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Proximate Composition, Antinutrients and Glycemic Index/Load of Garri Enriched with Corncob Flour Diets.

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Abstract: *Proximate composition, anti-nutrients and the glycemic index/load of garri enriched with corncob flour diets were evaluated. Garri and corncob flour were produced using standing methods respectively. Garri was enriched with corncob flour at the ration of 0%, 5% 10%, 15%, 20% and 25% and these samples were used to prepare diets which were subjected to proximate, anti-nutrients analyses. The glycemic levels were measured by feeding six out of seven groups of fasted albino rats with the respective diets. The seventh rat group was fed with white bread. The results showed that protein, ash, fat and crude/dietary fibre contents of the flours were increased with increase in the percentage levels of the added corncob flour while the carbohydrate contents reduced with increase in added level of percentage corncob flour. The antinutrients in garri and corncob flour were 10.77 - 11.25, 11.85 - 89.23; 1.64 - 8.90, 4.25 - 12.72 and 0.15 - 0.93 mg/100g of phytate, saponin, oxalate, trypsin-inhibitor and cyanide respectively. The glycemic index range was 36.2 to 59.5 and the glycemic load range was 17.70 to 32.42. It was observed that these parameters reduced as the ratio of corncob flour added to garri increased in the diet. The diet with the highest content of the corncob flour had the least values of GI and GL. This study showed that the garri diet enriched with corncob flour at 25% level produced a low glycemic food and improved the nutrient composition.*

Background: *Garri is a staple food in many parts of Nigeria and West Africa. Its frequent consumption results in spikes in the post-prandial blood glucose level – a trend which presents metabolic challenges for diabetics. In spite of the staple status of garri, in recent times its affordability frequently gets out of the reach of persons at the base of the consumption ladder due to rising inflationary trends. Corn cob is regularly trashed in seasons of glut, but studies have reported its content of a high level of fibre. The feasibility exists for exploiting indigenous "food wastes" for food applications – in this case, by blending with a staple food item to enhance bulk while boosting fibre content with its attendant health benefits.*

Materials and Methods: *Carefully de-seeded corn cobs dried and milled into corncob flour which was further dried, cooled and packaged in an air-tight container. Freshly harvested cassava tubers were peeled, washed, grated, packaged in a porous Hessian bag, dewatered, fermented, manually sieved and toasted over a low fire. Six samples of garri enriched corncob flour blends were prepared by supplementing garri with 0%, 5%, 10%, 15%, 20% and 25% of corncob flour respectively. These samples were used to prepare the experimental rat diets. The garri enriched with corncob flour was milled and equal portions of vitamin mix, salt, Casilan 90 and palm oil were added to each milled garri enriched with corncob flour samples after mixing thoroughly with water. The paste was baked at 150^oC, cooled and crushed to smaller pieces. The proximate and anti-nutrient compositions were determined. Twenty-eight albino rats, divided into seven groups of four rats each, were fasted over night. The first group was fed with reference food glucose and the other six groups were fed with the respectively prepared diets for 60 min. Their blood glucose were measured and the glycemic index and load were calculated.*

Results: *There were significant differences ($p>0.05$) in the numerical values of some of the parameters assessed across the samples and products. There were significant differences ($p<0.05$) in the moisture, crude protein, crude fibre and carbohydrate contents of the various garri-enriched corncob flour samples. However, there were no significant differences ($p<0.05$) in the crude fat and ash contents of the samples. The moisture content of the control sample was highest (11.53%). The moisture contents of the samples were progressively reduced as the percentages of corncob flour in the garri-enriched corncob flour were increased. Comparatively, the range of antinutrients in garri and corncob flour were 10.77 - 11.25, 11.85 - 89.23, 1.64 - 8.90, 4.25 - 12.72 and 0.15 - 0.93 mg/100g of phytate, saponin, oxalate, trypsin and cyanide respectively. Garri had higher phytate, oxalate, and cyanide contents which were significantly higher ($p<0.05$) than those of corncob flour. However, corncob flour had saponin content (89.23mg/100mg) which was more than seven times the saponins in garri (11.85mg/100g). The trypsin content of corncob flour was nearly three times higher than that of garri. The T-calculated values of the samples and the serum glucose concentration decreased with increase in the percentage ratios of the dietary fibre in the garri enriched corncob flour diets. The fasting serum glucose concentrations declined with elevation in the ratio of corncob flour used in the preparation of the diets.*

