PAT June, 2017; 13 (1): 74-79 ISSN: 0794-5213

Online copy available at www.patnsukjournal.net/currentissue

Publication of Nasarawa State University, Keffi

Micronutrient Composition of Wheat-Cocoyam Cookies Enriched With Soybean Flour

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Abstract
Composite flour blends of wheat-cocoyam-soybean were used in the production of cookies in order to determine their micronutrient composition. These cookies were subjected to mineral and vitamin content analysis. There were significant differences (p<0.05) in the mineral and vitamin contents of the cookies. Sodium and magnesium contents of the cookies were in the range of 120.80 – 123.20mg/100g and 77.60 – 83.20 mg/100g respectively. Sample WH100/0CS (WH= wheat flour; CS = cocoyam/soybean flour) differed significantly from other samples in its sodium and magnesium mean content values. The phosphorus content was in the range of 47.89 – 122.30 mg/100g. Sample WH60/20CS had the highest calcium mean content value of 49.43mg/100g while sample WH100/0CS had the least value of 26.72mg/100g. It was also observed that sample WH60/20CS had the highest mean content values in phosphorus, calcium and potassium. Significant differences existed in the vitamin content values of the cookies except in niacin. Sample WH60/20CS differed significantly from the other samples with a vitamin A value of 107.24IU/100g and vitamin C value of 4.69mg/100g. The mean values of the cookies showed that they can serve as good sources of micronutrient for the body and can help in reducing micronutrient deficiency through food-based approach.
Keywords: cookies, micronutrient, vitamin, mineral

Introduction

It is known that micronutrient deficiencies threaten about two billion people globally (FAO, 2013).Micronutrients play crucial roles in human nutrition, including the prevention and treatment of various diseases and conditions, as well as the optimization of physical and mental functioning. Vitamins and minerals are the two types of micronutrients. Though only needed in small amounts, they play important roles in human development and well-being, including the regulation of metabolism, heartbeat, cellular pH and bone density. Lack of micronutrients can lead to stunted growth in children and increased risk for various diseases in adulthood. Minerals are also available in two forms: macrominerals and microminerals. Macrominerals are needed in larger amounts and include: Calcium, Magnesium, Phosphorus, Sodium, Potassium. Microminerals are only needed in trace amounts and include: Iron, Copper, Iodine, Zinc, Fluoride. FAO strongly emphasizes that food-based approaches are sustainable strategies for improving the micronutrient status of populations (FAO, 1997). Increasing access to and availability and consumption of a variety of micronutrient-rich foods not only have a positive effect on micronutrient status but also contribute to improved nutrition in general (Aphane *et al*., 2003).Micronutrients are found naturally in a variety of plant- and animal-based foods. Although they can now be synthesized in the laboratory, a varied diet typically provides all of the vitamins and minerals necessary for human health.

Micronutrient malnutrition (MNM) is widespread in the industrialized nations, but even more so in the developing regions of the world. It can affect all age groups, but young children and women of reproductive age tend to be among those most at risk of developing micronutrient deficiencies. Food fortification tends to have a less immediate but nevertheless a much wider and more sustained impact. Although increasing dietary diversities generally regarded as the most desirable and sustainable option, it takes the longest to implement. Supplementation which is the term used to describe the provision of relatively large doses of micronutrients, usually in the form of pills, capsules or syrups, has the advantage of being capable of supplying an optimal amount of a specific nutrient or nutrients, in a highly absorbable form, and is often the fastest way to control deficiency in individuals or population groups that have been identified as being deficient.

Soybean has protein content of about 40% (Kure *et al.*, 1998) and also rich in calcium, iron, phosphorus and vitamins. Soy bean contains all the essential amino acids (Ihekoronye and Ngoddy, 1985). Cocoyams have nutritional advantages over root crops and other tubers crops (Lyonga and Nzietchueng, 1986). It has more crude protein than root and other tubers and its starch is highly digestible because of the small size of the starch granules, its contents of calcium, phosphorus, vitamins A and B vitamins are reasonable. Composite flour incorporating cocoyams has been used in extruded products such as noodles and macaroni (FAO, 1990).

