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Sensory Evaluation of Multiple Fortified Stock Powder

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Abstract: The aim of the study was to determine consumer sensory acceptability of multiple fortified stock powder in beef stew as compared to unfortified stock powder, which was used as a control. The panelists included 10 students from the Vaal University of Technology in the Republic of South Africa aged between 18 and 23 years consisting of nine females and one male, who have some knowledge of food evaluation and were also consumers of beef. The multiple fortified stock powder was classified as a functional food in the light of the addition of a range of nutrients. Ten semi-trained panelists, evaluated three differently prepared beef stew samples based on colour, flavour, off-flavour and after flavour acceptability by using a 5-point hedonic scale. Two samples were cooked for 10 min and 30 min respectively with fortified stock powder and the other sample with unfortified stock powder. The hedonic scale ranged from "unacceptable" (which was assigned the value of one), "moderately unacceptable" (value of 2), "acceptable" (value of 3)," moderately acceptable" (value of 4) and "highly acceptable" (value of 5) respectively. The results showed that multiple fortified stock powder cooked in beef stew was appreciably accepted by the semi- trained panel. Multiple fortified stock powder is comparable to ordinary stock powder in acceptability and would be accepted when introduced into the market with accompanying education. In conclusion, sensory evaluation should precede all future micronutrient food fortification programmes and multiple fortified stock powder should be promoted as a potential functional food.

Key words: Sensory, acceptability, hedonic scale, functional food, fortification, stock powder

INTRODUCTION

Micronutrient deficiencies: Over two billion people are at risk of micronutrient deficiencies and more than one billion are affected by it (World Health Organization and United Nations International Children's Fund, 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).

According to the report of the International Vitamin A Consultative Group (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) and Eckhardt (2007) further add that the groups with lower intakes of iron in South Africa include young children, adolescent girls and women. Standing Committee on Nutrition (2007) confirms that women especially in their reproductive age are among the most affected.

Causes of micronutrient malnutrition: The adequacy of food supplies at national level in most developing countries does not ensure that adequate food is available at the households or at the individual level. Factors that can influence the ability of an individual to acquire and utilize nutrients include:

- Food and water availability
- Food prices
- Income and purchasing power
- Women's workload
- Education level
- Local customs
- Sanitary conditions and
- Health status

The cost of ill health due to micronutrient malnutrition is difficult to quantify and it is defined as "Hidden Hunger" (World Health Organization, World Food Programme and United Nations International Children's Fund, 2007).

Prevalence of micronutrient malnutrition in South Africa: A national survey conducted by Yamanchi *et al*. (2006) on micronutrient status of South African children, revealed that xerophthalmia (clinical eye lesion leading to nutritional blindness) rates among approximately 11,000 children. Among this figure, the six to seven months of age groups were found to be surprisingly high, since clinical VAD was not considered to be a problem previously. Night blindness was prevalent in 12% of the children. Bitot's spots in 0.4-0.8%, corneal

Table 1: Micronutrients: Dietary intakes of South Africans (Bourne *et al*., 2007)

Micronutrient	Groups with lower intake
Iron	Black rural and urban settings
	Coloured Indian population Groups
	Young children, adolescent girls and women
Thiamin (B1)	Black and Indian population groups
Riboflavin (B2)	Black rural and urban settings
Niacin (B3)	Black and Indian population groups
Vitamin (B6)	All population groups of all ages except white males
Folate	Indians
	Rural black women of childbearing age
Vitamin A	Black children younger than ten years of age
	Urban black women
	Black and Indian men

xerosis in 0.2-0.7% and keratomalacia or corneal scarring in 0.1%. Prevalence of low serum retinol was higher in the rural areas thus 23% than in the urban areas 25%. Serum retinol levels were found to be low in pre-school children living in poor settlements near Durban, as seen in Table 1. This suggests that these groups should be targeted for vitamin A interventions (United Nations International Children's Fund South Africa, 2008). In addition VAD is also common among women from the poorest communities and stunting is also common (Adamson, 2006). Iron deficiency anaemia is also common among pregnant women, especially among women of Indian origin who are living in South Africa. A number of small studies reports the prevalence of anaemia in pregnancy, with 37% in the Johannesburg and 33% in the Gazankhulu area. Hatting *et al*. (2008) add that in terms of micronutrients (as shown in Table 1), riboflavin intake was found to be low in black rural and urban settings, as well as in the coloured and Indian population groups. The intake of iron was also very low in those very same population groups known to be vulnerable for iron deficiency. These include young children, adolescent girls and women.

