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Compliance and Consumer Acceptability of Multiple Fortified Stock Powder

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Abstract: The aim of the study was to determine consumer compliance and acceptability of multiple fortified stock powder within the Vaal Triangle Community in South Africa. The sample size was drawn from black female physical environmental sanitation workers and a few sedentary workers. Twelve and a half kilograms of stock powder were mixed with 125 g fortificant under controlled conditions. Sixty black women aged between 27-50 of low socio-economic status were randomly assigned into experimental and control groups. Data were obtained through questionnaire. No statistical significant differences were found between the fortified and the unfortified stock powder in terms of colour, flavour, smell and overall acceptability. Respondents found the powder safe and convenient to use. In conclusion, multiple fortified stock powders is comparable to ordinary stock powder in acceptability and would be accepted when introduced into the market with accompanying education. It is recommended that multiple fortified stock powder should be promoted as a potential functional food.

Key words: Fortification, micronutrient, multiple fortified stock powder, acceptability, functional food

INTRODUCTION

Many factors, including genetic make-up, dietary habits, lifestyle and the environment, influence a person's health status. Over the past decade dietary inadequacies of key vitamins and minerals have emerged as the most widespread and devastating nutritional deficiencies in the world (Dye, 2007). Vitamin A Deficiency (VAD), especially sub-clinical deficiency, affects about 285 million children under five years of age globally. An estimated two billion people are affected by Iron Deficiency Anaemia (IDA), with three point six billion being iron deficient (Whiting and Calvo, 2006).

Poor nutrition often starts in utero and extends particularly for girls and women well into adolescent life. The important role women play in improving families micronutrient status, has been well recognised; especially as women child bearers, child caretakers, food producers, food preparers and income earners. Women are thus at the crux of the cycle of micronutrient malnutrition and are critical role players in the success of most micronutrient interventions (Bhutta and Haider, 2008). Inexpensive and effective solutions are available towards addressing micronutrient deficiencies. Diversifying the diet to include more micronutrient rich foods or fortifying commonly consumed foods, can make an enormous difference in the attempt to address micronutrient deficiencies (World Bank, 2006).

Micronutrients, which are classified as vitamins and mineral elements are a group of organic compounds that are essential in small quantities for the normal metabolism of other nutrients such as protein and carbohydrate whereas micronutrient malnutrition is a disease caused by a dietary deficiency of vitamins and/or minerals (IVACG and INACG, 2007).

Micronutrient deficiencies are widely prevalent and remain amongst the devastating problems particularly in the developing world. Over two billion people are at risk of micronutrient deficiencies and more than one billion are affected by it (WHO and UNICEF, 2008). The three deficiencies of greatest public health significance are those of vitamin A, iron and iodine: these could lead to serious health problems, including blindness, anaemia, mental retardation, vulnerability to infectious diseases and in extreme cases, death (Unnevehr *et al*., 2007).

The underlying causes of micronutrient malnutrition include:

- Inadequate breast feeding practices
- Inadequate and incorrect complimentary feeding practices
- Inadequate caring capacity such as time and knowledge
- Low levels of family education, awareness knowledge and motivation
- Poor cooking and preparation methods, storage, preservation and processing facilities at household levels

- Beliefs and practices that restrict access to certain foods for family members
- Lack of institutional capacity in nutrition and lack of personnel traned in the various components of micronutrient deficiency prevention programmes
- Low production of micronutrient rich foods
- Insufficient marketing for key foods
- Poorly developed commercial food processing industry (Darton-Hill, 2007)

According to the report of the IVACG (2007) entitled Micronutrient status of the population, micronutrient intakes are inadequate in most population groups and rural and peri-urban dwellers are at a higher risk (Vorster *et al*., 2005). Eckhardt (2007) further add that the groups with lower intakes of iron in South Africa include young children, adolescent girls and women. SCN (2007) confirms that women especially in their reproductive age are among the most affected. Horton (2006) add that in terms of micronutrients, riboflavin intake was found to be low in black rural and urban settings as well as in the coloured and Indian population groups. Overall, a similarly low pattern of intake was found for vitamin B6, whereas the folic acid intake was low in Indian and rural black women of child bearing age. The vitamin A intake was low in black children younger than ten years of age and in urban black women (Gogia and Sachdev, 2009).