Materials and methods

The major raw materials that were used in this study include: cocoyam (*Xanthosoma sagittifolium)* i.e. *Ede ocha*, soybeans (*Glycine max*) and wheat flour. The items were purchased from Ekeukwu market in Owerri municipal, Imo State. All other reagents used were of analytical grade.

Processing of cocoyam into flour

Cocoyam cormels were processed into flour using the method described by Oti and Akobundu, (2007). Cocoyam cormels were peeled, sliced and washed with water. The slices were blanched at 75°c for 15 minutes in portable water. The blanched slices were oven dried at 60°C for 9 hours and milled to obtain flour which was subsequently sieved to yield flour of fine texture.

Processing of soybean into flour

Soybean flour was produced using the method described by Oluwamukomi *et al.* (2005). One kg of soybean were sorted, washed and boiled in water at 100^{o}C for 30min. The boiled soybean were dehulled manually, oven-dried at 55^{o}C for 16 hours, milled to obtain the flour followed by sieving using a sieve with 300 -μm aperture and then kept in an airtight plastic container until ready for further use. The composite cookies were produced using the method of Asomugha and Uwalaka (2000) using the blend formula Table 1.

Table 1: Blend formula for wheat-cocoyam cookies enriched with soy bean (%)

Samples	Wheat flour	Cocoyam flour	Soybean flour
WH60/20CS	60	20	20
WH70/15CS	70	15	15
WH80/10CS	80	10	10
WH90/05CS	90	5	5
WH100/0CS	100	0	0

WH = wheat flour; CS = cocoyam/soy bean flour

Vitamin and mineral elements determination

Thiamine, Niacin and Riboflavin content were determined using the colorimetric method (Okwu and Ndu, 2006). Vitamin A and C content were determined spectrophotometrically using the standard methods of AOAC (2000). The mineral components (sodium, magnesium, phosphorus, calcium, potassium) were analyzed using an Atomic Absorption Spectrophotometer (AAS, Model SP9, Pychicham UK).

Statistical analysis

All data were analyzed in triplicates and means subjected to analysis of variance ANOVA) while the least significant test was used to detect significant differences among the means (Iwe, 2002, 2007).

Results and Discussion

Mineral composition of the cookies

Table 2 shows the result of the mineral content of the wheat-cocoyam cookies enriched with soy bean flour. Minerals are known to play important metabolic and physiological reactions in the living system as anti-oxidant enzyme co-factor (Talwar *et al.*, 1989). There were significant differences in all the mineral components analyzed. The mean values for sodium were in the range of 120.80 – 123.20mg/100g with sample WH100/0CS having the highest mean value of 123.20mg/100g, closely followed by sampleWH90/05CS with mean value of 122.73mg/100g. Sodium acts systemically to strength developing teeth, for the prevention of dental carries by increasing tooth resistance to acid dissolution and promotes demineralization and also inhibit cariogenic microbial process (WHO/FAO 2001). Sodium helps to maintain osmotic pressure and regulate acid based balance in the body though not good when taken in high quantities. Prolonged consumption of foods high in sodium as well as sodium intake above the recommended value has been associated with high blood pressure and stiffening of arterial walls and, therefore, is a risk factor for cardio-vascular heart disease (CHD), which is a major cause of death in Europe (Gibbs *et al.*, 2000; He *et al.*, 2005).

