Nutrient Compositions of Banana and Water Melon Enriched Soy – Based Yoghurts

***Okudu, H.O[1] and Enwereji, O.U[1]**

[11]Department of Human Nutrition and Dietetics, Michael Okpara University of Agriculture, Umudike, Abia State, Nigeria.

***Corresponding Author:** helenokudu@yahoo.com*

ABSTRACT

***Background:** Soy-yoghurt is a fermented product from soybean; like other products developed from soybean, it is a good source of macronutrients and minerals but a poor source of most vitamins. Incorporating fruits in soy-yoghurt may enhance its vitamin compositions.*

Method: Soy- yoghurt was prepared using standard methods. The chemical composition of the yoghurt samples was determined in duplicate using the AOAC methods. The data generated were analysed using Statistical product for service solution version 20, means were separated and compared with Duncan multiple range test and Analysis of Variance, respectively.

***Results:** Moisture ranged between 82.06 % to 89.60 % in the products. Fat (3.48%), protein (3.33%) and carbohydrate (10.21%), calcium (118.12 mg/100g) and iron (1.30mg/100g) were significantly higher in plain soy-yoghurt. Banana and water melon enriched soy-yoghurt was significantly higher in phosphorus (166.42mg/100g), magnesium (47.60mg/100g) and zinc (2.00mg/100g), while potassium (174.10mg/100g) was significantly higher in banana enriched soy-yoghurt. Thiamin, (0.24mg/100g), riboflavin (0.27mg/100g), niacin (0.87mg/100g), ascorbic acid (169.16mg/100g) and β-carotene (64.11mcg/100g) were significantly higher in soy-yoghurt enriched with both banana and water melon.*

***Conclusion:** The study showed that incorporating both banana and water melon in soy-yoghurt increases its phosphorus, magnesium, zinc and vitamins values, were significantly higher in banana and water melon soy-based yoghurt while incorporating with banana alone enhances the potassium value better.*

Keywords: Soy- yoghurt, banana, watermelon, vitamins, enrichment.

INTRODUCTION

Yoghurt is a fermented dairy product normally produced from cow milk (1). It is produced by inoculating concentrated milk with culture of lactic acid bacteria, strephococcus thermophilus lactobacillus at 45°C (2). Its consumption worldwide could be attributable to its dense nutrient composition, flavour and probably its health benefits (3;4;5). Studies have shown that soy – yoghurt is becoming a preferred choice because dairy yoghurts are becoming expensive and their fat and cholesterol constituents also have some health implications (6,7).

Soybean (*Glycine max*) belongs to the family *leguminosae*. It is one of the oldest cultivated crops of the tropics and sub-tropical regions (8). It consists of three species namely - *Glycine ussuriensis* - wild, *Glycine max* - cultivated and *Glycine gracitis* – intermediate (9). A matured seed soybean seed contains approximately 35 % protein, 31 % carbohydrate, 17 % fats and 5 % mineral (10,11); and contains appreciable amounts of amino acids (12). Soybean exerts health promoting benefits and is one of the world's most important plant sources of quality protein and oil (8,13,14). The use of soybean as supplements, milk alternative and soy-yoghurt has been well documented (15,16,17). Though Soybean is a good source of protein, oil, iron, calcium, magnesium, potassium, phosphorus and other bioactive substances (11), it is however low in vitamins. This implies that products developed from soybean alone may be low or

deficient of these nutrients. Incorporation of banana and water melon in soy-yoghurt may enhance its vitamin values.

Watermelon (*Citrullus lanatus*) belongs to the *Curcurbitaceae* family (18). The fruit is composed of flesh (68 %), seeds (2 %) and rind approximately 30 % (19). Watermelon is a rich source of vitamins, minerals and antioxidants such as phenolics, carotenoids (20;21) and lycopene (18).

Banana is the common name for herbaceous plants of the genus *Musa;* it is a good source of beta-carotene, vitamin B_6, vitamin C, vitamin D and potassium (22). Consumption of a single banana is said to provide 23% of the potassium daily need of adults (23); its regular consumption is associated with reduced risk of, high blood pressure, stroke, high cholesterol and neurodegenerative diseases (Alzheimer's disease) (23).

Production of yoghurt with fruits has been shown not only to increase the market share of the fruits, reduces their losses during peak production times (24), but also improves the nutritive value properties of yoghurt (25). This work is therefore designed to determine the nutrient compositions of banana and watermelon enriched soy-yoghurt.