Iron Deficiency Anaemia is a global nutritional problem, affecting mainly infants, children and women of child bearing age. It is estimated that 30-60% of women and children in developing countries are anaemic. Even in developed countries such as the United States, iron deficiency continues to warrant significant public health concern because IDA affects approximately five percent of young children and five to ten percent of women of child bearing age (West *et al*., 2007). Literature indicate that functional foods have a high content of nutrients and are therefore cost-effective in addressing micronutrient deficiencies (Williams *et al*., 2006).

In recent years, food fortification has become a more realistic and accessible option for developing countries to end micronutrient malnutrition. Food fortification is one of the strategies of the department of health in South Africa to prevent and control micronutrient deficiencies. As a result of micronutrient intervention, fortification of margarine with vitamin A and D is mandatory. Some major bread manufacturers in South Africa are fortifying their bread and flour with B- vitamins and iron (WHO, 2005). In African countries like Nigeria, Madagascar, Eritrea and South Africa, more than 80% of current salt production is iodised (Lindsay, 2006). In Zimbabwe, certain brands of maize meal, bread and flour are now fortified with vitamin A, B1,B2, B3, niacin, folic acid and iron (Neumann, 2006). Sugar fortification is implemented on a regular basis in Guatemala and multiple fortification of wheat and corn flour in Venezuela. Most of the successful food fortification programmes in the developing world are those that use flavour and taste improvers such as salt, sugar, curry powder, monosodium glutamate and fish sauce and also foods that are consumed frequently such as flour, wheat, corn and rice (Bulusu *et al*., 2007). Authentic fish sauce in Thailand contains approximately 4-108 mg/100 mL of iodine In the Philippines and Indonesia three products; salt, flour and monosodium glutamate (MSG) which is centrally manufactured, were found suitable for food fortification because of their frequent consumption. Food-frequency survey showed that, on average, 94% of the children consumed MSG at least once a week (Winichagoon *et al*., 2006).

Multiple food fortification: Multiple fortification refers to the fortification of food vehicles with two or more micronutrients. Multiple fortification addresses two or more micronutrient deficiencies in a more cost-effective manner. In Thailand for instance, vitamin A and iron are used to fortify rice. Countries like Brazil, Japan, Philippines and the United States of America are practicing double fortification (USAID, 2008). Multiple fortification of cereal and weaning foods/formulas has already been done successfully. For instance, micronutrient multimixes for cereals (primarily wheat), in addition to iron and / or vitamin A often include thiamine, riboflavin and niacin (WHO, 2005). Efforts are still being made by the World Food Programme to develop and popularise commercial low-cost, multiple fortified weaning foods in developing countries, This is because the use of multiple fortified weaning products in developing countries has hardly met with success and the use is only restricted to the urban population with a higher purchasing power. The failure is due to existence taboos, lack of current knowledge, shortage of fuel and clean water for cooking, poor hygiene practices, short storage time and the low social prestige value for homemade products (Whiting and Calvo, 2006).

Selecting a food vehicle for fortification involves a food that:

- Is consumed by a sizeable proportion of the population including members of lower income groups and other people who are likely to be at risk of micronutrient malnutrition
- Can be distributed widely to reach key target groups throughout the country

- Is inexpensive
- Has no objectionable change in taste, colour or appearance after fortification
- Can be processed in units large enough to permit controlled fortification
- Retains appropriate levels of the nutrients (preferably heat-stable) after further processing or cooking (Hotz, 2009)

The effects of correcting these micronutrient deficiencies are:

- Preventing up to four out of ten childhood deaths
- Lowering the maternal deaths by more than one-third
- Increasing work capacity by 40%
- Improving the population intelligent quotient (IQ) by 10-15 points and
- Raising the Gross Domestic Product (GDP) by 5% (IVAG, 2007)

This research forms an integral part of the development of functional foods research programmes at the Vaal Triangle Technikon in South Africa. It involves the fortification of stock powder with multi-micronutrients, the determination of prevalence of micronutrient deficiencies (literature) and regular or average consumption of stock powder.

Stock powder is a staple condiment used throughout South Africa and thus fortification of stock powder with vitamin A, B1 (thiamine), B2 (riboflavin), B3 (niacin), B6 (cynocobalamin), B12 (corrinoids), folic acid and iron (cocktail of micronutrient), will provide a powerful means of delivering substantial amounts of micronutrients to many population groups.

The general objective of this study was to determine consumer compliance and acceptability with multiple fortified stock powder in the Vaal Triangle community in South Africa.

