
Equipment:			
- Fabrication of dry-mixers	2.0	-	2.0
- Heat sealers	0.3	-	0.3
- Freezer for storage	0.8	-	0.8
- Computer, printer and accessories	2.5	-	2.5
- Weighing scale (kitchen type)	0.2	-	0.2
- Balances: top loading	1.2	-	1.2
- Oven (97 L, fan-circulated 40 – 200°C)	2.5	-	2.5
- Infra-red portable thermometer	0.3	-	0.3
- Luxmeter (for light measurement)	0.3	-	0.3
- pH meter (bench)	2.0	-	2.0
Sub-totals	27.0	8.5	35.5
B. Technology Transfer			
Materials for pilot processing	1.5	1.0	2.5
Fuel and Maintenance cost	1.0	1.0	2.0
Resource personnel allowances	0.5	1.5	2.0
Per diem allowances	1.0	0.5	1.5
Training materials	-	0.5	0.5

Organisation of workshops and Meetings	-	1.5	1.5
Publication of reports	0.2	0.5	0.7
Sub-Totals	**4.2**	**6.5**	**10.7**
C. Administrative Expenses			
Utilities	1.0	1.2	2.2
Secretarial overtime allowances	0.2	0.2	0.4
Technicians overtime allowances	0.5	0.2	0.7
Sub-Totals	**1.7**	**1.6**	**3.3**
Total for the year	**32.9**	**16.6**	**49.5**
Add 15 % Overheads	**4.93**	**2.49**	**7.84**
Total for the Year	**37.83**	**19.09**	
Total Cost of the Project			**56.92**

Estimated Budget = US$ 56,920.00 (Fifty six thousand, nine hundred and twenty dollars.

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From: kwasi setsoafia <msetsoafia@yahoo.com>
To: oua.safgrad@cenatrin.bf <oua.safgrad@cenatrin.bf>
Date: Thursday, July 13, 2000 5:14 PM
Subject: Re: Proposal from Dr. Plahar

--- oua.safgrad@cenatrin.bf wrote: > 11/07/2000
>
>
> Dear Setsoafia,
>
> Greetings from Ouagadougou.
>
> Have you found a consultant to help edit the
> proceedings of the Ghana
> workshop ? We hope it will be done by the meeting in
> Ouagadougou. Please
> let us know it is progressing.
>
> Regards,
>
> Mahama Ouedraogo
> OAU/STRC-SAFGRAD
>
> Dear Mahama

Please find attached the micro nuytrien proposal
from Dr Plahar. I will send the pictures tomorrw.

All the best.

Setsoafia

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