DIETARY FIBER AND STARCH COMPOSITION OF AFRICAN YAM BEAN (*Sphenostylis sternocarpa*), MAIZE (*Zea mays*) AND GINGER (Zingiber *officiale*) POWDERS.

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ABSTRACT

Background: The major constraint in planning therapeutic diets with local foods is the dearth of nutrition information including dietary fibre and starch composition of local foods. This study determined the dietary fibre, starch, amylose and amylopectin contents of African yam bean (AYB), maize and ginger powders, and African yam bean gruel for their possible use in high dietary fibre confectioneries for diabetics, obese and overweight subjects.

Materials and Methods: Cream-coloured AYB seeds, white maize and fresh ginger roots were purchased from Orba International Market, Udenu Local Government Area of Enugu State, Nigeria. The three crops were processed into powders and analysed for dietary fibre, starch, amylose and amylopectin contents using AOAC methods.

Results: The total dietary fibre contents ranged from 9.4% in maize to 17.3%in ginger. The AYB had total dietary fiber content of 12.5% of which 1.7% and 10.2% of it were soluble and insoluble dietary fibres, respectively. The insoluble dietary fibre content (9.2%) of maize powder was higher than the soluble dietary fibre (0.2%). The AYB gruel had the least starch content of 38% while maize powder had the highest starch content (65%). The amylose contents were 22% in ginger powder, 27% in AYB gruel, 29% in maize powder and 31% in AYB powder. The amylopectin contents were higher than the amylose contents for all the samples, values varied from 69 to 78%.

Conclusion: African yam bean, maize and ginger powders, and African yam bean gruel contained high levels of dietary fibre. Their composite flours would have the potential of producing high dietary fibre confectionaries for subjects with chronic diet related non-communicable diseases such as diabetes and obesity.

KEY WORDS: African yam bean, maize, ginger, dietary fibre, starch, composition

INTRODUTION

The West African sub-region has a rich and varied biodiversity which plays an important role in the food security and nutrition of both the rural and urban populations (1). Investigations on African traditional foods are inspired by local indigenous knowledge that needs some scientific backing. The major constraint in planning therapeutic diets with local foods is the dearth of nutritional information including that of dietary fibre composition (2,3,4,5). Smith et al (1) had earlier reported that one of the main causes of poor results of food based interventions is the lack of knowledge of the available foods as well as their nutritional and health benefits.

Dietary fibre is one of the most talked about nutrients for health promotion and disease prevention. Current recommendations given by the United States National Academy of Sciences, Institute of Medicine (6) suggested that adults should consume 20–35 g of dietary fiber per day. Similarly, The Academy of Nutrition and Dietetics (AND), previously known as American Dietetic Association (ADA) recommended a minimum of 20–35 g/day for a healthy adult depending on calorie intake. The AND's recommendation for children is that intake should equal age in years plus 5 g/day. Popkin (7) reported that the world is shifting rapidly from diets dominated by animal and partially hydrogenated fats and low in dietary fibre to diets high in dietary fibre. Fiber is shown to induce a number of physiological effects such as increased faecal bulk, reduced levels of plasma cholesterol and reduced glycemic response to meals (8). In Nigeria, information is scarce on the daily dietary fibre consumption of an average Nigerian.

There is also paucity of data on the dietary fibre composition of traditional foods. However, there are a number of indigenous crops which could be valuable in composite flour for formulating diets high in fiber and phytochemicals. Such crops include African yam bean, maize and ginger.