MATERIALS AND METHODS

Determination of stock powder as a suitable vehicle for fortification (pilot study): This was the pilot study of a larger project in which the suitability of stock cube and stock powder as possible vehicle for fortification was determined.

To determine the suitability of stock powder as a vehicle for fortification, a questionnaire was developed, validated and sent out to 802 respondents (n-802). The data in the questionnaire include the amount of stock cube and stock powder consumed in a week, when and how the stock powder is used and the choice of flavours of stock cubes and stock powders that are frequently used. The sample was randomly selected in hypermarkets, townships, towns and institutions in the Vaal Triangle area in South Africa. The survey population comprised males and females of 15 years or older. Questionnaires were completed each week for four weeks and the answers compared. Based on the results the questionnaire was accepted to be reliable and valid as in both tests correlation of 90% was found.

Methods used to determine the compliance and acceptability of the multiple fortified stock powder

Packaging and distribution of stock powder: The development of multiple fortified stock powder is as follows:

- Twelve and a half kilogram of stock powder was mixed with 125 g of fortificant as instructed by Roche Products (Pty) Ltd in South Africa. The fortificants used as a cocktail of micronutrient is shown in Table 1. Every 5 g of multiple fortified stock powder used contained the following micronutrients: 500,000 RE of vitamin A, 0.420 mg of vitamin B1 (thiamine), 0.480 mg of vitamin B2 (riboflavin), 5.400 mg of vitamin B3 (niacin), 0.600 mg of vitamin B6, 0.134 mg of folic acid, 0.300 mg of vitamin B12, 18.000 mg of vitamin C, 4.620 mg of iron and 3.000 mg of zinc

The mixing was done in a large stainless steel dough mixer and was covered with aluminium foil in order to prevent exposure to light and the consequent biochemical and biological deterioration of the micronutrients. The mixer was also covered so as to prevent contamination and to prevent the destruction of micronutrients through oxidation. A mixing period of thirty minutes was adhered to so as to ensure an even distribution of fortificants in the stock powder. The mixing process was well controlled so as to ensure a homogenous mixture. The powder was later subjected to a nutrient-concentration analysis in a laboratory.

Table 1: Vitamin and mineral concentration in fortified stock powder

Vitamin/Mineral	Concentration per 5 g serving of stock powder
Vitamin A	500, 000 RE
Vitamin B1 (thiamine)	0.420 mg
Vitamin B2 (riboflavin)	0.480 mg
Vitamin B3 (niacin)	5.400 mg
Vitamin B6	0.600 mg
Folic acid	0.134 mg
Vitamin B12	0.300 mg
Vitamin C	18.000 mg
Iron	4.620 mg
Zinc	3.000 mg

The multiple fortified stock powders, as well as the unfortified stock powder, was packed in rigid 400 mL styrene curry tube containers of eight cm high and 12 cm in diameter. The containers were also provided with lids to prevent dust and dirt from contaminating the powder. The containers were coloured dark-grey to prevent the destruction of light-sensitive micronutrients such as vitamin A. The tightly covered containers contained 300 g of stock powder. Five milligram plastic spoons were provided for measuring purposes.

Code numbers representing fortified (Experimental) and unfortified (Control) powder, were written on the lids of the containers. The coding was single-blinded. Only the researcher knew the codes.

The stock powders were arranged in boxes and distributed to respondents at their workplaces. Distribution lasted for two days. Distribution of powders was repeated after 14 days in the same manner, so that respondents would be able to use the powder for a long period before answering any question about it. The multiple fortified stock powder was used for 6 weeks.

Instructions on how to use the fortified and unfortified stock powder is as follows: One level spoon full of the given powder was added to two teacups of boiling water, which was part of the liquid used in cooking the food. This was stirred very well until dissolved and then added to the stew, porridge or soup that was being prepared and allowed to boil for thirty minutes.

Recruitment of respondents: Recruitment of respondents was done at their work place after permission for the execution of the study during working hours had been granted. To motivate respondents to participate in the study, the purpose was explained. Volunteers who met the inclusion criteria were allowed to participate.

Thirty members were selected randomly and were assigned as experimental group for the use of the fortified stock powder; the other thirty were assigned to the control group for the use of the unfortified stock powder. The sample size was drawn from workers at the Vaal Triangle Technikon. These were black females aged between 27 and 50 years and that means all respondents who fell within the context of this study were in their reproductive age and were capable of giving birth.