Sample WH100/0CS has significantly higher magnesium value of 83.20mg/100g than other samples. The magnesium mean values for the cookies were 77.60 – 83.20mg/100g. Magnesium is needed for many biochemical reactions in the body. It helps to maintain normal muscles and nerve function, keeps heart rhythm steady, support a healthy immune blood and regulate blood sugar levels (Saris *et al.*, 2000). It has been reported that magnesium, zinc and selenium prevent cardiomyopathy, muscle degeneration, growth retardation, impaired spermatogenesis, immunogical dysfunction and bleeding disorder (Igwe *et al.*, 2011). Iron, zinc, copper and manganese strengthen the immune system as antioxidant enzyme cofactors (Talwar *et al.*, 1989). Minerals such as iron and zinc are low in cereal and tuber-based diets, but the addition of legumes can slightly improve the iron content of those diets. Minerals such as iron and zinc are low in cereal and tuber-based diets, but the addition of legumes can slightly improve the iron content of those diets (FAO, 2001).The phosphorus and calcium contents of the cookies were in the range of 47.89 – 122.30 mg/100g and 26.72 – 49.43mg/100g respectively. Calcium has been known to aid in strong bone and teeth formation. Without proper consumption of micronutrients, humans can suffer from diseases such as rickets (lack of vitamin D), scurvy (lack of vitamin C) and osteoporosis (lack of calcium).Deficiencies of certain minerals such as zinc and phosphorus had been shown to aggravate carbohydrate intolerance (Franz *et al.*, 2002). Calcium intake in diabetics had been shown to be beneficial and likely to reduce osteoporosis in older diabetics (Cryer *et al.*, 1994). The amount of calcium increased greatly in the wheat-cocoyam cookies enriched with soybean thereby agreeing with (Ayo et al., 2010,Igbabul et al., 2014,Dabels et al., 2016) who reported increased vitamins and minerals in composite bread.

Table 2: Mineral composition of wheat-cocoyam cookies enriched with soy bean (mg/100g)

Samples	Sodium	Magnesium	Phosphorus	Calcium	Potassium
WH60/20CS	120.80±0.40	77.60±2.78	122.30±1.39	49.43±2.30	358.00±0.40
WH70/15CS	121.73±0.23	78.40±3.67	91.30±1.03	42.75±2.32	349.33±0.46
WH80/10CS	122.20±0.20	80.80±1.39	77.37±1.61	37.41±2.32	333.60±0.40
WH90/05CS	122.73±0.12	82.40±1.39	51.30±0.63	33.70±2.32	284.93±1.22
WH100/0CS	123.20±0.42	83.20±1.39	47.89±0.46	26.72±2.32	264.53±0.83

Where WH = wheat flour; CS= cocoyam/soy bean composite flour

Vitamin Composition of the cookies

The results of the vitamin contents of the cookies are presented in Table 3. There were significant differences in the vitamin components analyzed for the cookies. Sample WH60/20CS was significantly higher than the other samples with mean value of 107.24IU /100g in vitamin A followed closely by sample WH70/15CS with 81.75 IU /100g. Sample WH100/0CS had the lowest mean value of 25.20 IU /100g vitamin A. Vitamin A promotes skeletal growth, normal tooth structure, healthy membrane, healthy skin, eyes and hair, it is also essential for good night vision (Ong, 1994). Vitamin A is important for visual health, immune function and fetal growth and development. Vitamin A deficiency is a public health problem in many parts of the world, particularly Africa and South-East Asia. Vitamin A refers to provitamin A carotenoids and the preformed retinols, plus their metabolites (Dabels et al., 2016). Vitamin A deficiency is the leading cause of non-accidental blindness. Children from impoverished Nations are especially susceptible because their inadequate intake and diminished stores of vitamin A fail to meet the increased needs associated with rapid growth (Wardlaw and Kessel, 2002; Dabels et al., 2016). Foods such as edible oils and fats, cereal grains, condiments, refined sugar and milk have been successfully fortified with vitamin A and studies have shown that consumption of vitamin A-fortified foods can improve vitamin A status. The vitamin A content of most staple diets can be significantly improved with the addition of a relatively small portion of plant foods rich in carotenoids, the precursors of vitamin A. The recommended daily intake of vitamin A for children (7 – 10years) is 400μg (FAO, 1988). However, nutritionally, high level of vitamin A is not desirable in human diets because excessive accumulation of this vitamin has been reported to cause vitamin A toxicity in the body (Onweluzo and Nwabugwu, 2009; Okoye and Obi, 2017).