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% (De Romana *et al*., 2005).

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 (United States Agency for International Development, 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 (World Health Organization, 2005). Efforts are still being made by the World Food Programme to develop and popularize 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).

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. This cannot be achieved until a successful sensory evaluation of the multiple fortified stock powder has been conducted.

Sensory evaluation, a major determinant of acceptability, is a scientific discipline which encompasses all of the senses and used to evoke measure, analyze and interpret reactions to the characteristics of foods and materials as they are perceived by the senses. It is also a major determinant in the subsequent adoption and use of the product (Otoo and Asiedu, 2009). Food Industry Foundation (2005) also confirms that knowing consumers' preferences and perception of the sensory characteristics of food and drink product is very important to food manufacturers and retailers alike. Today's consumers are discerning, demanding and more knowledgeable about food and expects products which are safe, good value and of high sensory quality (Duxbury, 2005). Bourne (2002) concluded with a look at the future: with the advent of more diverse styles of foods such as functional foods, the use of sensory analysis becomes even more important.

MATERIALS AND METHODS

Determination of stock powder as a suitable vehicle for fortification: This was also a 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 develop the multiple fortified stock powder: The development of multiple fortified stock powder is as follows:

Twelve and a half kilogram of stock powder were mixed with 125 g of fortificant as instructed by Roche. The fortificants used as a cocktail of micronutrient is shown in Table 2.

Table 2: 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 mcg
Vitamin C	18.000 mg
Iron	4.620 mg
Zinc	3.000mg

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 aluminum 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.

The multiple fortified stock powder, 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 diametre. 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.

Code numbers representing fortified (Experimental) and unfortified (Control) powder, were written on the lids of the containers. This was to assist in easy identification when using them in cooking the beef stew.

Recruitment of the panelists: The sensory panelists, consisting of nine female and one male, aged 18-23 years, from Vaal University of Technology who have some knowledge of food evaluation and were also consumers of beef were recruited to evaluate the acceptability of the three beef stew samples as shown in Fig. 1. Acceptability tasting occurred in the food science laboratory of the Department of Hospitality and Food Consumer Science at the Vaal University of Technology. Panelists were recruited by polite solicitation.

The study design: The study design for the sensory panel is explained in Fig. 1. To determine the sensory acceptability of the multiple fortified stock powder, ten semi-trained panelists evaluated three differently prepared beef stew samples based on colour, flavour, off-flavour and after-flavour acceptability by using a 5-point hedonic scale. Two samples were cooked for 10 min and 30 min respectively with fortified stock powder and the other sample with unfortified stock powder. The hedonic scale ranged from “unacceptable” (which was assigned the value of 1), “moderately unacceptable” (value of 2), “acceptable” (value of 3), “moderately acceptable” (value of 4) and “highly acceptable” (value of 5) respectively. Each sample of the beef stew was presented in identical white styrene curry tubes of the same size and shape, coded randomly with a three-digit number and plastic spoons were provided to panelists for tasting. Beef stew cooked for thirty minutes with multiple fortified stock powder was coded ”570”, beef stew cooked for ten minutes with multiple fortified stock powder was coded “349” and beef stew cooked with ordinary stock powder which was used as control was coded ”298”. The containers were free from odours and contamination, which might interfere with the results. All three samples were simultaneously presented in random order. Re-tasting of the samples was also allowed.

Sample preparation: Preparation for the beef stew samples involved collection of ingredients as seen in Table 3, utensils and equipment and cooking method in Fig. 2.

