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Physicochemical Properties Affecting Starch Digestibility *In Vitro* Using Diastase in Some Varieties of Cowpea and Soya Bean in Nigeria

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ABSTRACT

Carbohydrates are single most abundant class of organic molecules found in nature and its breakdown constitutes about 50% of the calories in the average diet that sustains animal life. A range of factors besides carbohydrates may influence digestibility and the release of calories. The nature of starch and its physical form, that is whether the food is raw or cooked, ground or whole also affects starch digestibility. Starch, lipids can complex with amylase and to retrogradation. Biu Local White, IT90K-277-2, IT89KD-391 (SAMPEA-12), IT97K-131-2, starch sample (BDH chemicals Ltd, Poole England), Enzyme Diastase (Lab Tech chemicals, activity min. 2000 u/g, LOD 110c 5%), weighing balance, water bath and centrifuge and standard method of AOAC and *in vitro* analysis was done. The starch content of the various cowpea varieties and soya bean were significantly less digestible than the pure standard starch and expressed in percentage digestibility with pure starch 100%, Biu local 60% and soya bean 40% at pH6 which is the optimum for the enzyme diastase activity. It is concluded that the differences in the composition of different cowpea varieties and soya bean affects the *in vitro* digestibility of the starch constituent.

Keywords: Diastase, starch, in vitro, cowpea, amylase, carbohydrates.

1. Introduction

Carbohydrates are single most abundant class of organic molecules found in nature[1]. The breakdown of dietary carbohydrates (mainly starch, sucrose and lactose) constitutes about 50% of the calories in the average diet that sustains animal life[2]. Early studies showed that starchy carbohydrates have very different effects on postprandial blood glucose and insulin responses in healthy and diabetic subjects, depending on the rate of digestion[3]. A range of factors besides carbohydrates may influence digestibility. These factors include the interaction of starch with fibre[4], antinutrient such as phytate, the association between starch and protein[5]. The nature of starch and its physical form, that is whether the food is raw or cooked, ground or whole also affects starch digestibility. Starch, lipids can complex with amylase and to retrogradation. Retrograted starch is highly resistant to pancreatic amylase digestion. Diets containing a debranching amylopecting to lipid complex (v-complex) have been shown to exhibit limited digestibility[6].

Cowpea seeds contain approximately 53-66% carbohydrate, most of which is found in the form of starch[7]. Starch from legumes, such as cowpea, has high amylose content[8]. It has been suggested that the high amylose content in legume starches is responsible for the extremely low post prandial glucose and insulin responses to lentils and beans when compared with responses to most cereal products[3]. Cooking and gelatinization of starch increases its susceptibility to enzymic degradation *in vitro* as well as its availability for digestion and absorption in the small intestine. A lose correlation exists between the degree of starch gelatinization and the rate of enzymic hydrolysis both *in vitro* and *in vivo*.

Dry beans (cowpea) contribute significantly to the nutrient of poor rural and urban dwellers in Nigeria. Cowpea, (*Vigna unguiculata* (L).) is a grain crop cultivated in a range of ecologies especially in the savanna regions and in the tropics and subtropics. Cowpea is mostly grown in dry areas along with millet, sorghum and maize. It is thought that the origin of the cultivated species of cowpea is Africa. Nigeria is the largest cowpea producer in the world and also has the highest level of consumption[9] this account for the relative low protein energy malnutrition (PEM) experienced in the savannah region of Nigeria[10]. However, not all available legumes are produced and consumed to the same extent. There are some constraints limiting the use of legumes as food[11]. These include the hard-to-cook (HTC) phenomenon; flatulence; beany flavor; tedious preparatory procedures; presence of antinutrients; poor digestibility as well as ignorance to their nutritive value[12]. There are few data in the literature on the anti-nutrients present in commonly available legumes in Nigeria, particularly the under-exploited ones[9]. This anti-nutrients or inhibitors include: tanins, phytates, saponins, lectins anti-alpha amylase, etc.

In vitro hydrolysis of cowpea starches increases with digestion time. Cowpea starch shows a low hydrolysis[8]. The aim of this research is to identify the physicochemical properties that affects starch digestibility in some varieties of local cowpeas.

2. Materials and Methods

This experiment was carried out in the Department of Biochemistry Laboratory, Faculty of Science, University of Maiduguri, Nigeria.