***Conclusion**: The diets formulated with garri which was replaced with corncob flour to levels of 15 - 25% increased the dietary fibre content and overall nutrient quality of garri; and reduced the blood serum glucose levels of diabetically-induced rats. Garri-corncob flour diet can, inferentially, be used to manage diabetes in human patients, as one of the ways of managing the disease is through nutritional therapy with diets high in dietary fibre. The inclusion of corncob flour to garri diet led to a reduction in the amount of antinutrients present.*

Key words: Corn cob, garri, glycemic index, glycemic load, anti-nutrients.

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I. Introduction

One of the major and most important products of cassava is *Garri*. Garri is made from fermented gelatinized fresh cassava root tubers. It is rich in carbohydrate. Cassava root tubers, from which garri is produced, are rich in dietary fibre, copper and toxic hydrogen cyanide. However, the method of processing cassava into garri reduces the toxic hydrogen cyanide content to very low and safe level [1]. It is a widely consumed food in Nigeria and is consumed principally as a main meal ("eba", made by turning it into a stiff dough by the addition of boiled water. Eba is eaten with different types of sauces) or taken as a snack when soaked in cold water, sweetened with sugar and consumed with roasted groundnut and sometimes, dry fish. *Garri* features more frequently up to 2 or 3 times in the daily diet of most households in the producing areas [2]. When processed into *garri*, the cassava bulk is reduced and shelf-life is increased. In order to process *garri*, cassava roots are peeled, washed, grated into mash, dewatered, pulverized, sieved, open pan-roasted, cooled and packaged; and these unit operations are usually done traditionally by women and sometimes children [3]. Garri is eaten in Nigeria and other West African countries. It is popular as a staple food due to its availability and comparative low cost, as well as its ease of preparation and storage [4].

Zea mays is the world's third leading cereal grain after wheat and rice. Worldwide, maize is grown as a food and fodder crop, as well as for supplying raw material for industries [5]. Corn cob finds use in many applications; one of which is as fibre in the fodder for most ruminant livestock despite its low nutritional value. Corn cob contains little protein (about 5%) and is mostly composed of fibre (cellulose, hemicellulose and lignin), together with ash and small amount of soluble materials [6]. Fibre is a complex carbohydrate which is resistant to digestion and absorption in the human small intestine, promoting beneficial physiological effects including laxation, blood cholesterol attenuation and/or blood glucose attenuation [7].

Diabetes mellitus comprises of heterogeneous group of disorders caused by a relative or absolute deficiency of insulin, resulting in abnormalities of carbohydrate and fat metabolism. The disease is caused by certain deficiencies, basically due to absence of, insufficient production of, or inability of the body to use; insulin produced by the beta cells of the pancreatic islets [8]. Several factors have been postulated to contribute to diabetes epidemic; environmental factors have been drawn as the major one because of the rapidity of the increase in "Type 2"or so called "maturity onset" diabetes. The factors are social-cultural dynamics, ageing, increasing dietary changes, reduced physical activity, other unhealthy lifestyle and behavioural patterns [9]. Diabetes mellitus produces the symptoms of frequent urination, increased thirst and hunger, extreme fatigue, blurry vision, etc. It is characterized by hyperglycemia, glucosuria and several microvascular and macrovascular complications [10]. The complications of diabetes are linked to oxidation stress induced by hyperglycemia that overcomes the body's natural anti-oxidant system [11]. The debilitating effects of diabetes mellitus include various organ failures, progressive metabolic complications such as retinopathy, risk of cardiovascular diseases, necrosis, stroke, kidney failure, foot ulcers and hypertension. It has been noted that at later stages of diabetes, lipid metabolism is affected and is seen as hyperlipidemia and hypercholesterolemia which are risk factors of artherosclerosis [12]. Patients with diabetes often have unhealthy high levels of low-density lipoproteins ("bad") cholesterol, low high-density lipoproteins ("good") cholesterol and high triglyceride in the blood serum. The triad of poor lipids often occurs in patients with premature coronary heart disease [13]. The number of people with diabetes has risen from 108 million in 1980 to 422 million as at 2014. The global prevalence of diabetes among adults over 18 years of age has risen from 4.7% in 1980 to 8.5% in 2014. In 2016, an estimated 1.6 million deaths were directly caused by diabetes, and about 422 million have diabetes worldwide – majority of which are low-income earners [14].