MATERIALS AND METHODS

Procurement of raw materials

Soybeans (*Glycine max*), fruits (*Musa* and *Citrullus lanatus*), glucose, stabilizer (corn flour) and starter culture (yoghurmet) were purchased from Ubani Main Market in Umuahia North Local Government Area, Abia State, Nigeria. Other reagents (ethylamine ditetra acetic acid (EDTA), hydroxylamine hydrochloride, concentrated ammonia solution, Black T indicator, ammonium molybdate, ferrous ammonium sulphate) used in this study were obtained from Biochemistry Laboratory of the National Root Crops Research Institute Umudike, Abia State.

Cleaning of soybean/production of soy-milk

The method described by Oloye (26) with some modification was adopted for the production of the soymilk. About 300g of soybean was used for the production of the milk. Stones and other extraneous materials were hand-picked. The soy-seeds were soaked in water for 2 h to remove the hulls. The dehulled soybeans were soaked in 0.5 % of $NaHCO_3$ solution for 20 minutes at ambient temperature. It was boiled under moderate heat for 10minutes and then rinsed. The soybean seeds were then milled with potable water (1:4 w/v) using an electronic blender (Philips, Model HR2001/70/AC 220-240V). The slurry was then strained using a muslin cloth. The filtrate was pasteurized at 85 °C for 25 minutes using a double boiler (Stainless Steel, ModelB063). The pasteurized milk was then be cooled and packaged in sterile plastic container.

Preparation of banana water melon purees

Ready-to- eat banana fruits were washed under tap water and manually peeled. Banana fruits were then chopped into cubes (50 mm diameter). Thereafter, they were blanched for 2 min by dipping in boiling water and allowed to cool down at room temperature. The banana pulp was then blended into puree using an electronic blender (Philips, Model HR2001/70/AC 220-240V).

Mature watermelon fruits were gently washed under tap water bisected manually using stainless knife. The pulp was aseptically removed and chopped into cubes (50 mm diameter). The pulp was blanched by dipping in boiling water. It was thereafter blended into puree using an electronic blender (Philips, Model HR2001/70/AC 220-240V).

Production of banana and water melon enriched soy-yoghurt

Yoghurt was prepared using the recovered milk (soy milk) as described by Oyeniyi *et al*. (27) with slight modification. Varying quantities of the banana puree (25 and 50ml respectively) and water melon (25 and 50ml respectively) were added to the milk labeled A, B, C, and D. The mixtures were heated at 85^{0}C for 5 minutes in a water bath, cooled to 44^{0}C under room temperature and inoculated with 0.5g starter culture (a mixture of *L. bulgaricus* and *S. thermophilus*). The samples were then fermented for 8h at 44^{0}C. The samples were each package in sterile plastic containers and immediately taken to the laboratory for chemical analysis.

Chemical analyses of banana and water melon enriched soy-yoghurt

The proximate compositions of the milk extracts were determined using standard AOAC (28) methods. Moisture content was determined gravimetrically. The crude protein content was determined using micro-Kjeldahl method, 6.25 was used as the nitrogen conversion factor. The crude fat content was determined using Soxhlet extraction method. The ash content was

determined by incinerating the samples at 600°C in a muffle furnace. Carbohydrate was obtained by difference.

Minerals were determined using wet-acid digestion method for multiple nutrients determination as described by the method of AOAC (28). The digest was used for the determinations of calcium (Ca) and magnesium (Mg) using the ethylamine ditetra acetic acid (EDTA) Versanate complexiometric titration method. Potassium (K) and sodium (Na) were evaluated using flame photometry method and phosphorus (P) by the vanadomolybdate method using the spectrophotometer (Model 3030, Perkin Elmer, Norwalk USA). Microminerals (Zn, Fe) were by Atomic Absorption Spectrophotometer (Model 3030 Perkin Elmer, Norwalk USA).

The β – carotene, riboflavin, niacin and thiamin of the products were determined spectrophotometrically as described by AOAC (28), while ascorbic acid was determined as described by AOAC (28) using titration method.

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Statistical analysis

The data generated from duplicate analysis were keyed into the computer and analyzed using Statistical product for service solution (SPSS version 20). Means and standard deviations were calculated. Analysis of Variance (ANOVA) was used to compare the means and mean separation was done using Duncan multiple range test. All calculations were done at 5% level of significance ($p < 0.05$).

RESULTS

Proximate composition of plain soy-based yoghurt, banana and water melon soy-based yoghurt

Proximate compositions of banana and water melon enriched soy-yoghurts are presented on Table 1. Moisture ranged between 82.06% to 89.60%, with plain soy- yoghurt having the lowest moisture content (82.06%) and water melon enriched soy yoghurt having the highest water content (89.60%). Fat (3.48%), protein (3.33%) and carbohydrate (10.21%) were significantly ($p<0.05$) higher in 100% soy yoghurt, while crude fibre (0.29%) and ash (0.76%) respectively were significantly higher in banana enriched soy yoghurt.