There were significant variations in the vitamin C content of the cookies. Sample WH60/20CS had the highest mean value of 4.69mg/100g.Vitamin C (Ascorbic acid) is an essential micronutrient required for normal metabolic function of the body, the importance of vitamin C to the human body is widely acknowledge throughout the globe, it is essential for formation of cholesterol, it lowers blood pressure and cholesterol level. Antioxidants such as ascorbic acid and carotenoids coupled with dietary fibre have been associated with prevention of nutritionally related diseases such as cancers, diabetes mellitus, coronary heart disease and obesity (Larrauri *et al.*, 1996). There is much ongoing investigation on the role of vitamin C in the prevention of chronic diseases such as cardiovascular disease, cancer and cataracts. Vitamin C is known to improve iron bioavailability. Ascorbic acid is heat labile and minimal cooking (steaming or stir-frying) is recommended to maximize its bio-availability. Higher levels of intake of vitamin C and folic acid are beneficial and protective to health. Some countries have already adopted higher levels of intake of these nutrients as desirable. The recommended daily intake of vitamin C is 30mg (FAO, 1982). It has been reported that substitution of wheat flour with African breadfruit flour in the production of cookies had greater effect in enhancing their vitamin C (ascorbic acid) contents (Ejidike and Ajileye , 2007; Okoye and Obi, 2017). The observation being an indication that African breadfruit is also a good source of ascorbic acid

There were some variations in the riboflavin and thiamine contents of the cookie samples. There mean values for riboflavin and thiamine were in the range of 0.07 – 0.13mg/100g respectively. According to FAO/WHO (2001), riboflavin aids in releasing energy to the body cells, enables utilization of fats, protein and sugars. There were no significant differences in the niacin content of the cookies (1.52 – 2.14mg/100g). Niacin aids normal functioning of tissues particularly skin, gastrointestinal tract and nervous system. It is used with other vitamin in the converting of carbohydrate to energy (FAO/WHO, 2001).The presence of these antioxidants (vitamins A and E), have protective effect against diabetes and cardiovascular diseases (Paul *et al*., 1985). The recommended daily intake of riboflavin and niacin are 1.8mg and 19.8mg respectively (FAO, 1982).

Table 3: Vitamin content of wheat-cocoyam cookies enriched with soybean

Samples	Vitamin A (IU/100g)	Vitamin C (mg/100g)	Riboflavin (mg/100g)	Niacin (mg/100g)	Thiamin (mg/100g)
WH60/20CS	107.24±0.17	4.69±1.02	0.07±0.01	1.52±0.01	0.04±0.00
WH70/15CS	81.75±0.34	4.12±1.02	0.07±0.01	1.59±0.01	0.05±0.00
WH80/10CS	51.59±3.44	2.93±1.02	0.10±0.01	1.81±0.02	0.05±0.00
WH90/05CS	26.88±0.34	2.93±1.02	0.11±0.00	1.97±0.02	0.06±0.00
WH100/0CS	25.20±0.35	2.35±1.02	0.13±0.02	2.14±0.01	0.06±0.00

Where WH = wheat flour; CS= cocoyam/soy bean composite flour

Conclusion

The use of wheat-cocoyam cookies enriched with soy bean at different substitution level (5% – 20%) have proved to be a good source of micronutrient for the body. The control of vitamin and mineral deficiencies is an essential part of the overall effort to fight hunger and malnutrition. Increasing access to and availability and consumption of a variety of micronutrient-rich foods like the wheat-cocoyam cookies enriched with soy bean flour will have positive effects on micronutrient status as well as contribute to improved nutrition.

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