Diabetes mellitus remains an incurable disease as there is yet no effective cure for it. The disease, being a metabolic endocrine disorder, is directly connected to carbohydrate, lipids and protein metabolism. Hence, nutrition therapy is extremely germane to diabetes management. Whilst dietary fibre-rich diets have been reported to reduce sugar release in diabetics, decrease levels of cholesterol and triglycerides and reduce obesity; a pertinent question is: "Can garri serve as a substitute to relatively expensive whole wheat when enriched with dietary fibre?" A possible means of enrichment of garri with dietary fibre is through supplementation of garri with corncob flour. Hence, there is the need to evaluate whether or not diets prepared from garri enriched with corncob flour have hypoglycemic and hypolipidemic effects on alloxan-induced diabetic rats fed with such diets.

II. Materials and Methods

Several quantities of corn-on-cob were bought from Relief Market, whilst the Cassava tubers used for processing of garri were harvested from a farm in Libie, Umunahu-Uratta - both in Owerri, Imo State Nigeria. The solvent and chemicals used for the study were of analytical grade..

Study Design: Experimental observational study.

Study Location: Nekede Autonomous Community, Owerri-West Local Government Area of Imo State, Nigeria.

Study Duration: June, 2019 to October, 2019.

Procedure methodology

Corn cob flour preparation

The corn kernels were removed manually from the ears of dry maize. The corn cobs obtained were sorted to remove defective ones after which they were washed thoroughly, cut into pieces and dried in a hot air oven (Gallenkamp, England) at a temperature of 65°C for 6 h. The dried pieces of the corncobs were milled into corncob flour using attrition mill (Bamfords No2, United Kingdom). The milled corn cob flour was finely sieved. The flour was further dried, cooled and packaged in an air-tight container.

Plate 1: Corn cobs

Plate 2: Dried corn cob flour

Preparation of Garri

Garri was processed using the method as reported by [15]. The freshly harvested cassava tubers were peeled, washed and grated in a commercial cassava grating machine located at MCC Road Owerri, Imo State, Nigeria. The grated meal was packaged in a porous Hessian bag and placed in a heavy hydraulic iron press for moisture removal. It was allowed to dry for three days during which the meal fermented. The meal was sieved manually and was toasted in an open pan over a low fire.

Diet formulation and Analytical procedures

Six samples of garri-enriched corncob flour blends were prepared by supplementing garri with 0%, 5%, 10%, 15%, 20% and 25% of corncob flour respectively. These samples were used to prepare the diets using the method described by [16] for preparation of experimental rat diet. The garri enriched with corncob flour was milled and equal portions of vitamin mix, salt, Casilan 90 and palm oil were added to each milled garri enriched with corncob flour samples after mixing thoroughly with water. The mixture was baked at 150°C for 20 minutes, cooled and crushed to smaller pieces with Corona® hand grinder (The Corona® Mill, Costa Rica). Proximate and anti-nutrient compositions were determined according to the methods described by [17]. Twenty-eight albino rats (divided into seven groups of four rats) were fasted over night. The first group was fed with reference food glucose and the remaining six groups were fed with the respective prepared diets for 60 min. Their blood glucose measurements were taken and the glycemic index and glycemic load were calculated.

