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The resistant starch content of some cassava based Nigerian foods

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Abstract

The resistant starch (RS) content of some Nigerian cassava varieties and staples, "fufu", "garri" and "abacha" processed from them were determined. Tubers of six varieties studied contained different concentrations of resistant starch, ranging from 5.70% in TMS 4(2)1425 to 7.07% in the TMS 30,572. Processing using traditional methods reduced the RS content in all cassava based foods compared with tubers from which they were processed. RS concentration was reduced by an average of 70.4% in "fufu", 52.8% in "garri" and 35.85% in "abacha" for the four varieties of cassava tested. Cassava processing steps involving fermentation were responsible for the major reductions in concentration of RS. Steps involving cooking or frying, resulted in increase in concentrations of RS relative to other processing methods. Modifications of traditional methods of processing such as the addition of bitter leaf during retting or the addition of oil to mash during dewatering of "garri" affected RS concentrations in foods studied. Results of this work suggest that manipulation of processing methods and conditions employed during cassava processing can be used to improve RS concentration in cassava based foods, thus making them more functional.

Keywords: Resistance starch; Functional food; Cassava

1. Introduction

Resistant starch is defined as that fraction of starch, which escapes digestion in the small intestine and passes into the large intestine where it is more or less fermented by gut microflora. It is considered a functional component of food due to the health benefits it confers following its consumption.

Many studies suggest that resistant starch (RS) intake decreases postprandial glycaemic and insulinemic responses (Bodinham et al., 2008; Brown, 1996; Li et al., 2010), lowers plasma cholesterol and triglyceride concentrations (Liu and Ogawa, 2009), increases satiety and decreases fat storage (Chiu and Stewart, 2013). Its beneficial effect on human type 2 diabetes has also been proposed (Bodinham et al., 2014). The prevalence of diabetes in Nigeria is expected to grow from 1,707,000 in the year 2000 to 4,835,000 in 2030 (WHO, 2015) RS as a prebiotic can promote the growth of beneficial microorganisms such as bifidobacteria, which exert a lot of beneficial effects on human body. Butyrate, a short chain fatty acid (SCFA) produced as a result of fermentation of RS has been hypothesized to reduce the risk of colon cancer and to benefit inflammatory bowel disease (Sajilata et al., 2006). These properties make RS an important functional fiber component of food, which can be exploited in the prevention and management of chronic non communicable diseases.

The nature of RS in foods is variable and is classified on the basis of its botanical source and processing. Resistant starch (RS) is naturally found in starchy foods such as potato, corn and rice and is classified into four subtypes based on its physicochemical properties. Type 1 (RS1) is physically unavailable starch. Amylolytic enzymes have no access to starch accumulated in undamaged plant cells as the gastrointestinal tract lacks enzymes capable of degrading the components of plant cell walls. Type 2 (RS2) is native granular starch, such as that found in potato and banana. Type 3 (RS3) is retrograded starch made by cooking/cooling processes on starchy materials occurring in the form of water-insoluble semi-crystalline structures. As a result of retrogradation, more thermostable structures are formed by amylose rather than by amylopectin. The amount of resistant starch produced this way

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increases along with the increasing amylose content of starch. Type 4 (RS4) is chemically modified starch (Waclaw, 2004).

According to the FAO (2013), Nigeria is the world's largest producer of cassava (about 54 million metric tons per annum), 95% of which is also consumed in the country. Major staple cassava based foods consumed in Nigeria are “garri”, “fufu” and “abacha”. "Garri" is granular flour with a sticky sour fermented flavor made from gelatinized fresh cassava tubers. "Fufu" is sticky dough made by pounding cooked fermented roots into a paste. "Abacha" is sun dried fermented cooked cassava chips.

Current methods of processing cassava into these foods remain essentially traditional and targeted at detoxifying cyanogenic glycosides and development of aroma. Several research studies have elucidated the biological and chemical mechanisms involved in these processes and considerable effort has been directed towards methods for the improvement of the nutritional value of these foods. However, as far as we know, very little attention has been paid to the processing of cassava for the purpose of improving its functional characteristics. Functional foods are foods that not only provide nutritional value but also provide health benefits when consumed in a regular diet

This study is intended to draw attention to this area of need, provide some baseline data about the occurrence of RS in cassava and to highlight the existence of the possibility of exploiting processing methods to improve the functional characteristics of our cassava based foods.

