Physico-Chemical and Sensory Properties of Cookies Prepared from Wheat Flour and Cashew-Apple Residue as a Source of Fibre

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ABSTRACT--- ***Physico-chemical and sensory attributes of wheat/cashew-apple (Anacardium occidentale L.) fibre residue composite cookies were investigated. Cashew-apple fibre (CAF) was produced by sun-dried method (samples A, B, C, D), oven-dried method (samples F, G, H, I) and milled. Composite flour of wheat/ CAF was prepared using different levels of substitution from 0 – 20%, with 0% (sample E, 100% wheat flour) as the control. Cookies were produced using the composite flour blends, physical and sensory characteristics of the cookies evaluated within 48h of production.Physical attributes evaluated includes cookie weight, height, diameter and spread ratio. The incorporation of fibre affected significantly (p≥0.05) cookie height and weight using both methods compared to thecontrol while values for cookie diameter and spread ratio of the control sample were significantly higher compared to those with CAF addition. In all the sensory attributes studied, there were significant reductions compared to the control. However, the aroma, taste and general acceptability of cookies were found to improve with increase in the levels of CAF added.Chemical composition of the cookies showed that protein and carbohydrate decreased with increase in the levels of CAF while moisture, fat, ash and fibre increased significantly (p≥0.05) compared to the control. The fact that the overall acceptability rating of CAF incorporated cookies were close to the control sample (8.3) with 0% CAF and that crude fibre content of the cookies produced with CAF addition increased showed that cashew-apple residue can actually be used as a source of fibre in the food industry. This demonstrates a potential for cookie production using CAF supplementation in a productive exploitation of the currently wasted resources as a raw material source for cookie production.***

Keywords--- Physico-chemical, sensory, evaluation, cookies, cashew-apple, residue, source, fibre.

1. INTRODUCTION

There is an increase in the consumption of refined sugar and processed foods, stimulants and sedatives among Nigerians due to urbanization and globalization which have led to changes in dietary habits. This has put the colon under stress, leading to negative consequences such as constipation, obesity, diabetes, cardiovascular diseases and colon cancer (1), which dietary fibre has proven to give protection (2, 3). Trowell*et al.,* (4) defined fibre 'as the remnant of plant cells resistant to hydrolysis (digestion) by the alimentary enzymes which components are hemicelluloses, cellulose, lignin, pectin, gums, waxes and oligosaccharides'.

Optimal absorption of nutrients from the food we eat is very important as well as elimination of the derived wastes. The colon is very important in the elimination of digestive wastes (5). To function efficiently, the colon needs fibre and fluid which act like biochemical sponges absorbing impurities, gases and toxins. Fibre reduces the intestinal transit time thereby diminishing the body's exposure to dangerous waste substances (6). The consumption of fibre rich diets has many health benefits which includes; the lowering of the risk of cancer in the lower digestive tract by boosting good bacteria and speeding up the elimination of substances lingering in the faeces (7). Fibre reduces the chances of developing breast cancer, and also increases bulk in the digestive track making it easier for food and waste matter to be easily eliminated. Two types of fibre exist; - soluble and insoluble fibre. These two are undegestible and they both have beneficial effects.

In recent years, there is a trend to find new sources of fibre that can be used in the food industry (8). Supplementation has been used to enhance fibre content of foods with special focus on cookies, crackers and other cereal – based products. Cashew-apple (*Anacardium occidentale L.*) comes in readily as a cheap source of fibre. It is composed of 4.08% of crude fibre according to the report byOgunjobi and Ogunwolu, (9) and was within the specification for commercial cashew-apple/cassava flour reported by Gomez *et al.,* (10). The studies carried out at Cocoa Research Institute of Nigeria (CRIN)

revealed that the present consumption of cashew-apple either in raw or processed form is about 10% of production (11). The implication of this is that 90% of cashew-apple produced is wasted annually in Nigeria as a result of its high perishability. Children and youths generally, do not like eating much of vegetables and fruits which are the major sources of fibre rather; they prefer cookies, cakes and chin-chin.