Table no 1: Recipe for the formulation of garri-enriched corncob flour diets (in %)

Components	Vit. Mix	Salt	Palm oil	Casilan 90	Garri	Corncob flour
GCCF-AD	1.5	1.5	10	22	65	-
GCCF-BD	1.5	1.5	10	22	61.75	3.25
GCCF-CD	1.5	1.5	10	22	58.50	6.50

GCCF-DD	1.5	1.5	10	22	55.25	9.75
GCCF-ED	1.5	1.5	10	22	52.00	13.00
GCCF-FD	1.5	1.5	10	22	48.75	16.25

Keys: **GCCF-AD** is 100% garri diet; **GCCF-BD** to **GCCF-FD** are diets made with blends of 95:5, 90:10, 85:15, 80:20 and 75:25 garri and corncob flour respectively; **Vit.mix** – Vitamin mixture; **Casilan 90** – High protein powder

Plate 3: Garri

Plate 4: Garri-enriched corncob flour diets

Plate 5: Rats undergoing feeding

Statistical Analysis

The results generated were subjected to statistical analysis using SPSS version 20 (SPSS Inc., Chicago, IL) and MS-Excel (Microsoft Inc., USA) at 95% confidence level. Analysis of variance (ANOVA) was applied to replicate determinations to detect the prevalence (or otherwise) of significant differences amongst the results. For replicate determinations, the mean and standard deviation from the mean for each measured parameter were calculated. Duncan's new multiple range test was used to segregate the means at 5% level of significance. The results are presented as mean ± standard deviation.

III. Results

Table no 2: Proximate composition of Garri-enriched Corn cob flour blends.

Diet	Moisture	Crude Protein	Crude fiber	Crude fat	Ash	Carbohydrate
GCCF – AD	$7.50^{a}\pm0.01$	$20.94^{d}\pm0.01$	$0.82^{f}\pm0.02$	10.52 ± 0.31	$5.56^{f}\pm0.03$	$54.66^{a}\pm0.02$
GCCF – BD	$7.22^{b}\pm0.02$	$20.97^{cd}\pm0.01$	$2.07^{e}\pm0.01$	10.68 ± 0.02	$5.72^{e}\pm0.02$	$53.34^{b}\pm0.02$
GCCF – CD	$6.96^{c}\pm0.02$	$20.98^{c}\pm0.01$	$3.37^{d}\pm0.04$	10.66 ± 0.03	$5.80^{d}\pm0.01$	$52.23^{c}\pm0.03$
GCCF – DD	$6.64^{d}\pm0.02$	$21.00^{bc}\pm0.05$	$4.68^{c}\pm0.01$	10.66 ± 0.03	$5.96^{c}\pm0.01$	$51.06^{d}\pm0.02$
GCCF – ED	$6.25^{e}\pm0.02$	$21.04^{ab}\pm0.02$	$5.85^{b}\pm0.01$	10.64 ± 0.02	$6.04^{b}\pm0.02$	$50.18^{e}\pm 0.01$
GCCF – FD	$6.08^{f}\pm0.02$	$21.05^{a}\pm0.05$	$7.21^{a}\pm0.01$	10.62 ± 0.02	$6.16^{a}\pm0.01$	$48.88^{f}\pm 0.01$
LSD	**0.013**	**0.041**	**0.034**	**Nil**	**0.039**	**0.021**

Values are means of triplicate determinations ± standard deviations from the mean. Means with different superscript letters along the columns are significantly different ($p<0.05$) from each other

GCCF – AD = 65:0 Garri-corncob enriched diet (100% garri diet)
GCCF - BD = 61.75: 3.25 Garri-corncob enriched diet (100% garri diet)
GCCF – CD = 58.5 : 6.5 Garri-corncob enriched diet (100% garri diet)
GCCF – DD = 55.25 : 9.75 Garri-corncob enriched diet (100% garri diet)

GCCF – ED = 52 : 13 Garri-corncob enriched diet (100% garri diet)
GCCF – FD = 48.75 : 16:25 Garri-corncob enriched diet (100% garri diet)

Table no 3: Mean glycemic responses of rat groups fed diet from blends of garri-enriched with corncob flour.