Compliance and acceptability questionnaire: To determine the compliance and acceptability of the given stock powder, questionnaires were handed out to all the respondents (n = 60) for them to complete on their own. Among the questionnaire items were: age, occupation, language, education level and area of residence. The questionnaire also sought response on colour, smell, taste and after taste of the given stock powder. Visits and follow-ups at respondents' work places were conducted to find out if respondents used the given stock powder.

RESULTS

The results of the questionnaire on the pilot study indicated that 97% of respondents used stock cubes and 21% preferred stock powder.

Respondents used various flavours of stock powder and stock cubes, with chicken being the most popular. This indicate that stock powder and stock cube is consumed by a sizeable proportion of the population and it is the right vehicle to select for fortification. as shown in Fig. 1.

Again, the results on the daily consumption of stock cubes and stock powder revealed that 79% of respondents used stock cubes and stock powder daily and 21% weekly.

Results of the acceptability questionnaire: Data obtained from the empirical study, were analysed using the Statistical Package for Social Science (SPSS@) version 10.1. Chi-square test was used to determine the significant differences between the Experimental and Control Groups. The statistically significant level was taken at P~0.05.

Age of respondents: On average, the age of respondents in the study was (39.95±5.79 years). Seventy-nine percent (44) were above the age of 35, indicating a risk age for pregnancy (Haadsma, 2009) and 21% (12) were below 35 years (Fig. 2) (Kruger *et al.*, 2005).

Occupation: Eighty-four percent (47) of the respondents were doing physical environmental sanitation work such

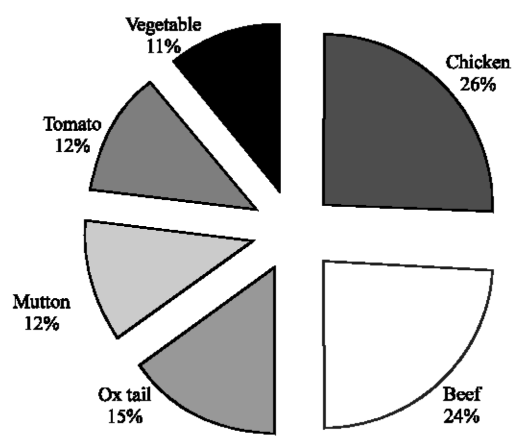

Fig. 1: Flavour popularity of stock cube or stock powder

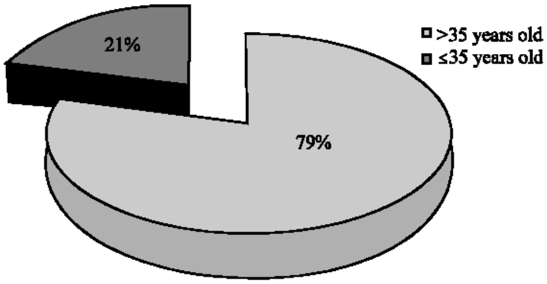

Fig. 2: Respondents age distribution (n = 56)

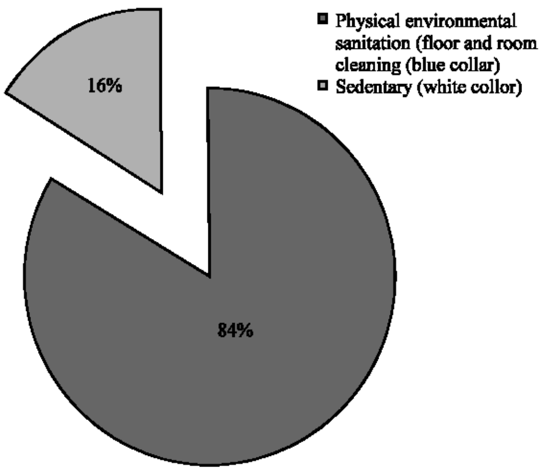

Fig. 3: Occupation of respondents (n = 56)

as floor and room cleaning and only 16% (9) were sedentary workers, as shown in Fig. 3. All respondents were Vaal Triangle Technikon employees. This kind of work implies that the respondents relied on low-income work for a living.

