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Full Length Research Paper

Chemical evaluation and sensory attributes of soymilk fortified with carrot powder

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This study evaluates the nutrient content and sensory attributes of soymilk fortified with carrot powder. Carrots, soybeans, sugar and flavourings were bought from local retailers in Ogige main market, Nsukka, Enugu State, Nigeria. The fresh carrots were washed, scrapped, trimmed, sliced, sundried, grinded, packaged and stored in a labeled polythene bag. The soybean seeds were sorted, cleaned, washed, soaked for 18 h, drained and blanched for 25 min at 89°C. The blanched beans were pulverized with hot water; the paste formed was diluted with water at 1:5 and then sieved to get the soymilk. The soymilk was cooked for 23 min at 87°C. Flavor agents and sugar were added and 20 g each of carrot powder was added to 500 and 600 ml of soymilk, respectively. The proximate composition, vitamin and mineral contents of the samples were determined using standard methods. Sensory attributes were also evaluated. The result reveals that the proximate composition, vitamin and mineral contents of the fortified soymilk (CS_2 and CS_3) were higher than the plain soymilk (CS_1). Sensory evaluation of soymilk indicated that Sample CS_1 was preferred to CS_3, while CS_2 was least preferred. Carrot powder addition to soymilk improved its micronutrients content.

Key words: Chemical, sensory, evaluation, soymilk, carrot powder, fortified.

INTRODUCTION

Globally, the micronutrient deficiencies of concern are deficiencies of vitamin A, vitamin C, iron, iodine and zinc. Vitamin A deficiency affects an estimated 125 to 130 million pre-school aged children and 7 million pregnant women in low-income countries (West, 2002). Zinc deficiency is considered to be among the ten largest contributing factors to the burden of disease in developing countries with high mortality (WHO, 2002). Improving zinc status through supplementation or fortification is part of a group of interventions that, if successfully implemented, could together help reduce child deaths globally by 63% (Jones et al., 2003). The World Health Organization (WHO) estimated that about 4 to 5 billion people are iron-deficient worldwide (Standing Committee on Nutrition, 2004). Iron fortification of commonly consumed foods (in settings where it is feasible) is likely the most cost-effective method in reducing iron deficiency in a population (Richard and Martins, 2008).

The basic cause of malnutrition (protein-energy malnutrition and micronutrient malnutrition) is poverty. The poor strata in developing countries such as Nigeria lack purchasing power and spend a large percentage of their income on staple food. Animal products and fruits are the important sources of micronutrients but they are often more expensive and unaffordable; therefore, it can be expected that multiple micronutrient deficiencies rather than singular deficiencies would be common in these settings (Richard and Martins, 2008). Although reduced energy intake remains a problem in many settings, suboptimal intakes of several micronutrients are more widespread and may be present even when energy needs are met.

Soybean is an Asian bean plant cultivated for its nutritious seeds, for forage and to improve the soil (Keshun, 1997). Soybean is nutritious and has gained wide acceptance, but it is not an excellent source of

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minerals and vitamins. Soymilk is an aqueous extracts of the soybean resembling milk (William and Akiko, 2004). The nutritional composition, appearance and flavor of good quality soymilk are remarkably similar to that of cow milk. Soymilk do not contain lactose and is therefore good for lactose intolerant (WISHH, 2006). It is also cholesterol free. Some brands are fortified with important vitamins and minerals such as calcium, vitamin D, vitamin B-12 and vitamin A (WISHH, 2006).

Carrots are rich in carotenes, some compounds that the liver transforms to vitamin A (Vincent, 2004). In recent years, the consumption of carrot and its related products has increased steadily due to the recognition of antioxidant and anticancer activities of β-carotene in carrot, which is also a precursor of vitamin A (Mridula, 2011). Carrots are processed into products such as dehydrated carrots, juice, beverages, candy, preserves, and halwa (Mridula, 2011).

Fortification of food is increasingly becoming one of the ways of combating micronutrient deficiency in the world. Fortification is the addition of nutrients at levels higher than those found in the original or in comparable foods (ILSI/FAO, 1997). Food fortification is also a process by which a nutrient is added to commonly eaten foods to improve the quality of the food. The food that carries the nutrient is the food vehicle, and the nutrient added is the fortificant. Food fortification has been commonly used as a method to control micronutrient deficiencies.