Cowpea varieties and soya bean samples was collected from Lake Chad Research Institute and Borno State Agricultural Development Programme which were developed by IITA in collaboration with Institute of Agricultural Research of the Ahmadu Bello University Zaria, University of Maiduguri and Agricultural Development Programmes of Borno, Kaduna, Kano and Katsina State, Nigeria. They are: Biu Local White, IT90K-277-2, IT89KD-391 (SAMPEA-12), IT97K-131-2, starch sample (BDH chemicals Ltd, Poole England), Enzyme Diastase (Lab Tech chemicals, activity min. 2000 u/g, LOD 110c 5%), weighing balance, water bath and centrifuge.

2.1. In vitro Digestibility of Cowpea

In vitro digestibility of cowpea starch was carried out according to Lee *et al*.[13]. Determination of phytic acid was carried out according to the methods of Davies and Reid[14]. Tannin content was determined by the quantitative method of Price *et al*.[15] and proximate analysis was done using the AOAC[16].

3. Results and Discussion

The result of the proximate composition of the varieties of cowpea and soya is shown in percentage in Table 1, the *in vitro* digestibility of starch in different varieties of cowpea and soya bean is presented in Table 2 while Phytochemical and water absorption capacity of varieties of cowpea and soya bean is depicted on Table 3.

Table 1: Proximate compositions of the different varieties of cowpea

Sample	Dry matter	Moisture	Crude protein	Fat	Ash	Crude fibre	carbohydrates
Soya bean	91.6	8.4	45.83	22.03	6.6	1.12	16.02
Biu local	95.8	4.2	13.39	3.0	1.0	9.0	69.41
IT90K-277-2	94.3	5.7	14.96	3.0	2.0	10.0	64.34
IT89KD-391	95.8	4.2	19.87	4.0	1.0	8.0	62.93
IT97K-131-2	94.7	5.3	14.79	3.0	2.0	13.0	16.91

Table 2: *In vitro* digestibility of starch in different varieties of cowpea and soya bean

samples	pH6		pH7	
	Amount of glucose released	Percentage digestibility (%)	Amount of glucose released	Percentage digestibility (%)
Pure starch	6.83±0.24	100.0	10.78±0.16	100.0
Soya bean	2.78±0.31	40.0	4.30±0.2	39.9
Biu local	4.1±0.10	60.0	6.45±0.15	59.8
IT90K-277-2	4.0±0.1	58.6	5.35±0.25	49.6
IT89KD-391	3.6±0.1	52.7	5.05±0.05	46.8
IT97K-131-2	3.15±0.25	46.1	4.9±0.1	45.6

Results are mean ± standard deviation of triplicate values

Table 3: Phytochemical and water absorption capacity of varieties of cowpea and soya bean

Samples	Tannins (mg/g)	Phytic acid (mg/g)	H_20 Absorption capacity (%)
Soya bean	0.80	2.8	1.25
Biu local	1.07	4.3	1.21
IT90K-277-2	0.97	7.95	1.16
IT89KD-391	1.27	3.8	1.21
IT97K-131-2	1.21	2.95	1.32

The starch content of the various cowpea varieties and soya bean were significantly less digestible than the pure standard starch (BDH chemicals Ltd, Poole England). This may be due to the presence of non-starch components, which interfered with the diastase hydrolysis. The presence of fibre in foods reduces digestibility of the starch contents of such foods as reported by Bobboi *et al*.[3]. Physical properties such as shielding structures (protein matrix, cell walls) may also slow down starch digestion. The rate of starch digestion in soya bean is low probably due to the lipid content which increases complex formation with amylase[1]. Starch-granule-bound protein may also probably contribute to poor starch digestibility as reported by Eggum *et al*.[17].

Tannin content of the cowpeas varies considerably due to the fact that polyphenols responsible for seed color are predominantly located in the pericarp and/or testa of pigmented cultivars of legumes. It is possible that other factors such as year of production, storage, varietal differences and growing

conditions could have influenced the concentration of tannins which in turn accounts for low values of glucose released by diastase as shown by the different varieties of cowpea.

The low value of phytate in soya bean could be due to the nature of proteins which can also affect starch digestibility as observed by Ene-Obong[12].

5. Conclusion

It is thus concluded that the differences in the composition of different cowpea varieties and soya bean affects the in vitro digestibility of the starch constituent. The higher the protein, fat and fibre cotent of the cowpea, lowers the in vitro digestibility of the starch constituent. Thus, this is important in the management of diets for carbohydrate disorders such as diabetes mellitus.

6. Recommendations

More effort is needed to encourage the increases production and consumption of processed indigenous legumes as they may remain the cheapest source of nutritious food. The processed flours and composites of this cowpeas could be incorporated into many traditional dishes for infants, children, adults especially those with carbohydrate disorders and be used in the bakery.

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