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Mob: +92 300 3008585, Fax: +92 41 8815544
E-mail: editorpjn@gmail.com

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Nutrient and Phytochemical Composition of Formulated Diabetic Snacks Made from Two Nigerian Foods *Afzelia africana* and *Detarium microcarpium* Seed Flour

Onyechi, Agatha Uchenna, Ibeanu, Vivienne Nkiruka, Eme, Paul Eze, Ossai and Ossai, Chilaka
Department of Home Science, Nutrition and Dietetics, University of Nigeria, Nsukka, Nigeria

Abstract: Diabetes is a major public health problem and is also a common cause of morbidity and mortality worldwide. The aims of this study was to assess the nutrient and phytochemical composition of formulated diabetic snacks made from *Afzelia africana* and *Detarium microcarpium* seed flour. The seeds of *Afzelia africana* and *Detarium microcarpium* were purchased from a local market in the South Eastern Nigeria. The seeds were sorted by removing stones and spoilt ones, pieces of pods from them. *Afzelia* flour was produced using soaking and roasting method. The flour of detarium seeds was produced by boiling, soaking and milling. Recipes for the snacks were formulated based on the soluble non-starch polysaccharide (s-NSP) content of the wheat flour and the two flours made from *Afzelia africana* and *Detarium microcarpium*. The proximate composition, vitamin, mineral and phytochemical contents of the snacks were determined using standard methods. Data generated were analyzed using Statistical Package for Social Sciences (SPSS) version 17. The fibre content of Afzelia and Detarium snacks were (2.58-2.88) and (2.34-2.4%), respectively. The carbohydrate content was 47.18-50.18 and 57.63-59.35%, respectively, retinol content was 2.63-7.87mg/100g and 5.24-5.26mg/100g respectively, zinc content was 0.61-0.78mg/100g and 0.54-0.63mg/100g, respectively and phosphorus content was 0.45-0.91mg/100g and 1.12-1.36mg/100g, respectively. The tannin content was 0.63-1.03mg/100g and 0.60-0.62mg/100g, respectively while the saponin content was 0.76-0.88mg/100g and 0.74-0.88mg/100g. The formulated diabetic snacks had appreciable amounts of nutrient. The phytochemicals present were in the acceptable range. There is need for food industries to produce snacks and foods using Afzelia and Detarium flours for diabetics because of its increased fiber thereby helping to curb the incidence of diet related disease like non chronic communicable diseases.

Key words: Nutrients, phytochemicals, afzelia, detarium, snacks

INTRODUCTION

The incidence of diabetes mellitus has continued to grow and takes an enormous human and monetary toil each year. Diabetes mellitus is a group of metabolic disorders characterized by elevated blood glucose, intense thirst, profuse urination and rapid wasting which result from defects in insulin secretion or action or combination of both (Gordon, 2002). Gordon (2002) stated that improper regulation of blood glucose results in either hyperglycemia (high blood glucose) or hypoglycemia (low blood glucose). It is a global health disorder affecting millions of people worldwide with an increasing incidence and prevalence (Wokoma, 2002). Diabetes mellitus occurs throughout the world and it is on the increase in most parts of the world. For many years chronic disease like diabetes that is diet related has been characterized as “disease of affluence” seen in developed countries (Standing Committee on Nutrition, 2006). However in many parts of sub-Saharan African among the urban dwellers, there is a marked increase in the prevalence of obesity and diabetes. This is showing a worrying trend as it is affecting a large proportion of the population and is appearing earlier in life (Standing Committee on Nutrition, 2006). It is a global epidemics that pose a great public health challenge.

Legumes are rich in complex carbohydrate both starch and dietary fiber which have potential to lower blood sugar level, blood pressure and cholesterol level. This especially is important for people with diabetes. A possible reason for this is their low glycemic index (this refers to how quickly foods raise blood sugar levels) (Health News, 2009). These dietary components are commonly found in *Afzelia africana* and *Detarium microcarpum* both of which are legumes. High fiber diets have been implicated in the treatment of diabetes mellitus (Tredger and Ransley, 1978). It is therefore necessary to explore the efficiency of a lesser known legume in the management and control of blood glucose among diabetics (Onyechi and Nwachi, 2008). *Afzelia africana* and *Detarium microcarpum* are Nigerian soup condiments are high in dietary fiber among their dietary fiber content ranges from 37-72% (Ene-Obong and Carnovale, 1992). These soup

Corresponding Author: Onyechi, Agatha Uchenna, Department of Home Science, Nutrition and Dietetics, University of Nigeria, Nsukka, Nigeria

condiments are commonly used among the Ibos in the South Eastern Nigeria to thicken vegetable soup. These foods are underutilized and not consumed by the urban dwellers.