Diet	Time (minutes) 0	30	60	90	120
White bread	82.67^a±0.01	197.00^a±0.04	199.08^a±0.04	186.44^a±0.19	145.86^b±0.26
GCCF – AD	80.29^f±0.07	145.51^b±0.32	149.92^b±0.14	138.12^b±0.19	125.82^a±0.32
GCCF – BD	81.33^c±0.03	144.02^c±0.03	148.36^c±0.06	131.93^c ±0.13	122.03^c±0.07
GCCF – CD	80.47^e±0.27	140.59^d±0.14	144.29^d±0.06	130.08^d±0.13	120.36^d±0.08
GCCF – DD	81.59^b±0.12	130.63^e±0.06	138.97^e±0.05	126.69^e±0.04	115.33^e±0.01
GCCF – ED	79.59^g±0.21	126.94^f±0.11	136.29^f±0.05	124.97^f±0.07	106.33^f±0.03
GCCF – FD	80.63^d±0.06	115.33^g±0.02	127.93^g±0.13	110.73^g±0.12	104.98^g±0.05
LSD	0.0108	0.0458	0.0487	0.053	0.8421

Values are means of triplicate determinations ± standard deviations from the mean. Means with different superscript letters along the columns are significantly different (p<0.05) from each other
GCCF – AD = 65:0 Garri-corncob enriched diet (100% garri diet)
GCCF – BD = 61.75: 3.25 Garri-corncob enriched diet (100% garri diet)
GCCF – CD = 58.5 : 6.5 Garri-corncob enriched diet (100% garri diet)
GCCF – DD = 55.25 : 9.75 Garri-corncob enriched diet (100% garri diet)
GCCF – ED = 52 : 13 Garri-corncob enriched diet (100% garri diet)
GCCF – FD = 48.75 : 16:25 Garri-corncob enriched diet (100% garri diet)

Table no 4: Glycemic index (GI), glycemic load (GL) and GI classification of experimental diets

Diet	Glycemic Index	Glycemic load	Glycemic Index classification
GCCF – AD	59.5	32.42	Moderate
GCCF – BD	57.7	30.78	Moderate
GCCF – CD	54.4	28.41	Low
GCCF – DD	48.4	24.72	Low
GCCF – ED	44.7	22.43	Low
GCCF – FD	36.2	17.70	Low

GCCF – AD = 65:0 Garri-corncob enriched diet (100% garri diet)
GCCF – BD = 61.75: 3.25 Garri-corncob enriched diet (100% garri diet)
GCCF – CD = 58.5 : 6.5 Garri-corncob enriched diet (100% garri diet)
GCCF – DD = 55.25 : 9.75 Garri-corncob enriched diet (100% garri diet)
GCCF – ED = 52 : 13 Garri-corncob enriched diet (100% garri diet)
GCCF – FD = 48.75 : 16:25 Garri-corncob enriched diet (100% garri diet)
***GI/GL Classification:** 70 or more = **High**; 56 – 69 = **Moderate**; 55 and less = **Low** [18].

Table no 5: Antinutrient contents (mg/100g) of Corn cob flour and garri samples.

Antinutrient	Corn cob flour	Garri	LSD
Phytate	10.77^b±0.01	11.25^a±0.02	0.0914
Saponin	89.23^a±0.06	11.85^b±0.01	0.0001
Oxalate	1.64^b±0.11	8.90^a±0.03	0.0609
Trypsin-inhibitor	12.72^a±0.02	4.25^b±0.02	0.1218
Cyanide	0.15^b±0.12	0.93^a±0.08	0.0914

Values are means of triplicate determinations± standard deviations from the means. Means with different superscript letters along the rows are significantly different (p<0.05) from each other.