Cookies are consumed all over the world as snack food by children and adults. It is a form of confectionery product dried to a low moisture content (12), softer when compared to biscuits. Cookies had been suggested as a better form of composite food than bread because of its ready to eat nature, wide consumption by different categories of people and relatively long shelf-life (13). These characteristics make protein-rich cookies attractive in countries where protein energy malnutrition is prevalent (14) and also in areas needing child feeding programmes, low income and disaster relief operations (15).Cookies with high sensory ratings had been produced from blends of wheat/cowpea flours (16), wheat/soybean (17), wheat and full fat soya (18, 19, 20) and composite flour from wheat and plantain (21). All these efforts were aimed at improving the nutritional content of the cookies and also to enhance crop utilization. Recently, attempts had been made to produce cookies from non-wheat based composite flours with high nutritional and sensory properties from unripe plantain and defatted sesame flour blends (22), cassava groundnut – corn starch blends (23), pigeon pea, cocoyam and sorghum flour blends (24), composite flour of plantain and bambara groundnut protein concentrate (25). Health conscious people are moving away from consumption of refined baked products to the consumption of functional, natural and fibre rich products. There are various forms of imported fibre supplements in the Nigerian market today. These supplements are relatively expensive and drain our foreign exchange reserves. This research focuses on utilizing fibre from cashew-apple which has been wasting in the various cashew orchards across the nation, in cookie production and to evaluate the physical, proximate and sensory attributes of the cookies. It will be beneficial if cashew-apple which is less utilized can be used as a source of fibre in bakery products such as cookies and many others.

2. MATERIALS AND METHODS

2.1. Materials

Mature, ripe cashew-apples (*Anacardium occidentale L.*) yellow and red varieties were harvested from an orchard at Uturu, Abia State, Nigeria for the preparation of the cashew fibre. Wheat flour, Simas margarine (PT Satim Ivomas Pratama, Indonesia), salt and sugar (Dangote Nigeria Plc., Lagos), baking powder, eggs and powdered milk (Peak brand) were purchased from Everyday Supermarket, GRA, Port Harcourt, Rivers State, Nigeria.

2.2. Preparation of cashew apple fibre

Twenty kilogram mature,ripe cashew-apples were used. The nuts were detached from the apples manually. The apples were sorted to remove unwholesome ones, soaked in hot water (80 ± 1^0C) for 20 min and rinsed in cold water. The cashew juice was extracted by manual expression. Then the residue was washed to ensure that the juice was totally removed and then weighed. The residue was divided into two equal portions; one part was sun-dried for 10hat average ambient temperature of 30^0C and the other oven dried at 65^oC for 8h. The dried residue was left to cool and then milled in a domestic blender (Philips brand) at low speed for 5 min. The cashew-apple fibreobtained was weighedand sealed immediately in a polyethylene bags and stored at room temperature (28^oC).

2.3. Cookies formulation and preparation

The cookies were formulated from the standard cookie recipe and produced according to the method described by Oyewole*et al.*, (26) with some modifications. In all cases, the products contained 5, 10, 15 and 20 grams of cashew-apple fibre consecutively in relation to wheat flour as shown in Table 1.

Margarine and sugar were blended in a Philips blender at a medium speed until a light and fluffy cream was formed. One whole egg (medium size) and powderedmilk were added while blending. Wheat flour was sieved using British standard Sieves(250µm particle size); cashew-apple fibre (residue), baking powder and salt were slowly added into the cream mixture. The dough was flattened using rolling pin on a smooth surface lightly floured table,4mm thick circular cookies were cut, placed on greased baking trays and were baked in an oven at 130^0C for 20 min.

Table 1: Cookie formulation with different percentage of cashew-apple fibre.

	Levels of substitution				
Ingredients(g)	**Control**	**5% CAF**	**10% CAF**	**15% CAF**	**20% CAF**
Wheat flour	100.00	95.00	90.00	85.00	80.00
Sugar	35.00	35.00	35.00	35.00	35.00
Margarine	40.00	40.00	40.00	40.00	40.00
Milk powder	10.00	10.00	10.00	10.00	10.00
Baking powder	2.00	2.00	2.00	2.00	2.00
Salt	0.50	0.50	0.50	0.50	0.50
Egg (medium)	1	1	1	1	1
CAF	0	5.00	10.00	15.00	20.00

CAF: Cashew-Apple Fibre

2.4. Physical properties of cookies

The measurement of cookies' weight, diameter, height (thickness) and spread ratio were done using the procedure outlined by Oyewole*et al.,* (26). Cookies' weight was taken by scaling five cookies from each sample and the average (mean) noted. The diameter (D) was measured by taking two measurements from one cookie in 90^0 rotations. A total of five cookies were measured from each sample and the average (mean) noted. The height (thickness) of cookies was measured by taking three measurements from one cookie and total height of the five cookies taken, then the mean noted.

2.5. Proximate composition

Crude protein, Fat, Ash and Moisture content were determined using the method of AOAC (27). Total available carbohydrate was determined using the anthronereagentmethod as described by Osborne and Voogt (28).