Language: The language spoken by 79% (44) of the women was South Sotho, 5% (3) spoke Xhosa and Tswana, 4% (2) spoke North Sotho and 7% (4) spoke other languages. Table 2 shows the different languages spoken by the respondents. This indicates that South Sotho is the language most widely spoken and understood by the black community in the Vaal Triangle Metropolitan Area.

Area of residence: Most respondents, 87% (49), lived in the surrounding townships of the Vaal Triangle area, namely Sebokeng and Sharpeville. Approximately 9% (5) lived in the hostels provided by the employers and only 2% (1) lived in informal settlements and farms as shown in Fig. 4.

Education level: Respondents reported a reasonable level of education. Figure 5 present the education level attained

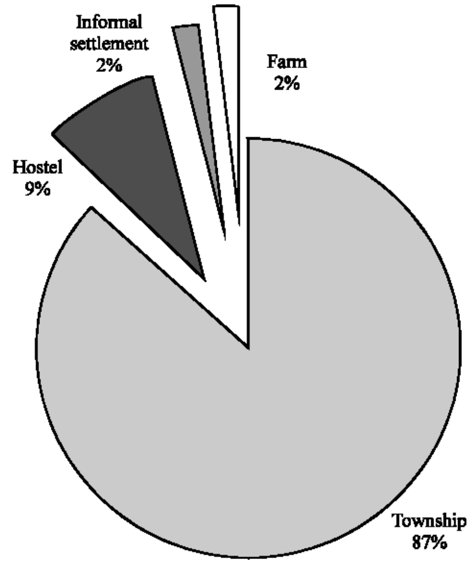

Fig. 4: Area of residence

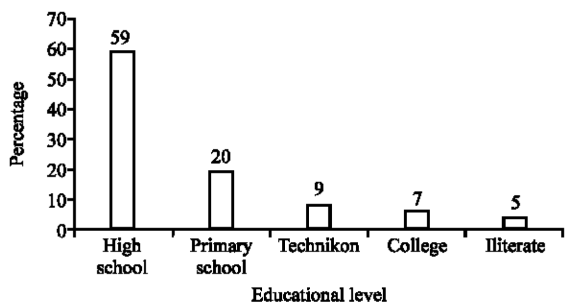

Fig. 5: Educational level

Table 2: Language of respondents (n = 56)

Language	No.	Percentage
South Sotho	44	79
Xhosa	3	5
Tswana	3	5
North Sotho	2	4
Other languages	4	7

by the respondents. Fifty nine percent (33) attained high school education, 20% (11) had primary school education, 9% (5) had a technikon education, 7% (4) attained college education and 5% (3) had never attended school. This implies that the respondents' literacy level was adequate for their active participation in the study.

Responses on the acceptability of the multiple fortified stock powder and the unfortified stock powder

Responses to change of colour of food after cooking: There was no statistically significant difference between the groups in terms of change of colour of food after cooking (p = 0.121). Table 3 indicates that 72% (21) of respondents in the fortified group, did not detect any

Table 3: Responses on acceptability of the multiple fortified stock powder and the unfortified stock powder

	Fortified stock powder (%)		Unfortified stock powder (%)	
	Change detected	No change detected	Change detected	No change detected
Responses to change of colour of food after cooking	28	72	11	89
Responses to smell of stock powder in food after cooking	0	100	0	100
Responses to medicinal taste in food after cooking	7	93	4	96
Responses to after taste	14	86	19	81

colour change in their cooked food and 89% (24) of respondents in the unfortified group also did not detect any colour change. Only 28% (8) of the respondents in the fortified group and 11% (3) of respondents in the unfortified group detected a change of colour in their food after having cooked with the powder.

Smell of stock powder: There was no significant statistical difference in responses of respondents regarding smell of the powder (p = 0.136). No smell was detected in the fortified stock powder.

Responses to medicinal taste in food: There was no statistical difference between the groups in terms of medicinal taste detected in the food prepared with the multiple fortified stock powder (p = 0.596), as shown in Table 3 although the unfortified groups scores were lower than that of the fortified group. This shows that a few respondents in the fortified group who are highly sensitive to taste, may have detected the change of taste in their food.

Responses to after-taste: Very little difference was found between the different powders in terms of after-taste (p = 0.580), as seen in Table 3. The difference was not statistically significant, that is, no objectionable taste was detected after swallowing the food prepared with the multiple fortified stock powder. However, 19% (5) of the respondents in the unfortified group surprisingly detected some after-taste in their food as compared to 14%(4) in the fortified group, but these were not significant statistical difference.