IV. Discussion

Proximate Composition of Garri-enriched Corn cob flour blends

The results of the proximate analysis of the Garri-enriched Corn cob flour blends are shown in Table 2. Significant differences (p>0.05) were recorded in the values of the diverse parameters across the samples. The ranges of values for the different parameters across the diets are as follows: Moisture (6.08 – 7.50%), Crude protein (20.94 – 21.05%), Crude fibre (0.82 – 7.21%), Crude fat (10.52 – 10.68%), ash (5.56 – 6.16%) and carbohydrates (48.88 – 54.66%). Generally speaking, the crude fibre, crude protein and ash contents of the diets were observed to increase with elevations in the level of addition of Corn cob flour in the formulation. The results showed that diet GCCF-AD had the highest moisture (7.50%) and carbohydrate (54.48%) values which decreased significantly (p<0.05) as the percentage ratios of corncob flour in the diets increased. There were, however, significant increases in the crude fibre and ash contents of the diets as the percentage ratios of corncob flour were increased (Table 2). The marked increase in the fibre content of the diets as the proportion of corn cob was increased suggests that corn cob is a rich source of dietary fibre which plays a vital function in the prevention of several diseases of the alimentary canal, whilst also increasing faecal bulk and causing a decline in the level of serum cholesterol [19].The ash content of any food material represents the inorganic elements obtained after the combustion of the organic materials in the food and these inorganic materials are composed of mineral element (calcium, magnesium, iron, phosphorus etc) which are important for building rigid structures and regulatory functioning of the body [20]. The crude protein content of diet GCCF-FD was 21.05% and was significantly higher (p<0.05) than those of the other diets with exception of the diet GCCF-ED. The lowest (20.94%) crude protein value was recorded in diet GCCF-AD, the control diet. Overall, the protein content of the diets were relatively high. There was, however, no significant difference in the crude fat content of the diets.

Diet classification and glycemic responses of rat groups fed diet from blends of garri-enriched with corncob flour Tables 3 and 4 reveal the outcomes of the average glycemic responses of rat groups fed with the experimental diet and the glycemic index, glycemic load and glycemic index classification of garri-enriched with corncob flour diet repectively. The GCCF-AD and GCCF-BD diets (65:0 and 61.75:3.25 Garri-corncob enriched diets (out of 100% garri diet)) were in the moderate range of glycemic index classification, whilst the other samples can be said to be of low glycemic index [18]. The effect of corncob inclusion in the reduction of GI value becomes noticeable beyond the level of the blending ratio in the GCCF-BD diet (61.75:3.25 Garri-corncob enriched diets (out of 100% garri diet) (Table 4). The glycemic responses of the rat groups were found to rise 30 min after the consumption of the diets and the highest glycemic responses were obtained in 60 min before they started falling to values which were higher than responses recorded when the rats were not yet fed, that is, fasting glucose response values (Table 3). Fig 1 shows the graphs of glycemic responses of the various rat groups on both reference and formulated diet vs time after ingestion of the diets. The area under each of the curves was divided by area under the reference diet curve to obtain the glycemic index of respective diets. The control diet (GCCF-AD) had the highest glycemic index (59.50) and glycemic load (32.42), while the diet containing 75: 25 garri-corncob flour had the least glycemic index (36.20) and glycemic load (17.70) (Table 3). There were significant reductions (p<0.05) in both glycemic indices and glycemic loads of the diets with increase in the ratios of corncob flour in the diets. Diets GCCF-AD and GCCF-BD had moderate glycemic indices and glycemic load while diets GCCF-CD, GCCF-DD, GCCF-ED and GCCF-FD had low glycemic indices and glycemic loads.

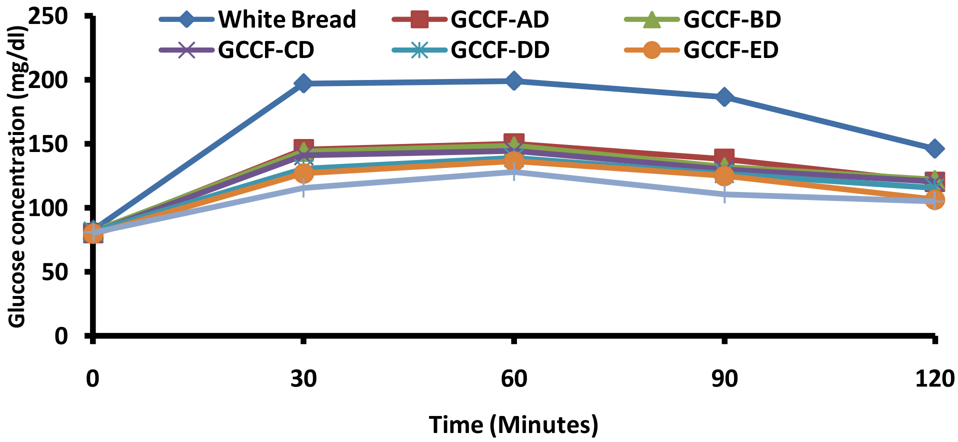

Fig. 1: Glycemic responses of the various rat groups on both reference and formulated diet vs time after ingestion.