There was therefore need to incorporate these foods into more acceptable food vehicles for urban dwellers. This will increase the consumption of these foods that have great potential in the prevention and management of diet related chronic diseases like diabetes. This work was aimed at formulating snacks from *Afzelia africana* and *Detarium microcarpium* as a means of achieving a better diabetic control. Nutrient analysis of the snacks was determine the composition of the snacks. The conception of this work was generated from the observation of the authors in clinical setting that non-insulin dependent diabetics in urban areas Nigeria do not have healthy snacks for diabetic control.

MATERIALS AND METHODS

Source of raw materials/samples: The *Afzelia africana* and *Detarium microcarpium* seeds were purchased from Orie-oba market in Udenu Local Government Area of Enugu State, Nigeria.

Sample preparation

Processing of *Afzelia africana* flour: Afzelia flour was produced using soaking and roasting method. The seeds of *Afzelia africana* were sorted by removing stones and spoilt ones, pieces of pods. The seed was soaked in cold water for 12 hours with continuous removal of water and roasted traditionally in a sand bath at a temperature 120°c with continuous stirring for 45min. The seeds were cracked, dehulled, the cotyledon removed. The dehulled seeds were cracked and milled with attrition mill and sifted using a 40 mesh sieve to produce a fine *afzelia* flour.

Processing of *Detarium microcarpium* flour: The flour of detarium seeds was produced by boiling, soaking and milling. The seeds of *Detarium microcarpium* were sorted by removing stones and pieces of pods, cleaned and boiled for 45-60 minutes until the deep brown purple skin could peel off easily when touched. The skin of the seed was removed and the cotyledon soaked in water for 60 minutes. The cotyledons were washed three times and the water changed each time. The seed were then soaked overnight. The cotyledons were washed, sun dried for 24 hours and ground into fine powder with the use of attrition mill and sifted using 40 mesh sieves to produce *detarium* flour.

Recipe development: Recipes were formulated based on the soluble non-starch polysaccharide (s-NSP) content of the wheat flour and the two flours made from *Afzelia africana* and *Detarium microcarpium* (Onyechi and Nwachi, 2010). Trial recipes were formulated and products developed form the composites. Based on this trial run, the final recipe was then adopted that gave the desired quality characteristics of the products.

Calculations for the proportion of flour used

Wheat flour:

100g gave 2.3g of soluble NSP

If 100g ←2. 3g of soluble NSP

How many grams will give (X) ←lg of soluble NSP

X = 43.4g

***Afzelia africana* flour:**

100g gave 29.3g of soluble NSP

If 100g →29.3g of soluble NSP

How many g will give (X) → 4g of soluble NSP

X = 13g

***Detarium microcarpum* flour:**

100g gave 59.8g of soluble NSP

If 100g →59.8g of soluble NSP

How many g will give X → 4g of soluble NSP

X →6.6g

Method of preparation of the cookies: All ingredients butter, honey, eggs, salt and flour were weighed separately into different bowls. The butter and honey were creamed together until light and eggs were added and further creamed until fluffy. The flour and salt were added and stirred to form a dough which was rolled and cut into desired shapes. These were placed in a greased baking pans and baked for 30 minutes at a temperature of 75°C until golden brown.

Method of preparation of muffins: The oven was pre-heated to 55°C. The dry ingredients, flour, baking powder, salt were weighed individually into a large mixing bowl and mixed together. The eggs, milk, oil and water were beaten together and stirred into the flour mixture, mixed quickly until moistened. The batter was then poured into creased paper lined muffin pan and baked for 30-37 minutes until golden brown.