Mineral composition of plain soy-based yoghurt, banana and water melon soy-based yoghurt (mg/100g)

Mineral compositions of banana and water melon enriched soy-yoghurt on Table 2, showed that plain soy- yoghurt had significantly ($p<0.05$) higher calcium (118.12 mg) iron (1.30mg) values respectively. Banana and water melon enriched soy-yoghurt was significantly higher in phosphorus (166.42mg), magnesium (47.60mg) and zinc (2.00mg), while potassium was observed to be significantly higher in banana enriched soy-yoghurt (174.10mg).

TABLE 1: Proximate composition of plain soy-based yoghurt, banana and water melon soy- based yoghurt

Samples	Moisture (%)	Protein (%)	Fat (%)	Crude fiber (%)	Ash (%)	Carbohydrate (%)	Energy (kcal)
A	$82.05^{d}\pm0.05$	$3.33^{a}\pm0.02$	$3.48^{a}\pm0.03$	$0.27^{ab}\pm0.01$	$0.66^{cd}\pm0.02$	$10.21^{a}\pm0.01$	$85.48^{a}\pm0.02$
B	$85.61^{c}\pm0.04$	$2.82^{b}\pm0.03$	$3.11^{b}\pm0.02$	$0.25^{b}\pm0.01$	$0.70^{bc}\pm0.01$	$7.70^{b}\pm0.05$	$70.07^{b}\pm0.01$
C	$87.11^{b}\pm0.05$	$2.54^{c}\pm0.02$	$3.05^{b}\pm0.02$	$0.29^{a}\pm0.01$	$0.76^{a}\pm0.01$	$6.25^{c}\pm0.03$	$62.61^{c}\pm0.03$
D	$89.60^{a}\pm0.05$	$2.60^{d}\pm0.03$	$3.08^{b}\pm0.01$	$0.20^{c}\pm0.01$	$0.64^{d}\pm0.02$	$3.88^{d}\pm0.02$	$53.64^{d}\pm0.02$

Colum with different superscripts are significantly ($p\leq0.05$) different from each other

A = Plain Soy-based yoghurt

B = Banana, watermelon soy-based yoghurt

C = Banana soy-based yoghurt

C= Watermelon soy-based yoghurt

Table 2: Mineral composition of plain soy-based yoghurt, banana and water melon soy- based yoghurt (mg/100g)

Sample	Calcium	Phosphorus	Magnesium	Potassium	Iron	Zinc
A	$118.12^{a}\pm0.04$	$170.32^{c}\pm0.05$	$41.24^{d}\pm0.03$	$157.30^{d}\pm0.05$	$1.30^{a}\pm0.01$	$1.80^{b}\pm0.02$
B	$105.61^{b}\pm0.05$	$186.40^{a}\pm0.04$	$47.60^{a}\pm0.03$	$166.42^{b}\pm0.05$	$0.82^{b}\pm0.02$	$2.00^{a}\pm0.02$
C	$99.32^{d}\pm0.04$	$170.50^{b}\pm0.05$	$46.40^{b}\pm0.03$	$174.10^{a}\pm0.01$	$0.76^{c}\pm0.02$	$1.72^{d}\pm0.01$
C	$102.30^{c}\pm0.05$	$167.20^{d}\pm0.05$	$42.11^{c}\pm0.03$	$162.60^{c}\pm0.01$	$0.70^{d}\pm0.02$	$1.75^{c}\pm0.02$

Colum with different superscripts are significantly ($p\leq0.05$) different from each other
A = Plain Soy-based yoghurt
B = Banana, watermelon soy-based yoghurt
C = Banana soy-based yoghurt
C= Watermelon soy-based yoghurt

Table 3: Vitamin composition of plain soy-based yoghurt, banana and water melon soy- based yoghurt

Sample	Thiamin (mg/100g)	Riboflavin (mg/100g)	Niacin (mg/100g)	Ascorbic acid (mg/100g)	B-carotene (meg/100g)
A	$0.18^{d}\pm0.01$	$0.20^{e}\pm0.01$	$0.81^{d}\pm0.02$	$162.35^{c}\pm0.04$	$50.2^{d}\pm0.05$
B	$0.24^{a}\pm0.01$	$0.27^{a}\pm0.02$	$0.87^{a}\pm0.01$	$169.16^{a}\pm0.05$	$64.11^{a}\pm0.05$
C	$0.20^{c}\pm0.01$	$0.25^{c}\pm0.01$	$0.82^{d}\pm0.01$	$165.05^{b}\pm0.04$	$60.36^{b}\pm0.04$
D	$0.22^{b}\pm0.01$	$0.24^{d}\pm0.01$	$0.85^{c}\pm0.03$	$162.35^{c}\pm0.05$	$51.52^{c}\pm0.05$