2. Materials and methods

2.1. Cassava varieties

Six improved cassava varieties of the Tropical Manihot Species (TMS); TMS 30,555, TMS 117, TMS 693, TMS 30,572, TMS98/0505 and TMS 4(2) 1425, as identified by the International Institute for Tropical Agriculture (IITA) Ubiaja field, Edo State, were used for this study. Cassava roots were harvested from nine-month old plants.

2.2. Processing of cassava roots into cassava based food products

Traditional methods, which have been extensively studied and widely reported in literature, were used to process the various cassava based foods. "Garri" was processed using the method reported by Oluwole et al. (2004). Cassava roots were peeled, washed and grated into a mash. The mash was stuffed into a clean sack. The cassava mash filled sack was left to stand under the weight of a solid slab at room temperature for 72 h to achieve both dewatering and fermentation. The dewatered mash was sieved using a sieve to break the mash cake into smooth granules and then fried to obtain "garri" granules. Oil "garri" was prepared by a modification of this process, which comprised the addition of palm oil (10 g/kg) to grated cassava mash before dewatering and garrification.

The method described by Ogbo (2006) was adopted for the processing of "fufu". Cassava roots were peeled, washed, cut into pieces of approximately 10 cm length × 5 cm diameter and soaked in plastic containers. The container was left under room temperature to ferment until tubers retted. The resulting retted roots were hand pulverized, wet sieved and dewatered in a clean sack. Modifications of this method used by some processors were performed by the addition of 10 g mild steel nails and 5 g of bitter leaves/L of steep water.

The method of Ogbo et al. (2004) was employed to process "abacha". The cassava roots were washed, boiled for 10 mins, peeled and sliced as thinly as possible using a hand held shredder. The slices were soaked in water for 48 h, washed, drained and spread in mats to sun dry. Modification of the process comprised boiling the cassava root for 20 instead of 10 min.

The schematic diagram of the methods for processing of the cassava based foods is presented in Fig. 1.

2.2.1. Determination of resistant (RS) and digestible (DS) starch

Samples used for the determination of resistant and digestible (non-resistant) starches were prepared as follows. Cassava tubers were diced, and the various processed samples of foods broken up as appropriate and then dried in the oven (Gallenkamp) at 50 °C until they attained less than 15% moisture. Moisture content of the samples was determined by method 967.03, AOAC (2005). The dried samples were subsequently ground into fine powder using a hand operated grinder.

Resistant starch was determined using a kit assay (K-RSTAR, Megazyme Bray, Co. Wicklow, Ireland). This kit follows the protocols of the AOAC method 2002.02 (2003) procedures explicated by Niba and Hoffman (2003). Samples (100 ± 0.5 mg) prepared as already described were incubated with pancreatic α-amylase (10 mg/ml) solution containing amyloglucosidase (AMG) for 16 h at 37 °C with constant shaking. After hydrolysis, samples were washed thrice with ethanol (99% v/v and 50% ethanol) followed by centrifugation. The separated pellet from supernatant was further digested with 2 M KOH. Digested pellet and supernatant were separately incubated with AMG. Glucose released was measured using a glucose oxidase-peroxidase (GOPOD) reagent kit (K-GLOX, Megazyme Bray, Co. Wicklow, Ireland) by absorbance at 510 nm against the reagent blank. The glucose content of the supernatant and digested pellet were used in calculation of digestible starch (DS) and Resistant Starch (RS) respectively by applying the factor of 0.9.

2.2.2. Determination of cyanide content of the cassava based foods

Total cyanides in dried food samples were analyzed spectrophotometrically using the picrate paper method of Bradbury et al. (1999). The method involved the immobilization of linamarase in a round filter paper disc containing phosphate buffer at pH 6.0. The disc was placed in a flat bottomed plastic bottle. A 100 mg portion of the powdered food sample was added to the filter paper and 0.5 ml of distilled water was added. This was followed immediately by the addition of a