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), calcium and phosphorus (using atomic absorption spectrophotometric method). Beta carotene and vitamin E content of the samples were determined using the method of Pearson (1976). Saponin was determined using the Obadoni and Ochuko (2001) method and tannin content was determined using the method of Harbourne (1983).

Statistical analysis: Data generated from the study were statistically analyzed using mean and standard deviation. The difference in the nutrient composition of the snacks (cookies and muffin) was tested using the independent measures t-test and was significant at $P<0.05$.

RESULTS

Table 5 showed the proximate composition of the different snack products. The moisture content of the snacks varied from 4.99-11.21%. The sample AAM had the highest moisture content (11.21%), followed by AAC (10.96%) and then DTM (6.75%). The sample DTC had the least moisture content (4.99%). The crude fibre varied from 2.34-2.88%. The sample AAM had the highest crude fibre content (2.88%). Other samples AAC, DTC and DTM had 2.58, 2.49 and 2.34%, respectively. The crude protein ranged from 15.77-24.52%. The sample AAC had the highest protein value (24.52%) followed by DTC (24.01%). Samples AAM and DTM had protein content of 21.89 and 15.77%, respectively. The crude ash varied. It ranged from 0.55-2.66%. The sample DTM had the highest crude ash value (2.66%) followed by AAM (2.22%) and then DTC (1.05%). The sample AAC had the least ash value (0.55%). The fat content of the samples varied from 11.11-14.87%. The sample DTM had the highest value (57.63%). Other samples AAC, DTC and AAM had fat values of 14.21%, 11.11 and 11.62%, respectively. The carbohydrate content ranged from 47.18-59.35%. Sample DTC had the highest carbohydrate content (59.35%) followed by DTM (57.63%). The samples AAC and AAM had carbohydrate values of 47.18% and 50.18% respectively. Table 6 showed the micronutrient composition of different snacks products. The vitamin A varied from 2.63-7.87 µg/100g. The sample AAM had the highest vitamin A content (7.87 µg/100g). Samples DTC and DTM had comparable vitamin A content of 5.24 µg/100g and 5.26 µg/100g respectively. The sample AAC had the least vitamin A content (2.63 µg/100g). The vitamin E content ranged from 0.66-2.29 mg/100g. The sample DTC had the highest vitamin E content (2.29 mg/100g) followed by DTM (1.62 mg/100g). Samples AAC and AAM had the same vitamin E value of 0.66 mg/100g. The calcium value of the samples ranged from 0.13-0.17 mg/100g. The sample AAM and DTM had the highest calcium value (0.17 mg/100g). Samples AAC and DTC had 0.13 mg/100g and 0.16 mg/100g, respectively. The iron content ranged from 0.04-0.77 mg/100g. Sample DTM had the highest iron content (0.77 mg/100g). The samples AAC and AAM had comparable values of 0.39 mg/100g and 0.38 mg/100g, respectively while the sample DTC had the least value (0.04 mg/100g). The

Table 1: Soluble, Insoluble and Total NSP content g/100g of wet and dry *Detarium microcarpium* (DT) and *Afzelia africana* (AA) food samples

Food sample		Wet powder (g/100g)	Dried powder (g/100g)
AA	Soluble NSP	27.4	39.3
	Insoluble NSP	6.1	6.5
	Total NSP	33.5	45.8
DT	Soluble NSP	55.9	59.8
	Insoluble NSP	3.7	4.0
	Total NSP	59.6	63.8

Source: Onyechi (1995).

Table 2: Dietary fiber composition of wheat flour g/portion used for wheat flour

Food sample		Dried powder (g/100g)
Wheat flour	Soluble NSP	1.76
	Insoluble NSP	3.52
	Total NSP	5.28

Source: Odoh and Ene-Obong (2001).

Table 3: Proportion of flours and ingredients in the final recipe of cookies

Ingredients	Wheat (76%) and Afzelia (AA) (24%)	Wheat (87%) and Detarium (DT) (13%)
Flour	338.4g	300g
Milk (Skimmed)	100.0g	100g
Butter (fat)	75g	75g
Honey	10mls	10mls
Egg	50g	50g
Vanilla essence	A cap	A cap
Water	135mls	80mls

Key: Vanilla essence was the flavor agent.
Oven temperature was set at 75°C because of the thickness of the cookies.