DISCUSSION

From the findings, the age range of the respondents was 27-50 years, indicating that all respondents fell within the category of women of reproductive age. Women of this age group are among the high risk groups for micronutrient deficiency. For instance Darton-Hill *et al*., (2005) reported that among groups of people with lower iron and vitamin A intake are young children, adolescent girls and women. Hughes (2006) also estimated that 43% of all women worldwide are anaemic. Under apartheid policies, black people were reduced to a state of abject poverty, which affected the health and welfare of many women and their children. The selection of category of women for the micronutrient food fortification intervention was informed by the knowledge that the nutritional status of a woman in her reproductive years could affect not only her offspring but also succeeding generations. It is prudent therefore for the women to understand the implications for themselves and their families if they make poor nutritional choices. Ensuring optimal nutrition throughout the child bearing years through acceptability of multiple fortified stock powder may prove to be a critical step towards improving delivery complications of the women. Again, acceptability and compliance of the multiple fortified stock powder by these women therefore will spread the health message and reduce the incidence of micronutrient deficiencies in the young child and the population at large.

Again, responses in Figure 3 show that majority of the respondents were doing physical environmental sanitation jobs (blue collar) (84%). This implies that the women in their reproductive age used in this study are in low income jobs which possibly reduced their purchasing power and could have led to their indulgence in junk food and thus probably may have prevented a variety of foods to be eaten, including micronutrient rich foods. Indeed, literature surveyed indicates that factors which could influence the ability of an individual to acquire and utilize nutrients include income and purchasing power and health status (Labadarious *et al*., 2005). Also, the findings showed that 88% of the women reside in townships (Fig. 4). This can indicate a sign of maternal poverty and vulnerability to under nutrition, poor shelter and government health services which are of poor quality even when available (Garrib *et al*., 2006). The literature survey shows that majority of South African households live in poverty, with less food, (mainly staples) available in the home (Mostert *et al*., 2005). An intervention in the form of the compliance and acceptability of multiple fortified stock powder is therefore of relevance to preventing micronutrient deficiencies.

No research studies could be found in the literature on compliance and acceptability to multiple fortified stock powder. The appearace, taste and aroma of multiple fortified stock powder were evaluated to assess consumer compliance and acceptability. People do not eat what was not appealing (Köster, 2009). Literature studied shows that visual attributes play an important role in consumer's acceptance of food.

Respondents positive attitude towards the powder indicate that there was no organoleptic changes to the fortified stock powder. This quality accounts for the acceptability. The findings also indicate that respondents exposure to and their prior knowledge of stock powder might have contributed to the compliance and acceptability of the product. This is so because respondents in the fortified group and all the respondents in the unfortified group were already consuming stock powder at home. This is confirmed in literature which stated that a commonly used vehicle is needed in order to increase compliance and acceptability of a new product. Ismail (2006) also confirm that compliance behavior depends on beliefs and attitude. Previous studies done on respondents' acceptability of fortified cassava flour, which was their staple food, with groups of pregnant and lactating mothers found that cassava flour was acceptable (Faber, 2005). Finally, the findings suggest that foods prepared with multiple fortified stock powder are generally comparable in acceptability to food prepared with ordinary stock powder. There is no significant statistical difference. The reason for the acceptability may be that the characteristics of the food prepared do not appear significantly changed by the stock powder (Arvola *et al*., 2008).

CONCLUSIONS

Micronutrient food fortification is effective when it is acceptable to the respondents and they comply with the use thereof.

The findings proposes that a common vehicle to carry the nutrients must be identified The pilot study shows that stock cube and stock powder were popular condiments that are consumed in constant quantities by a large proportion of families without segregation of the socio-economic status in the Vaal Triangle area.

Consumer compliance and acceptability should precede all future micronutrient fortification programmes. Micronutrient food fortification is very important and must be sustained. Multiple fortified stock powder is recommended as a potential functional food at medium and large industry because respondents complied with and accepted the stock powder.

Multiple fortified stock powder was accepted in terms of colour, taste and overall acceptability showing the impact of fortification of foods that are commonly consumed.

The respondents could not differentiate between the fortified and the unfortified products.

Micronutrient food fortification is very important and must be sustained: The food industries in South Africa in conjunction with all relevant role players can expand micronutrient food fortification towards attaining a sustainable and long-term solution to micronutrient deficiency.

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