Soymilk can be fortified with carrot powder, which is a good source of beta-carotene. Carrot does not contain only beta-carotene, but also contains considerable amount of iron, zinc, vitamin C, vitamin E, potassium, phosphorus (NPHIF, 2006).

MATERIALS AND METHODS

Sources of materials

Carrot, soybean, sugar and flavourings used were purchased from local retailers in Ogige main market, Nsukka in Enugu State, Nigeria.

Sample preparation

Production of carrot powder

Fresh carrots (2.4 kg) were washed, scrapped and its end trimmed to remove dirt. It was grated using a grating machine and sun dried for three days (until crispy). The dried carrots were ground into powder with a blender, packaged and stored in labeled polythene bag (Seagate, 2002).

Production of soymilk

Soybeans (500 g) were sorted and cleaned to remove dirt and stones, washed twice to remove dust, and soaked for 18 h. The soaked beans were drained and blanched for 25 min at 87°C, pulverized with hot water, the paste diluted with water (1:5) and sieved to get the soymilk. The soymilk was cooked for 23 min at 87°C, flavor agents and sugar were added and the milk was allowed to cool (Enwere, 1998). The plain milk was coded CS_1.

Method of fortification

Soymilk 500 and 600 ml were each fortified with 20 g of carrot powder and were coded as CS_2 and CS_3, respectively. The fortified soymilk provided 1/3 {350 Retinol Equivalent (RE)} of vitamin A requirement of an adult (1000RE) per day. It also provided a considerable amount of vitamin C, iron and zinc.

Chemical analysis

The moisture, ash, fat, protein and crude fibre content of the samples were determined using the method of AOAC (2005) methods. Carbohydrate content was obtained by difference. The AOAC (2005) standard methods were also used to determine iron (using phenanthroline method) and zinc (using dithizone method).
Beta carotene and vitamin C content of the samples were determined using the method of Pearson (1976).

Data collection

A nine point Hedonic scale rating form was used, where 9 was the highest score, and 1 was the least score. This was used to test for color, taste, flavor, mouth feel and overall acceptability. The degree to which a product was liked was expressed as: like extremely much (9), like very much (8), like moderately (7), like slightly (6), neither like nor dislike (5), dislike slightly (4), dislike moderately (3), dislike very much (2), dislike extremely much (1).

Like extremely much to like slightly constituted good, while dislike slightly to dislike extremely much constituted poor. Neither like nor dislike shows that the product was neither good nor bad. The judges were randomly chosen from second and final year students of the Department of Home Science, Nutrition and Dietetics, University of Nigeria, Nsukka. A total of 50 students were chosen, and the judges were selected from 50% of the sample population. Thus, 25 judges were randomly selected for participation from 25 YES options and 25 NO options. Those who picked the YES options constituted the judges. The judges were trained on how to taste the samples and grade their responses. The sensory evaluation test was conducted in the diet laboratory of the Department of Home Science, Nutrition and Dietetics, University of Nigeria. The arrangement was such that the judges did not see the grading of others to avoid bias. The samples were coded.

Data analysis

The laboratory analyses were carried out in triplicates. The mean and standard deviation were calculated. The sensory evaluation results were statistically analyzed. The mean and standard error of mean was calculated using analysis of variance separated by Duncan's new multiple range test. Significance was accepted at $P \leq 0.05$. All these were done using Statistical Packaged for the Social Sciences (SPSS) version 17.

RESULTS

The results in Table 1 present the proximate composition of the plain soymilk and soy milk fortified with carrot powder. The moisture content of the samples varied from

Table 1. Proximate composition of different soymilk beverages in percentages (%).

Samples	Moisture	Protein	Fat	Crude fibre	Ash	Carbohydrate
CS_1	89.84	2.08	1.18	Trace	0.46	6.44
CS_2	86.76	2.38	1.45	1.04	1.06	7.31
CS_3	87.53	2.41	1.49	0.84	0.99	6.74

CS_1 = Plain soymilk, CS_2 = 500 ml of soymilk fortified with 20 g carrot powder, CS_3 = 600 ml of soymilk fortified with 20 g carrot powder.

Table 2. Vitamin and mineral content of the samples.

Samples	Beta-carotene (RE)/100 g	Vitamin C (mg)/100 g	Iron (mg)/100 g	Zinc (mg)/100 g
CS_1	13.40 ± 0.10^a	8.70 ± 0.10^a	1.44 ± 0.07^b	35.77 ± 0.07^c
CS_2	90.10 ± 0.21^c	9.82 ± 0.10^a	1.86 ± 0.07^b	39.13 ± 0.12^c
CS_3	78.40 ± 1.30^b	9.53 ± 0.00^a	1.78 ± 0.00^b	38.33 ± 0.35^c

Mean ± SD with different superscripts are significantly different with a < b < c ($P < 0.05$).