Table 4: Proportions of flour and ingredients in the final recipe for muffin

Ingredients	Wheat (76%) and Afzelia (AA) (24%)	Wheat (87%) and Detarium (DT) (13%)
Flour	338.4g	300g
Baking powder	4 teaspoons	4 teaspoons
Milk (Skimmed)	1½ cup	1½ cup
Vegetable oil	½ cup	½ cup
Honey	20mls	20mls
Egg	2 (140g)	2 (140g)
Vanilla essence	A cap	A cap
Water	90mls	50mls
Salt	A pinch	A pinch

Key: Oven temperature was set at 55°C because of its nature.
Note that this weight of flour gave six cookies and muffins and has 5g of soluble Non-starchy polysaccharides.

Table 5: Proximate composition of the different snack products (%)

Sample	Moisture	Crude fibre	Crude Protein	Crude Ash	Fat	Carbohydrates
AAC	10.96±0.00	2.58±0.00	24.52±0.00	0.55±0.01	14.21±0.02	47.18±0.01
DTC	4.99±0.03	2.49±0.01	24.01±0.00	1.05±0.00	11.11±0.00	59.35±0.01
AAM	11.21±0.00	2.88±0.01	21.89±0.00	2.22±0.03	11.62±0.03	50.18±0.01
DTM	6.75±0.00	2.34±0.00	15.77±0.01	2.66±0.03	14.87±0.01	57.63±0.01

Mean ± SD of 3 determinations.

Key: AAC: Cookies made from wheat flour 76% and *Afzelia africana* seed flour 24%.
DTC: Cookies made from wheat flour 87% and *Detarium microcarpum* seed flour 13%.
AAM: Cookies made from wheat flour 76% and *Afzelia africana* seed flour 24%.
DTM: Cookies made from wheat flour 87% and *Detarium microcarpum* seed flour 13%.

Table 6: Micronutrient composition of the different snack products

Sample	Vitamin A (µg/100g)	Vitamin E (mg/100g)	Calcium (mg/100g)	Iron (mg/100g)	Zinc (µg/100g)	Phosphorus (mg/100g)
AAC	2.63±0.01	0.66±0.01	0.13±0.01	0.39±0.02	0.61±0.00	0.45±0.00
DTC	5.24±0.00	2.29±0.01	0.16±0.00	0.04±0.00	0.63±0.01	1.12±0.01
AAM	7.87±0.01	0.66±0.02	0.17±0.01	0.38±0.02	0.78±0.02	0.91±0.03
DTM	5.26±0.02	1.62±0.04	0.17±0.02	0.77±0.02	0.54±0.03	1.36±0.03

Mean±SD of 3 determinations.

Key: AAC: Cookies made from wheat flour 76% and *Afzelia africana* seed flour 24%.
DTC: Cookies made from wheat flour 87% and *Detarium microcarpum* seed flour 13%.
AAM: Cookies made from wheat flour 76% and *Afzelia africana* seed flour 24%.
DTM: Cookies made from wheat flour 87% and *Detarium microcarpum* seed flour 13%.

Table 7: Phytochemical composition of the different snack products

Sample	Tannin (mg/100g)	Saponin (mg/100g)
AAC	0.63±0.01	0.76±0.02
DTC	0.62±0.02	0.74±0.03
AAM	1.03±0.01	0.88±0.01
DTM	0.60±0.01	0.84±0.01

Mean ± SD of 3 determinations

Key:

AAC: Cookies made from wheat flour 76% and *Afzelia africana* seed flour 24%.

DTC: Cookies made from wheat flour 87% and *Detarium microcarpum* seed flour 13%.

AAM: Cookies made from wheat flour 76% and *Afzelia africana* seed flour 24%.

DTM: Cookies made from wheat flour 87% and *Detarium microcarpum* seed flour 13%.

zinc content of the samples varied from 0.54-0.78 µg/100g. The sample AAM had the highest zinc content (0.78 µg/100g) followed by DTC (0.63 µg/100g) and then AAC (0.61 µg/100g). The sample DTM had the least iron value (0.54 mg/100g). The phosphorus content ranged from 0.45-1.36 mg/100g. The sample AAC had the least phosphorus value (0.45 mg/100g). Samples DTC and DTM had comparable values of 1.12 mg/100g and 1.36 mg/100g while the sample AAM had a phosphorus content of 0.91 mg/100g.