African yam bean (AYB) (*Sphenostylis stenocarpa*) is a lesser known pulse as well as an underutilized leguminous crop (9). The mature seeds are eaten in various forms in many parts of Nigeria. The seed contains 21.10% protein,5.7% crude fiber,12% ether extract,74.12% carbohydrate and 3.20% ash(10) Interest in African yam bean is increasing because of its ability in lowering blood glucose in both healthy and diabetic adults (2,5,10). Ezeonwuka (11) also reported the hypoglycaemic potential of AYB. Maize (*Zea mays*) is one of the major staples in Nigeria and other developing countries. It is readily available, produced extensively in different parts of Nigeria and features prominently in many Nigerian diets. Ginger (*Zingiber officiale*) is a perennial herb with fleshy rhizomes and tuberous edible root. As a spice, ginger is used to improve taste in dishes, aroma in confectioneries like cakes, bread, cookies and in beverages such as beer and soft drinks (12). In recent times, ginger has attracted interest because of its herbal qualities which are of health benefits. Ginger is commonly known as digestive aid. It increases the production of digestive fluids and saliva. It is also used in the treatment of cough, fever, diarrhea, rheumatism, vomiting and in wound healing (12,13)
The objective of this study was to determine the dietary fibre composition, starch, amylose and amylopectin contents of African yam bean, maize and ginger powders and, African yam bean gruel. These crops could be potential food materials for formulating high fiber snacks for management of diabetes and obesity.

MATERIALS AND METHODS

Sample collection

Cream-coloured AYB seeds, white maize grains and fresh ginger roots were purchased from Orba International Market, Udenu Local Government Area of Enugu State, Nigeria.

Preparation of AYB flour

The AYB seeds were hand-picked to remove foreign materials and damaged seeds. About 200g of the seeds were washed in clean water, drained and roasted in an aluminium roasting bowl (*Agbada*) until the seeds were slightly cracked. The roasted seeds were milled into fine powder using a mill (Thomas Wiley Mill Model ED-5). The powder was packaged in a clean airtight plastic container and stored at ambient temperature (29±2°C) prior to analysis.

Preparation of AYB gruel

The AYB (125g) powder and 600ml of tap water were mixed thoroughly in a sauce pan. The sauce pan containing the mixture was put on fire and boiled with constant vigorous stirring to avoid lumps and thereafter, simmered for a minute.

Preparation of AYB gruel powder

The AYB gruel was dried in solar dryer and milled. The powder was packaged in an airtight plastic container and stored at ambient temperature (29±2°C) prior to analysis.

Preparation of maize powder

About 200g of the white maize seeds were hand-picked to remove foreign materials and damaged seeds and then, milled into powder using laboratory mill. The powder was packaged in a clean airtight plastic container and stored at ambient temperature (29±2°C) prior to analysis.

Preparation of ginger powder

About 400g fresh ginger roots were thoroughly washed, sliced into thin slices(1cm thick), dried in a solar dryer, milled into flour and packaged in a clean airtight plastic container.

Analytical methods

All the samples were analysed for their *fibre composition (total, soluble and insoluble dietary fibre), starch, amylose and amylopectin contents* at Eurofins Scientific Incorporation Nutrition Analysis centre, United States of America using enzymatic gravimetric method of AOAC 991.43(14)

RESULTS

Table 1 shows that the total dietary fibre contents ranged from 9.4% in maize powder to 17.3% in ginger powder. The AYB had 12.5% total dietary fiber content with 1.7% and 10.2% of it as soluble and insoluble dietary fibres, respectively. The proportion of insoluble dietary fibre in maize powder (9.2%) was higher than that of the soluble dietary fibre (0.2%). The maize powder had the

highest starch content of 65% and was followed by ginger which contained 46% starch. The starch contents of the AYB powder and AYB gruel were 41 and 38%, respectively. The amylose contents were 22% in ginger powder, 27% in AYB gruel, 29% in maize powder and 31% in AYB powder. The ginger powder (78%) contained the highest amount of amylopectin. This was followed by maize powder, African yam bean powder and African yam bean gruel with amylopectin contents of 71, 73 and 69%, respectively.