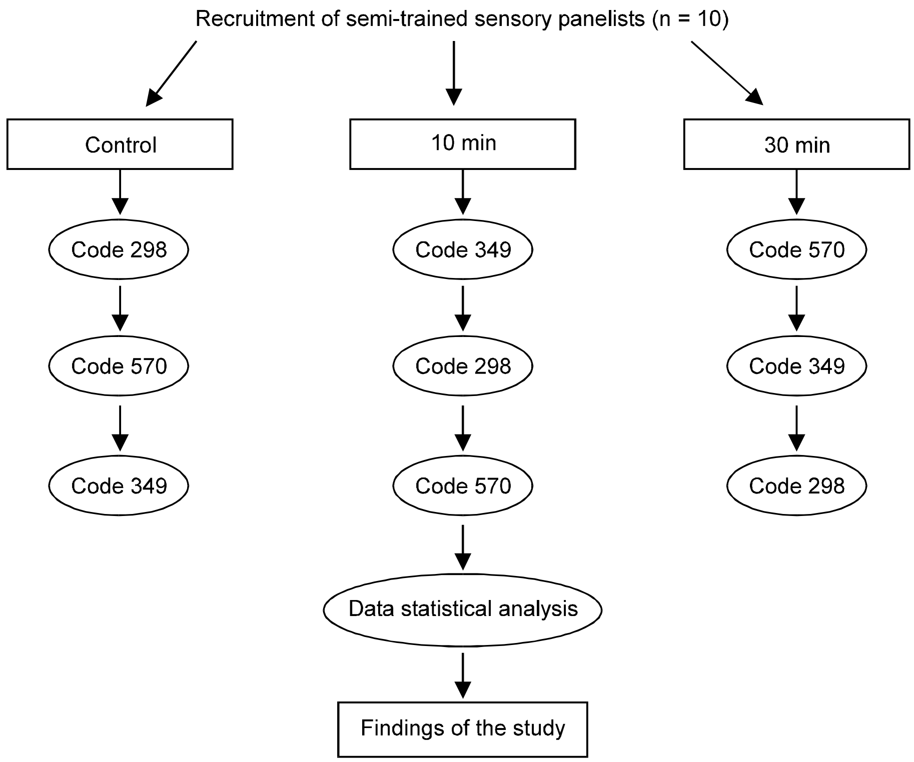

Fig. 1: Study design for sensory evaluation

Table 3: Ingredients used in the preparation of beef stew and quantities

Ingredients	Quantities in control group 60 min cooking	Quantities in experiment group 30 min cooking	Quantities in experiment group 10 min cooking
Chuck steak	800 g	800 g	800 g
Multiple fortified stock powder	-----	5 g	5 g
Unfortified stock powder	5 g	------	------
Onion	100 g	100 g	100 g
Salt	5 g	5 g	5 g
Vegetable cooking oil	15 ml	15 ml	15 ml
Cold water	250 ml	250 ml	250 ml
Boiling water	250 ml	250 ml	250 ml
End weight	1,000 g	1,150 g	1,150 g

Utensils and equipment used for the preparation of beef stew with fortified and unfortified stock powder: Utensils used for the preparation of beef stew are as follows:

- Three Identical aluminum saucepans with tight-fitting lids
- Frying pan
- Small saucepan for boiling water
- Cook's knife
- Measuring jug
- Wooden spoon and
- Chopping board

The Equipment used were:

- Electric stove and
- Electronic weighing scale

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

Results of the sensory evaluation: The data obtained from the semi trained sensory panel were statistically analyzed using SPSS® Version 10.1. Analysis of Variance (ANOVA) for comparing mean (SD) between samples was used.

Cooking method followed for beef stew

Collection of ingredients
Chuck steak, onion, vegetable oil, fortified stock powder, unfortified stock powder, salt, cold water and boiling water

↓

Methods
Excess fat trimmed, bones removed and beef cut into half centimeter square pieces

↓

Beef browned in heated cooking oil in three identical saucepans simultaneously at setting number four (moderately hot)

↓

Chopped onions added and sauteed until transparent

↓

The three saucepans removed from heat and 250 ml of cold water added to each saucepan

↓

Additional 250 ml of boiling water was mixed with 5 g of unfortified stock powder and added to saucepan number one (control). The three saucepans covered with tight fitting lids to prevent moisture loss

↓

Three saucepans brought to the boil simultaneously at setting three on the stove (moderate heat) and cooked for 60 min

↓

10 and 30 min before cooking time expire, 250 ml of boiling water mixed with 5 g of multiple fortified stock powder added to saucepan number two and three respectively. The covered saucepans allowed to continue to boil