2.6. Determination of crude fibre

Crude fibre was determined using the AOAC method (27). The samples were defatted for 3h with petroleum ether using soxhlet apparatus, the fat free material was placed in 200ml beaker and 50ml of 1.25% w/v sulphuric acid was added and covered with a watch glass. Content of the beaker was heated gently on a hot plate for 30 min (acid hydrolysis). At the end of the acid hydrolysis, the beaker was filtered under vacuum through a buchner funnel fitted with filter paper (Whatman No.40) and with boiling water until the washings was no longer acidic to litmus. The residue was washed back into the beaker with 1.25% NaOH, boiled for 30 min covered with a wash glass. The resulting insoluble material was transferred to a dried pre-weighed ashless filter paper and washed thoroughly first with hot water until the washing is no longer alkaline to litmus and then with 15ml of ethanol (95%) by volume, dried at 105^0C for 1h. The ash was then cooled and weighed. The weight of the ash was subtracted from the increase weight on the paper due to the insoluble material and the difference reported as fibre.

2.7. Sensory analysis

Sensory evaluation of the sampleswere conducted within 24h after baking using twenty (20) untrained panellists of students and staff of the Department of Food Science and Technology,Rivers State University of Science and Technology, Port Harcourt. Nine coded cookie samples were presented to each panellist for each session. They assessed the cookies for colour, texture, crispness, taste, aroma and overall acceptability using 9-point hedonic scale as described by Iwe (29),with 1 and 9 representing the least score (dislike extremely) and the highest score (like extremely), respectively.

2.8. Statistical analyses

The data obtained were subjected to analysis of variance (ANOVA) using Statistical Package for Social Science (SPSS) version 16.0 software 2007. All analysis was done in triplicate using Duncan Multiple Range Test (DMRT) for means separation.

3. RESULT AND DISCUSSION

Physical characteristics of the cookies' weight, diameter, height and spread ratio as shown in Table 2, showed that there were significant differences ($p<0.05$) in all the samples in terms of weight with addition of cashew-apple fibre. This could be as a result of the ability of insoluble fibre to absorb water up to 15 times its own weight and swelling up in size, as reported by Oyewole*et al.,* (26) andOgunjobi and Ogunwolu, (9). Sun-dried and oven dried samples have similar observation in terms of weight, height and spread ratio, compared to the control. However sample E was significantly higher compare to other samples in terms of the spread ratio. This could be as a result of the gluten in 100% wheat flour that is responsible for spreading or rising characteristics of dough.

Table 2.Physical characteristics of cookies with added levels of cashew-apple fibre.

Samples	Weight (g)	Diameter (cm)	Height (cm)	Spread ratio (d/h)
A	2.91^{c}	3.00^{c}	0.48b	6.25^{c}
B	2.73^{d}	3.07^{b}	0.48^{b}	6.40^{b}
C	2.65^{e}	2.92^{c}	0.49^{b}	5.96^{d}
D	3.11^{b}	3.05^{b}	0.52^{a}	5.87^{e}
E	2.75^{d}	3.13^{a}	0.42^{c}	7.45^{a}
F	2.95^{c}	2.97^{gc}	0.51^{a}	5.82^{e}
G	3.07^{c}	3.01^{b}	0.50^{a}	6.02^{d}
H	3.19^{b}	3.03^{b}	0.49^{b}	6.18^{c}
I	3.31^{a}	3.02^{b}	0.50^{a}	6.04^{d}

Mean Scores of five determinations. Figureswithin the same column not having the same letter superscript are significantly ($p<0.05$) different.

KEY: CAF = Cashew apple fibre

Samples: A = 5%, B = 10%, C = 15%, D = 20%, E = 100%, F = 5%, G = 10%, H = 15% and I = 20%.

The sensoryproperties for fibre enriched cookies are presented in Table 3. Sample E (100% wheat flour) was significantly ($p \geq 0.05$) higher on respect to colour, texture, crispness and aroma, in both methods adopted; however, 20% level of added fibre compared favourable in taste and general acceptability for sun-dried method with the control (sample E) while 20% fibre addition was generally acceptable for the two methods investigated and showed no significant difference with respect to overall acceptability. This result is similar to the one reported by Ogunjobi and Ogunwole (9) for cashew-apple powder/cassava blends.

Table 3. Mean sensory scores of cookies' production with added levels of cashew-apple fibre.