Colum with different superscripts are significant ($p\leq0.05$) different from each other
A = Plain Soy-based yoghurt
B = Banana, watermelon soy-based yoghurt
C = Banana soy-based yoghurt
C= Watermelon soy-based yoghurt

Vitamin composition of plain soy-based yoghurt, banana and water melon soy-based yoghurt

Vitamin compositions of banana and water melon enriched soy-yoghurts are shown on Table 3. The result on vitamins showed that thiamin, (0.24mg), riboflavin (0.27mg), niacin (0.87mg), ascorbic acid (169.16mg) and β-carotene (64.11mcg) contents of 25%banana and 25% water melon enriched yoghurt were significantly higher than values (0.18mg, 0.20mg, 0.81, 162mg and 50.2mg) obtained for plain soy yoghurt. Values of vitamins obtained in 50% banana enriched soy-yoghurt and water melon enriched soy-yoghurt were also significantly lower than those of banana and water melon enriched soy-yoghurt.

DISCUSSION

Moisture was high in all the products; water melon soy-based yoghurt however had significantly higher moisture contents than the other products. The high moisture found naturally in water melon fruits may be the reason for the high moisture obtained in water melon substituted soy-yoghurt (29). Water plays

significant role in the body; consumption of these products may enhance a lot of physiological processes in the body (30). Fat and protein values were observed to decrease significantly in all the soy- based substituted yogurts while crude fibre and ash values banana soy- based yoghurt increased with 7.40% and 15.15% respectively over the values obtained for plain soy-based yoghurt. Low fat and protein observed in the banana and water melon substituted soy- based yoghurts as compared with the plain soy-based yoghurt could be because banana and water melon are both poor sources of plant fat and protein (29). It is however worthy of note that the fat levels in all the products fell within range classified as "high fat" for yoghurt (31). Fats (particularly the unsaturated fats) play significant roles in the body: they are known as dense source of energy, as well as carrier of fat soluble vitamin in the body. When compared with other study, the protein obtained for plain soy-based yoghurt (3.33%) and 2.54 to 2.82% obtained for soy-based substituted yoghurts were lower than values reported for plain soy – based yoghurt and strawberry soy-based yoghurt (4.35% and 3.87% respectively) in a similar study (32). Fat values in all the products in the current study were higher than fat values (1.95% and 2.16% respectively) reported in that study. The difference in protein and fat in the two studies could be a function of varietal difference in the soybean used or effect of type of the substituent. Higher energy value observed in the plain soy-based yoghurt compared to the energy values of the substituted soy-based yoghurt could also be attributed to the function of its carbohydrate, protein and fat compositions.

Minerals are important components of nutrients needed in the body (33). Calcium and iron respectively were observed to be significantly higher in plain soy- based yoghurt than in the substituted soy- based yoghurt. Higher values of calcium and iron observed in plain soy- based yoghurt could be because legume is a better source of calcium and iron than most fruits and vegetables (29). The study however showed that substituting plain soy- based yoghurt with 25% each of banana and water melon puree increase the values of phosphorus and magnesium soy – based yoghurt with 9% and 15% of phosphorus and magnesium respectively; while substituting plain soy- based yoghurt with 50% banana puree increased the values of potassium and zinc of soy-based yoghurt with 10.6% of potassium and 11% zinc respectively. Increase in phosphorus in this study is contrary to the findings of Mbaeyi-Nwoha *et al*. (34) who reported decrease in phosphorus content with addition of African bush mango juice to plain soy yoghurt.

The entire vitamins analysed (with the exception of ascorbic acid in water melon soy- based yoghurt) appear to be significantly higher in the substituted soy-based yoghurts than in the plain soy - based yoghurt. This outcome was expected because fruits and vegetable are better sources of vitamins than legume (29). Combining banana and water melon together; however seems to increase the vitamins better than substituting with either banana or watermelon alone. Blending of different foods could be a means of enhancing their nutrient compositions. Consumption of these products particularly the banana, water melon soy-based yoghurt may enhance proper development in individuals particularly children who are known to need the B-vitamins, ascorbic acid and vitamin A for proper physical and mental development (33).

CONCLUSION

Moisture was high in all the products. Protein, carbohydrate, energy, calcium and iron were significantly higher in plain soy - based yoghurt. Phosphorus, magnesium, zinc and all the vitamins were significantly higher in banana and water melon soy-based yoghurt while potassium was significantly higher in banana soy – based yoghurt. The study showed that substituting soy-based yoghurt with blend of banana and water melon enhances the values of most of micronutrients than substitution with either banana or water melon puree alone.

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