↓

All three saucepans remover from heat after 60 min

↓

The beef stew dished for sensory evaluation

Fig. 2: Procedure for the preparation of multiple fortified beef stew

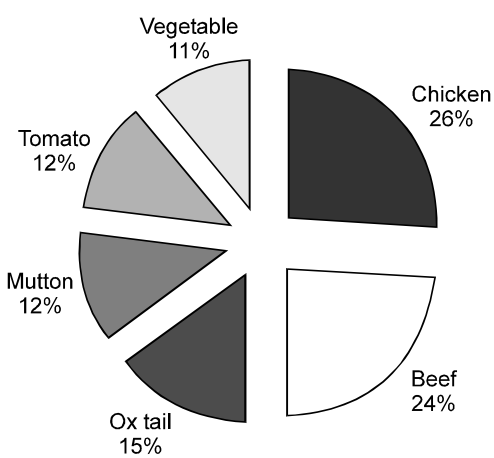

Fig. 3: Flavour popularity of stock cube or stock powder

Mean sensory scores for colour, flavour, after-flavour and off-flavour of beef stew cooked with multiple fortified stock powder for 10 and 30 min respectively and beef stew cooked with unfortified stock powder (control)

Colour sensory acceptability of beef stew: In terms of colour acceptability in Table 4, the panel rated the beef stew cooked with unfortified stock powder (control) as acceptable (3.24) on the 5-point hedonic scale. Colour of beef stew cooked with multiple fortified stock powder cooked for 10 min was acceptable (3.44) by the panel. Beef stew cooked with multiple fortified stock powder for 30 min was also rated acceptable (3.16) for colour. These indicate that there was no difference in colour between the control group and the experimental group. The 10 and 30 min can be an acceptable cooking time for the multiple fortified stock powder to obtain the desirable beef stew colour.

Table 4: Mean sensory scores for beef stew

Variable	Control group	10 min group	30 min group
Colour	3.24±0.71	3.44±0.71	3.16±0.38
Flavour	2.91±0.32	3.58±0.55	3.18±0.47
After-flavor	3.04±0.46	3.72±0.53	2.99±0.40
Off-flavour	2.77±0.72	3.08±0.90	2.94±0.56

Flavour sensory acceptability of beef stew: Data in Table 4 show that the flavour of beef stew cooked with unfortified stock powder was acceptable (2.91) by the panel. Flavour of beef stew cooked with multiple fortified stock powder for 10 min was rated moderately acceptable (3.58) by the panel. Beef stew cooked with multiple fortified stock powder for 30 min was also acceptable on the hedonic scale (3.18) in terms of flavour. These indicate that no objectionable flavor was detected in the beef stew cooked with multiple fortified stock powder for 10 min and 30 min. The 10 and 30 min cooking time should be recommended to consumers in future stock powder fortification.

After-flavour acceptability of beef stew: After-flavour taste of beef stew cooked with unfortified stock powder in Table 4 was rated acceptable (3.04) by the sensory panel. The after-flavour taste of beef stew cooked with multiple fortified stock powder for 10 min was rated moderately acceptable (3.72) and the after-flavour taste of beef stew cooked with multiple fortified stock powder for 30 min was also rated acceptable (2.99). These indicate that after the panel swallowed the stew no objectionable taste was detected in the mouth.

Off-flavour acceptability of beef stew: Data in Table 4 indicate that there was no off-flavour taste detected in the beef stew cooked with unfortified stock powder, and was rated as acceptable (2.77). Beef stew cooked with multiple fortified stock powder for 10 min was rated acceptable by the panel in terms of off-flavour (3.08). The panel detected no off-flavour taste in the beef stew cooked with multiple fortified stock powder for 30 min and was rated as acceptable (2.94).

Mean change between the control, 10 and 30 min group

Mean change of colour between the control, 10 and 30 min group: Comparing the mean change of colour between groups in Table 5, there was no statistical significant difference in colour between group one (control) and the beef stew cooked with multiple fortified stock powder for 10 min. Again, there was no statistical significant difference in colour between group one (control) and the beef stew cooked with multiple fortified stock powder for 30 min. Mean change of colour between beef stew cooked with multiple fortified stock powder for 10 min and beef stew cooked with multiple fortified stock powder for 30 min found no statistical significant difference.

Mean change of flavour between the control, 10 and 30 min group: Comparing the mean change for flavour in Table 5 between beef stew cooked with unfortified stock powder and beef stew cooked with multiple fortified stock powder for 10 min, there was no statistical difference. Again, when the flavours of beef stew cooked with unfortified stock powder and the beef stew cooked with multiple fortified stock powder for thirty minutes compared, there was no statistical significant difference shown (-0.27 where p = 0.197). There was no statistical difference in flavour between beef stew cooked with multiple fortified stock powder for 10 min and beef stew cooked with multiple fortified stock powder for 30 min (0.40, where p = 0.060).