Table 7 showed the phytochemical composition of the different snack products. The sample AAM had the highest tannin content (1.03 mg/100g). Samples AAC, DTC and DTM had tannin values of 0.63 mg/100g, 0.62 mg/100g and 0.60 mg/100g, respectively. The saponin content of the samples ranged from 0.74-0.88 mg/100g. The sample AAM had the highest saponin content (0.88 mg/100g), followed by DTM (0.84mg/100g). Samples AAC and DTC had comparable saponin values of 0.76 mg/100g and 0.74mg/100g, respectively.

DISCUSSION

The result of this study showed that the nutrient content of two snacks (cookies and muffins) varied slightly. These variations were a function of the different compositions of the samples and their sources (*Afzelia africana* and *Detarium microcarpum*). The moisture content of *Afzelia africana* snacks was high compared to the detarium snack and the control. The implication is that the shelf life of snacks made from *Afzelia africana* may be limited compared to those made from *Detarium microcarpum*. The high moisture seen in *Afzelia africana* snacks could be attributed to the quantity of water added during the preparation of the snack. The fibre contents of the cookies and muffins were quite low and similar. *Afzelia africana* snacks had a higher fibre content than *Detarium microcarpum* snacks. Studies have shown the importance of fibre in glycaemic control and improved morbidity of diabetic patients (Odenigbo, 2001). The protein content of the snacks was high (15.77%-24.52%) compared to snacks made from other edible leguminous seed flours such as pigeon peas (8.0%), cowpeas (9.0%) and soyabeans (10.0%) (Olaofe *et al*., 1994). However, the result of this study was similar to the study done by Ene-Obong and Obizoba (1995) which showed similarity in the protein content of the snacks produced in both studies. The higher ash content of *Detarium* snacks was indicative of more minerals content than the other snacks. The fat content of *Detarium* snacks (11.11-14.87%) was higher than *Afzelia* snacks (11.62- 14.21%). It showed that Afzelia snacks are better snacks to be taken by the diabetics than the *Detarium* snacks because of its lower fat

content. However, the fat content of snacks made from other leguminous seeds like, calabash kernel (43.2%) (Oshodi and Adeladun, 1993) and soyabean seed (23.5%) (Olaofe *et al*., 2004) were higher compared to *detarium* and *afzelia* snacks. The fat content made from snacks of different cultivars of African yam beans (1.93%) were lower compared to *detarium* and *afzelia* snacks (Olaofe *et al*., 2009).

The result of this study also revealed *detarium* [vitamin A (5.24-5.26mg/100g), vitamin E (1.62-2.29mg/100g), calcium (0.16-0.17mg/100g), iron (0.04-0.77mg/100g), zinc (0.54-0.63mg/100g) and phosphorus (1.12-1.36mg/100g) and *afzelia* (vitamin A (2.63-7.87mg/100g), vitamin E (0.66mg/100g), calcium (0.13-0.17mg/100g), iron (0.38-0.39mg/100g), zinc (0.61-0.78mg/100g) and phosphorus (0.45-0.91mg/100g) snacks had appreciable amount of these nutrients. The presence of these antioxidants (vitamins A and E), have protective effect against diabetes and cardiovascular diseases (Paul *et al*., 1985). Studies have shown correlations between antioxidants and diabetic control (Adeyeye, 1998). 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 presence of tannins and saponins in the formulated snacks could have some health benefits. Tannins are water soluble polyphenols and have been reported to have anticarcinogenic and antimutagenic potentials which protect cellular oxidative damage, including lipid perioxidation in man (Chung *et al*., 1998). Saponins are known to inhibit growth of cancer cells, lower cholesterol levels, boosts immunity and energy and acts as a natural antibiotic (Marye, 2011).

Conclusion: The formulated snacks (cookies and muffins) had a good nutrient profile. They contained good amount of protein, fibre, carbohydrates and vitamin A. Some phytochemicals such as tannin and saponins were also present in the acceptable range. There is need for industries to invest on large scale production of these snacks in order to provide variety of snacks for the diabetics and also reduce the incidence of diet-related non communicable diseases in the populace.

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