86.76 to 89.84%. CS_1 had the highest moisture value (89.84%) while the CS_3 has the least value (86.76%). The protein values of the products ranged from 2.08 to 2.41% and the sample CS_3 had the highest value (2.41%). The fat content of the sample followed the same trend with that of protein. It ranged from 1.18 to 1.49%. The crude fibre content of the products varied from trace to 1.04%. The CS_2 and CS_3 had 1.04% and 0.84% crude fibre, respectively. The ash content ranged from 0.46 to 1.06% and the CS_2 had the highest ash value (1.06%). The trend of the carbohydrate content of the samples was similar to that of the ash value. The CS_2 had the highest value (7.31%) while CS_1 had the least value (6.44%).

The result in Table 2 presents the vitamin and mineral content of plain soymilk and soymilk fortified with carrot powder. Vitamin A contents of the products varied from 13.40 to 90.10 RE/100 g. CS_2 had the highest value followed by CS_3 while CS_1 had the least value (90.1, 78.4 and 13.4%, respectively). There were significant ($P < 0.05$) differences in the vitamin A content of the products. Vitamin C of the products ranged from 8.07 to 9.82 mg/100 g. The sample CS_2 had the highest value (9.82 mg/100 g) while CS_1 has the least value (8.07 mg/100 g). There were differences in the vitamin C values of the products; however, it was not significant ($P \geq 0.05$). The iron content of the products varied from 1.44 to 1.86 mg/100 g. CS_2 had the highest value followed by CS_3, while CS_1 had the least value (1.86, 1.78 and 1.44 mg/100 g respectively). The zinc content differs from 35.77 to 39.13 mg/100 g. It follows the same trend with that of iron values and the differences between the products was not significant ($P \geq 0.05$).

Table 3 presents the sensory attributes of plain soymilk and soymilk fortified with carrot powder. The colour of the products differed. The values ranged from 5.64 to 7.88. CS_1 had the highest value (7.88) while the CS_2 had the least value (5.68). There were significant differences in the colour of the products at $P \leq 0.05$. The flavour of the products varied from 4.80 to 7.40. It followed the same trend with the colour. There were significant differences in the flavor of the products at $P \leq 0.05$. The mouth feel of the products ranged from 4.32 to 7.68. CS_1 had the highest value (7.68) while the CS_2 had the least value (4.32). There were significant differences in the mouth feel of the products at $P \leq 0.05$. The general acceptability of the products differs. Its value ranged from 4.20 to 8.36. CS_2 had the least value, followed by CS_3, while CS_1 had the highest value (4.20, 5.28 and 8.36 respectively). There were significant differences in the general acceptability of the products ($P \leq 0.05$).

DISCUSSION

Proximate composition

The higher moisture content of CS_1 (89.84%) suggests that the product is more diluted than the soymilk fortified with carrot powder. The value corresponds with that of Enwere (1998), who stated that about 92.75% of soymilk is water. The protein content of the soymilk blends were increased as a result of the added carrot powder. CS_3 has more protein content compared with the other products. This result confirmed that when nutrients from different foods are blended, the nutrients so produced would be better than any of the food alone (Egbekun et al., 2004). The fat content of the control soymilk (CS_1) (1.18%) was lower than that of the soymilk blends-CS_2 (1.45%) and CS_3 (1.49%). This is as result of the synergistic effect of the soymilk and carrot powder. This is in line with the work done by WISHH (2006) which stated that the fat content of plain soymilk is 1.02%, and that it may vary depending on the ingredient added.

The crude fibre of CS_2 (1.04%) and CS_3 (0.84%) were

Table 3. Sensory attributes of plain soymilk and soymilk fortified with carrot powder.