Mean change of after-flavour between the control, 10 and 30 min group: Data in Table 5 indicate that there was no statistical significant difference by comparison in after-flavour taste between beef stew cooked with unfortified stock powder and beef stew cooked with multiple fortified stock powder for 10 min (0.68, where p = 0.03). There was no statistical significant difference in after flavour taste between beef stew cooked with unfortified stock powder for 10 min and beef stew cooked with multiple fortified stock powder for 30 min (0.05, where p = 0.812). The 10 and 30 minute cooking time should be recommended to consumers in future fortification. Also, there was no statistical difference in after-flavour taste between beef stew cooked with multiple fortified stock powder for 10 min and beef stew cooked with multiple fortified stock powder for 30 min (0.73, where p = 0.002). The acceptability indicates that high population coverage can be achieved when introduced into the market.

Mean change of off-flavour between the control, 10 and 30 min group: By comparison in Table 5, there was no statistical significant difference in off-flavour taste between beef stew cooked with unfortified stock powder and beef stew cooked with multiple fortified stock powder for 10 min (-0.31, where p = 0.356). There was

Table 5: Mean change between groups

Variable	Control group vs 10 min	Control group vs 30 min group	10 min vs 30 min
Colour	-0.2, p = 0.477	0.008, p = 0.775	0.28, p = 0.321
Flavour	-0.67*, p = 0.003	-0.27, p = 0.197	0.40, p = 0.060
After-flavor	-0.68*, p = 0.03	0.05, p = 0.812	0.73*, p = 0.002
Off-flavour	-0.31, p = 0.356	-0.17, p = 0.611	0.14, p = 0.675

no statistical difference in off-flavour taste between beef stew cooked with unfortified stock powder and beef stew cooked with multiple fortified stock powder for 30 min (-0/17, where p = 0.611). No statistical significant difference in off-flavour was detected between beef stew cooked with multiple fortified stock powder for 10 min and beef stew cooked with multiple fortified stock powder for 30 min (0.14, where p = 0.675).

DISCUSSION

No research studies could be found in the literature on sensory evaluation and acceptability to multiple fortified stock powder. The colour, flavour, after-flavour and off-flavour of beef stew cooked with multiple fortified stock powder were evaluated to assess consumer sensory acceptability. People do not eat what was not appealing and colour serves as a signal of the quality of accepted foods (Koster, 2009). Literature studied showed that visual attributes play an important role in consumer's acceptance of food and that, colour is certainly the most salient aspect of the visual aspect of food. The result again implies that, surface texture can also give important clues to the sensory properties of food and in spite of numerous ways by which the appearance attributes of food can affect consumers acceptance, the majority of research on the role of appearance in food acceptance, has focused on the influence of colour (Keith *et al*., 2007). The flavour acceptability of the multiple fortified stock powder may be attributed to the stock powder itself being a flavour improver and this again is in support of literature which indicate that most of the successful food fortification programmes in the developing world are those that use flavour and taste improvers (Eddy *et al*., 2007). Furthermore, the panelist positive attitude towards the flavour of the beef stew indicate that there was no organoleptic change to the fortified stock powder and this quality accounts for the flavour acceptability. The findings also indicate that the panelists exposure to and their prior knowledge of stock powder as well as beef might have contributed to the acceptability of the product (Ismail, 2006). This is so because panelists in the experimental group and all the panelists in the control group were already consuming stock powder and beef at home. This is confirmed in literature which stated that a commonly used vehicle is needed in order to increase the acceptability of a new product (Ismail, 2006). Faber (2005) also confirmed that acceptability behavior depends on beliefs and attitude. Previous studies done on respondents flavour and after-flavour 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 foods prepared with ordinary stock powder. There is no significant difference. The reason for the acceptability may be that the characteristics of the stew prepared did not appear significantly changed by the fortified stock powder (Dean *et al*., 2008). It cannot be said that the fortificant used remained stable after cooking because the panel only used their senses of sight, smell and taste to evaluate the fortified stock powder and would be impossible to test the stability of the fortificant with these senses. Literature indicate that vitamin A, (fat soluble) vitamin B_2 (riboflavin), vitamin B_3 (niacin), vitamin B_6 and vitamin B_{12} which are water soluble, are also stable to heat however, vitamin B_1 (thiamine) and folic acid, although water-solouble, are destroyed by heat (Fukuwatari and Shibatata, 2008). Accessing the stability of the multiple fortified stock powder can be served as future research.

Conclusion:

- 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.
- Sensory evaluation 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 the panelists 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 panelists 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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