Table1. Dietary fiber (total, soluble, insoluble) composition, starch, amylose and amylopectin contents of powder and gruel from African yam bean, maize and ginger

Samples	Dietary fibre					
	Total	Soluble	Insoluble	Starch	Amylose	Amylopectin
African yam bean flour	12.5	1.7	10.2	41	31	69
African yam bean gruel	14.8	ND	ND	38	27	73
Maize powder	9.4	0.2	9.2	65	22	71
Gingerpowder	17.3	ND	ND	46	22	78

ND, not determined. Values are means of three replications

DISCUSSION

The high levels of total dietary fiber in all the samples indicate that these crops are good sources of dietary fiber. Dietary fiber (DF) components are grouped into water soluble DF such as pectin and gums, and water insoluble DF such as cellulose, hemicelluloses and lignins. Both African yam bean and maize flours contained higher amounts of insoluble DF than soluble DF. Soluble fibers show some functional properties such as water holding, oil holding, swelling capacity, viscosity or gel formation etc (15) .These properties are useful for understanding the physiological effects of DF. A high DF intake has been related to several physiological and metabolic effects. Thus, insoluble and soluble dietary fibers are of great importance in the well-being of the body. Insoluble DF provides roughages that speed up the elimination of faeces, thus, decreasing the time that the body is exposed to harmful substances. It increases the faecal bulk (16). Insoluble fibers tend to accelerate the movement of food through the system (17).It provides favourable environment for the growth of the beneficial intestinal flora (15).Soluble fibers mix with the food in the stomach to prevent or reduce the absorption by the small intestine of potentially dangerous substances from foods. Soluble fibers bind dietary cholesterol and carries it out of the body thereby preventing it from accumulating in the inner walls of arteries where it may set the stage for high blood pressure(17).Diets recommended for weight reduction usually encourage consumption of various foods recognized as good sources of dietary fiber(16). African yam bean gruel could be used in this regard. Fiber has been shown to promote glucose attenuation and laxation and can reduce the risk of coronary heart disease, colon cancer and obesity (8).Ou et al (18) suggested that dietary fiber has at least three pathways for lowering glucose production after a meal. These include 1) increasing the viscosity of the contents in the small intestine, thereby suppressing glucose diffusion, 2) preventing glucose diffusion by absorbing glucose and 3) suppressing amylase activity and delaying glucose release. Starch is the major carbohydrate reserve in plant tubers and seed endosperm where it is found as granules (19). Starch is composed of two components, amylose

and amylopectin which are present in varying amounts. The amylose component makes up approximately 20-30% of the starch molecule while the amylopectin, makes up 70-80% of the structure of starch (15). Maize is known to be a good source of starch (18). The high amounts of amylopectin in these crops in relation to amylose was in agreement with the report of Onimawo and Akubor (15) that amylopectin is four times higher than amylose in starch molecule. Starch has a range of applications in the food and non food products. In various foods, starch could perform the function of adhesion, binding, clouding, dusting, flowing aid, foam strengthening, antistaling, gelling, moisture retention, shaping, stabilizing, thickening etc.(15). In food systems, starches are selected based on its viscosity during cooking and cooling, viscoelastic effect which reflects behaviour of the starch with respect to ease of deformation and elasticity of swollen granules, breakdown of viscosity under stress, stability of the starch in frozen storage, gel tenderness etc (15).The high levels of amylopectin in the crops studied make them suitable for making foods of soft gel consistency(15).The amylose contents of these crops are high when compared to other foods and drinks((20). Glycemic index (GI), a numerical classification used to quantify the relative blood glucose response to foods, drinks etc, is influenced by amylose to amylopectin ratio (15).Starch with high amylose proportion is a low GI starch (15). Glycemic index ranks foods on how they affect glucose level. The development of diabetes mellitus, obesity, cancer and cardiovascular diseases has been linked to the intake of high GI foods while intake of low GI foods has been shown to play a role in the treatment of these diseases (21)

Conclusion

African yam bean (AYB), maize and ginger powders and AYB gruel contained high levels of total dietary fibre and amylopectin but moderate levels of starch and amylose. Based on these properties, the powders have the potential of producing high dietary fibre confectioneries for subjects with chronic diet related non-communicable diseases such as diabetes and obesity.

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