Antinutrient contents (mg/100g) of Corn cob flour and garri

For garri and corncob flour respectively, anti-nutrients with values determined were shown in the Table 5. The values each of the anti-nutrient in garri differed significantly from that of corncob flour (p<0.0.5). High levels of phytate needs to be avoided in food because it is precipitated in form of phosphorus which bind divalent minerals such as Calcium, Zinc and Iron in the digestive tracts and makes them unavailable to the body [21]. Phytate levels exceeding 50mg/100mg in food stuff is detrimental to animals including humans [22]. Fortunately the amount of phytate detected in both garri (11.25mg/100g) and corncob flour (10.77mg/100g) were below 50mg/100g. Phytate levels in food could be reduced through cooking and baking. This results in reduction in binding capacity for minerals in food [23]. Low levels of phytate are beneficial to humans as it reduces blood lipid, blood glucose response and cancer risk [24]. On the other hand, high phytate diets have been reported to be used in the inhibition of dental caries and platelet aggregation in the treatment of hypercalciuria and kidney stones in humans, and as an antidote against acute lead poisoning [25]. Saponin in the corncob flour (89.23mg/100g) was very much higher than in the garri (11.85mg/100g) sample. Diets containing Saponin below 1g/kg (100mg/100g) are safe for consumption and are unlikely to exert anti-nutritional effect to living organisms [26]. Saponin is said to act as a cardiac depressant and has hypocholesterolemic, antimicrobial and anti-carcinogenic effects [27]. However, a high level of Saponin in diets can lead to formation of a complex which can reduce protein digestibility. The garri sample had an oxalate content of 8.90mg/100g while corncob flour had oxalate content of 1.64mg/100g. Consumption of excess amounts of oxalate leads to the formation of calcium oxalate which is implicated in kidney stones [28]. The amounts of oxalate in garri (8.90mg/100g) and corncob flour (1.64mg/100g) were below 5g/100g level stated by [29] to be fatal to humans. Nonetheless, high oxalate content has negative effect on human health by forming insoluble complex with calcium ions, thereby limiting calcium utilization, absorption and bioavailability [30]. Trypsin inhibitor is known to interfere with utilization of trypsin (an amino acid). It’s presence limits the use of legume seed protein. It causes pancreatic enlargement and growth depression [31]. Small levels of trypsin inhibitor in human foods have been suggested to have cancer-reducing factors [32]. The level of trypsin inhibitor in the garri and corncob flour (4.25 and 12.72mg/100g respectively) are within acceptable safe levels for humans and corresponding with the report of [33]. The value of hydrogen cyanide obtained in this study was 0.9mg/100g for garri and 0.15mg/100g for corncob flour. Hydrogen cyanide (HCN) is toxic to monogastric animals when ingested in large quantities. High levels of hydrogen cyanide have been implicated in cerebral damage and lethargy in man and animals. The hydrogen cyanide obtained for garri is much lower that the WHO permissible level of hydrogen cyanide in garri (1.0mg/100g) [34], as well as the value of 4.78mg/100mg, 4.32mg/100g and 4.91mg/100g reported for Ohaji, Oguta and Ngor Okpala garri samples respectively reported by [34].

V. Conclusion

The addition of corncob flour to garri brought about a significant improvement on its nutritional composition and raised the dietary fibre content level from the results obtained. The inclusion of corncob flour to garri diet led to a reduction in the amount of antinutrients present. A strong correlation has been established between an increase in the level of substitution of garri with corn cob flour and a drop in the glycemic response. It is concluded that garri diet produced using the ratio 25:75 for corncob flour and garri respectively, will give a low glycemic load product which shows great promise for consumption by diabetic patients.

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