Samples	Colour	Flavour	Mouth feel	General acceptability
CS_1	7.88 ± 0.18^c	7.40 ± 0.27^c	7.68 ± 0.14^c	8.36 ± 0.15^c
CS_2	5.68 ± 0.44^a	4.80 ± 0.48^a	4.32 ± 0.46^a	4.20 ± 0.15^a
CS_3	6.36 ± 0.33^b	6.04 ± 0.43^b	5.04 ± 0.42^b	5.28 ± 0.51^b

Note: Mean ± SD with different superscripts are significantly different with a < b < c (P ≤ 0.05).

significantly increased, while that of CS_1 is trace. This agrees with the work done by Enwere (1998) that soymilk contains no crude fibre. The presence of crude fibre in CS_2 and CS_3 suggests that carrot powder had significant amount of crude fibre (Vincent, 2004). The fortified soymilk had higher ash content than the unfortified soymilk. This might be as a result of higher mineral content of the carrot powder (Vincent, 2004). The carbohydrate content of the fortified soymilk blends had higher carbohydrate content than that of the unfortified soymilk. The higher value for CS_1 (6.44%) corresponds with the work published by Enwere (1998) that soymilk contains 6.3% carbohydrate.

Vitamin and mineral content

The higher beta-carotene content of CS_2 (90.1 RE) followed by CS_3 (78.4 RE) suggest that they were fairly good sources of the nutrient. However, the lower value for CS_1 (13.4 RE) is an indication of its poor source of the nutrient. The higher micronutrients levels of CS_2 and CS_3 suggests that they are better sources of beta-carotene, ascorbate, iron and zinc than CS_1. On the other hand, the lower values of the micronutrients for CS_1, suggests that plain soymilk is not a good source of the micronutrient as compared with CS_2 and CS_3. These increases in the micronutrients might be attributed to synergistic effect of carrot to soymilk. This result confirmed that when nutrients from different foods are blended, the nutrients so produced would be better than any other foods alone (Egbekun et al., 2004).

Sensory attributes

The higher general acceptability (8.36) of the plain soymilk suggests that it was best accepted by judges compared with fortified soymilk samples. This could be as a result of being familiar with plain soymilk more than its blends. This is a commonly observed phenomenon (Enwere, 1998).

Conclusion

This study shows that the nutritive values of all the fortified soymilk were improved both in quantity and quality. The proximate composition, mineral and vitamin content of the fortified soymilk were higher than the plain soymilk. The result of the sensory evaluation of the soymilk reveals that the judges accepted the plain soymilk more than the fortified soymilk.

REFERENCES

AOAC (2005). Official methods of analysis 14th Ed: Association of official analytical chemists, Washington D.C., U.S.A.

Egbekun MK, Isolokeu PC, Akubor PI (2004). Chemical and Sensory properties corn cassava-soybean flour blends for the production of "Ojeaku"- A Nigeria traditional food. Book of Abstracts. Nutr. Soc. Nig. P. 9.

Enwere NJ (1998). 'Foods of Plant Origin'. Afro Orbis Publications Ltd. 22-27:219-221.

ILSI/ FAO (1997). Food Fortification approaches. Alabama. P. 8.

Jones G, Steketee RW, Black RE, Bhutta ZA, Morris SS (2003). Bellagio Child Survival Study Group. How many child deaths can we prevent this year. Lan. 362:65-71.

Keshun L (1997). Soybeans Chemistry, Technology and Utilization: Chapman and Hall. P. 23.

Mridula D (2011). Physico-chemical and sensory characteristics of β-carotene rich defatted soy fortified biscuits. Afr. J. Food. Sci. 5:305-312.

National Public Health Institute of Finland (NPHIF) (2006). Nutrition Unit Based on the Fineli Food Composition Database Release 6, Finland.

Pearson D (1976). The chemical analysis of foods. 7th Edition. Churchill Livingstone Edingburg London.

Richard DS, Martin WB (2008). Nutrition and Health in Developing Countries. Humana Press. pp. 497-499.

Seagate W (2002). Processing of carrot powder". U.S.A. Chesa Publishers. Inc. P. 9.

Standing Committee on Nutrition (2004). The fifth report on the world nutrition situation: Nutrition for improved development outcomes. Geneva, United Nations System.

Vincent M (2004). Gulf Hurricane Relief and providing critical aid to Evacuees. Alaska.

West KP (2002). Extent of vitamin A deficiency among pre-school children and women of reproductive age. J. Nutr. 132:2857-2866.

William S, Akiko A (2004). 'Tofu and Soymilk production': The Book of Tofu. Soy foods centre. New age food study centre. 11: 213-215.

WISHH (2006). Humanitarian soymilk. National Academy Press. Washington D.C. pp. 24-56.

World Health Organization (WHO) (2002). The world health report 2002: reducing risks, promoting healthy life. Geneva.