Samples	Colour	Texture	Crispness	Taste	Aroma	Overall acceptability
A	6.8^{b}	7.1^{b}	6.6^{c}	7.7^{b}	6.8^{b}	7.4^{b}
B	6.3^{c}	6.5^{b}	6.4^{cd}	7.2^{c}	6.7^{b}	7.15^{bc}
C	6.2^{c}	7.0^{b}	7.0^{bc}	7.2^{c}	6.9^{b}	7.2^{bc}
D	6.2^{c}	6.9^{b}	6.9^{bc}	7.9^{a}	6.8^{b}	7.7^{a}
E	8.4^{a}	7.9^{a}	8.4^{a}	8.2^{a}	8.3^{a}	8.3^{a}
F	7.0^{b}	7.2^{ab}	7.5^{b}	7.5^{b}	7.2^{b}	7.5^{b}
G	6.0^{c}	6.5^{b}	6.2^{c}	7.1^{c}	6.8^{b}	7.2^{bc}
H	5.7^{d}	5.7^{c}	5.6^{d}	7.1^{c}	7.2^{b}	7.0^{c}
I	6.1^{c}	6.6^{b}	6.3^{c}	5.6^{b}	7.2^{b}	7.8^{a}

Values are means of 20 panelists. Figureswithin the same column not having the same letter superscript are significantly ($p<0.05$) different.

KEY: CAF = Cashew apple fibre

Samples: A = 5%, B = 10%, C = 15%, D = 20%, E = 100%, F = 5%, G = 10%, H = 15% and I = 20%.

Proximate composition of cookies formulated with incorporation of CAF is presented in Table 4. The result showed that the values for moisture, fat, ash and crude fibre increased with increasing levels of the CAF. Ogunjobi and Ogunwole, (9) also observed an increase in these proximate compositions in the production of biscuit with cashew apple powder/cassava blends.

The moisture content of the cookies increased significantly ($p \geq 0.05$)with the increase in the levels of cashew-apple fibre added. However, the highest moisture content of 6.9% was obsvered in sample D (20% fibre), for sun-dried method which was not different from 6.6% of observed 20% oven-dried method. This observation was in agreement with the report of Smith (30) who established that moisture content of cookies should not exceed 14%. Okaka (12) also reported low moisture for cookies. Kiin-Kabari and Giami (25) reported a moisture content range of 5.4 - 6.8%for cookies enriched with different levels of bambara groundnut protein concertrate. The percentage fat content range from 18.12 – 20.4 and was found to increase significantly with increase in the levels of cashew-apple fibre added. The ash content of cookies also increased with increase in cashew-apple fibre.

The crude fibre content of the cookie samples range from 6.9% (control) to 9.4% in samples with 20% cashew-apple fibre; indicating a progressive significantincrease in fibre content with cashew-apple fibre suplementation. This observation is of health benefit since it falls within the range of high fibre cookies as reported by many researchers (31, 32). The crude protein content of the fibre enrichedcookies was observed to decreased significantly with increase in cashew-apple fibre addition.Only 5% fibre added compared significantly with the control in the two methods studied. This observation was different from work of Ogunjobi and Ogunwole (9), who reported an increasein crude protein in biscuitsproduced with cashew-apple powder/cassava blends.

Table 4: Proximate composition of cookies with added levels of cashew-apple fibre.

	Compositions (%)					
Samples	**Moisture content(%)**	**Fat(%)**	**Crude protein**	**Carbohy-drate**	**Ash**	**Crude fibre**
A	5.8^{c}	18.3^{c}	11.2^{a}	42.7^{a}	1.6^{c}	7.5^{d}
B	6.3^{a}	19.1^{a}	10.6^{c}	42.4^{a}	1.9^{b}	8.1^{c}
C	6.3^{a}	19.6^{a}	10.1^{d}	42.5^{a}	2.2^{a}	8.8^{b}
D	6.9^{a}	20.4^{a}	9.6^{e}	42.3^{a}	2.6^{a}	9.4^{a}
E	5.2^{d}	18.1^{c}	11.8^{a}	42.8^{a}	1.4^{d}	6.9^{e}
F	5.7^{c}	18.2^{c}	11.2^{a}	42.7^{a}	1.7^{c}	7.6^{d}
G	6.1^{b}	18.7^{b}	10.5^{c}	42.6^{a}	2.0^{b}	8.0^{c}
H	6.2^{ab}	18.8^{b}	10.1^{d}	42.6^{a}	2.3^{a}	8.7^{b}
I	6.6^{a}	19.4^{a}	9.3^{e}	42.5^{a}	2.5^{a}	9.4^{a}

Values in the same column not having the same letter superscript are significantly ($p>0.05$) different.

KEY: CAF = Cashew apple fibre

Samples: A = 5%, B = 10%, C = 15%, D = 20%, E = 100%, F = 5%, G = 10%, H = 15% and I = 20%.

4. CONCLUSION

The addition of cashew fibre improved the crude fibre contents of cookies irrespective of the method used in sample preparation. Both the physical and sensory properties were acceptable in terms of overall acceptability. However, only 5% of cashew fibre addition could provide the neccesary protein content when compared with the control. Therefore, cashew-apple fibre could be utilized in cookie production.

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