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Proximate Composition and Antihyperglycaemic Effects of Selected Plant Products

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Abstract
The proximate, dietary fibre, mineral and antinutrient compositions of *Gongronema latifolium* (leaves), *Gymnema sylvestre* (leaves), *Corchorus olitorius* (leaves) and *Bulchozia coriceae* (seeds) were evaluated. Diabetes was induced in selected albino rats while the control groups were normal. Both groups were fed diets containing different levels of each plant product (0, 2.5, 5.0, 10.0 and 20.0% respectively) for twenty-eight days. Effects of plant products on blood glucose, sodium, potassium, phosphorus, calcium and magnesium levels of experimental animals were evaluated. The crude protein, fat, dietary fibre and carbohydrate composition of the four plant products were significantly ($p<0.05$) different. Insoluble and soluble dietary fibre were significantly ($p<0.05$) higher in *G. sylvestre* and *G. latifolium* respectively. Sodium and potassium levels were highest in *C. olitorius.* Saponin content was highest in *G. latifolium.* There was a dose-dependent decrease in blood glucose and sodium concentration in all the diets groups. *C. olitorius* fed-diet reduced mean body weights of experimental animals throughout the four weeks of study.

1. Introduction

Diabetes is a group of metabolic disorders resulting from impaired pancreatic function where production and function of insulin is either limited, impaired or ceases altogether [1]. The most common form of diabetes is the type 2 diabetes. Treatment and management of diabetes has remained a great challenge for decades [2]. Type 2 diabetes mellitus may be aggravated by the presence of diseases like obesity, hypertension and other factors like aging and lack of adequate exercise [3, 4]. Worldwide, the number of diabetes patients has been extrapolated to double its present status of over 200 million people by the year 2030 [5, 6]. Nutrition and lifestyle modification are known to influence an individual's susceptibility to diseases including diabetes [2]. Previous researchers have reported a significant reduction in type 2 diabetes mellitus under conditions of body mass control and exercise [7, 8]. In diabetes, the role of diet is to provide sufficient calories to maintain ideal body weight and minimize associated complications [9].

Human health is inextricably linked to diet and many foods have nutraceutical effects [10]. Nutraceuticals are involved in the treatment and management of diseases including cancer, arthritis and even diabetes [11]. Some plant products with the potentials for the

control/management of type 2 diabetes exist in different cultural settings but most of them have not been scientifically evaluated for their efficacy. The present research investigates the antihyperglycaemic effects of four plant products namely: *Gongronema latifolium*, *Corchorus olitorius*, *Bulchozia coriceae* and *Gymnema sylvestre.*

2. Materials and Methods

2.1. Plant Materials

Fresh matured leaves of the plants (*Gongronema latifolium*, *Corchorus olitorius*, and *Bulchozia coriceae*) were obtained from Umuahia main market, Abia state, Nigeria. *Gymnema sylvestre* was obtained from Bioresource Development Conservation Programme Centre (BDCPC) Aku, Enugu state, Nigeria. They were thoroughly cleaned, sun-dried, ground in a Thomas Wiley Laboratory Mill (Model 4 USA) and stored for subsequent use in glass containers with screw lids.

2.2. Proximate, Mineral and Phytochemical Analysis

Protein, fat, crude fiber, moisture and ash contents of plant products were determined by standard AOAC methods [12]. Carbohydrate was estimated by difference. Sodium, potassium, calcium, magnesium and phosphorus were determined as described by Pearson [13]. Sodium and potassium were analyzed with the flame photometer. Calcium and magnesium were determined using the Vernasate (EDTA) Complexometric titration method, while phosphorus was determined using the spectrophotometer (Spectronic 21). The method of Price and Butler [14] was used for the determination of tannin content. Phytate was determined using the method of Thompson and Erdman [15]. Oxalates were analyzed by the method Ukpabi and Ejidoh [16]. Saponin was determined by the method of Agrawal [17]. Trypsin inhibitor activity was determined by the method of Kakade *et al.* [18]. Dietary fiber was determined by the method described by James [19].

2.3. Animal Feeding Experiments

Formulation of diets,

Experimental diets were formulated to incorporate 0-20% of the dried pulverized plant products in each case (see table 1).

Table 1. *Experimental diets.*

Ingredients (g)	Diet 1	Diet 2	Diet 3	Diet 4	Control diet
Carbohydrate	81.70	81.70	81.70	81.70	81.70
Protein	11.30	11.30	11.30	11.30	11.30
Fat	2.00	2.00	2.00	2.00	2.00
Fiber	3.00	3.00	3.00	3.00	3.00
Vitamins and minerals	2.00	2.00	2.00	2.00	2.00
Gongronema latifolium	2.50	5.00	10.00	20.00	-
Bulchozia coriceae	2.50	5.00	10.00	20.00	-
Gymnema sylvestre	2.50	5.00	10.00	20.00	-
Corchorus olitorius	2.50	5.00	10.00	20.00	-

Wistar albino rats of 5 weeks old and weighing 54-81g were used for the study. They were divided into 5 groups of 5 animals each. The controls consisted of non-diabetic rats fed diets without plant products and diabetic rats (induced with alloxan) fed diets without plant products. The treatment diets contained 2.5, 5.0, 10.0 and 20.0 per 100g diet of each of the plant products respectively.

2.4. Blood Parameters

Blood glucose was estimated by the method described by Trinder [20]. Oral glucose tolerance and triglycerides were determined by the method of Fossato [21]; while total cholesterol and high density lipoprotein were estimated by the method of Tiez [22]. Low density lipoprotein was determined by the method of Friedewald *et al.* [23]. Serum potassium, sodium and phosphorus were determined by the method of Terri and Sessin

[24], Marina [25] and Henry *et al.* [26] respectively.

3. Result

Table 1 presents the proximate composition of the plant products. *G. sylvestre* had the highest amount of crude protein and ash (39.69% and 14.70% respectively) while *B. coriceae* had the lowest amount of protein and ash (13.28% and 4.53% respectively). The protein, fat, fibre and carbohydrate compositions of the different plant diets were statistically different.

Table 2. *Proximate Composition of Plant Products used for Experiments.*

Plant product	Protein (%)	Fat (%)	Ash (%)	Moisture (%)	Fiber (%)	Carbohydrate (%)
Bulchozia coriceae	13.82 ± 0.38^{d}	$2.50 \pm\pm 0.06^{c}$	4.53 ± 0.07^{d}	1.34 ± 0.02^{b}	1.74 ± 0.09^{d}	77.18 ± 0.27^{a}
Gymnema sylvestre	39.69 ± 0.53^{a}	3.47 ± 0.09^{b}	14.70 ± 0.13^{a}	1.22 ± 0.01^{c}	4.10 ± 0.12^{b}	36.82 ± 0.68^{d}
Gongronema latifolium	18.10 ± 0.39^{c}	2.03 ± 0.03^{d}	12.80 ± 0.03^{c}	1.84 ± 0.10^{a}	4.63 ± 0.12^{a}	60.60 ± 0.48^{b}
Corchorus olitorius	24.10 ± 0.44^{b}	4.06 ± 0.07^{a}	13.33 ± 0.09^{b}	1.80 ± 0.02^{a}	3.87 ± 0.09^{c}	52.85 ± 0.59^{c}
$LSD_{0.05}$	1.43	0.21	0.29	0.05	0.34	1.71

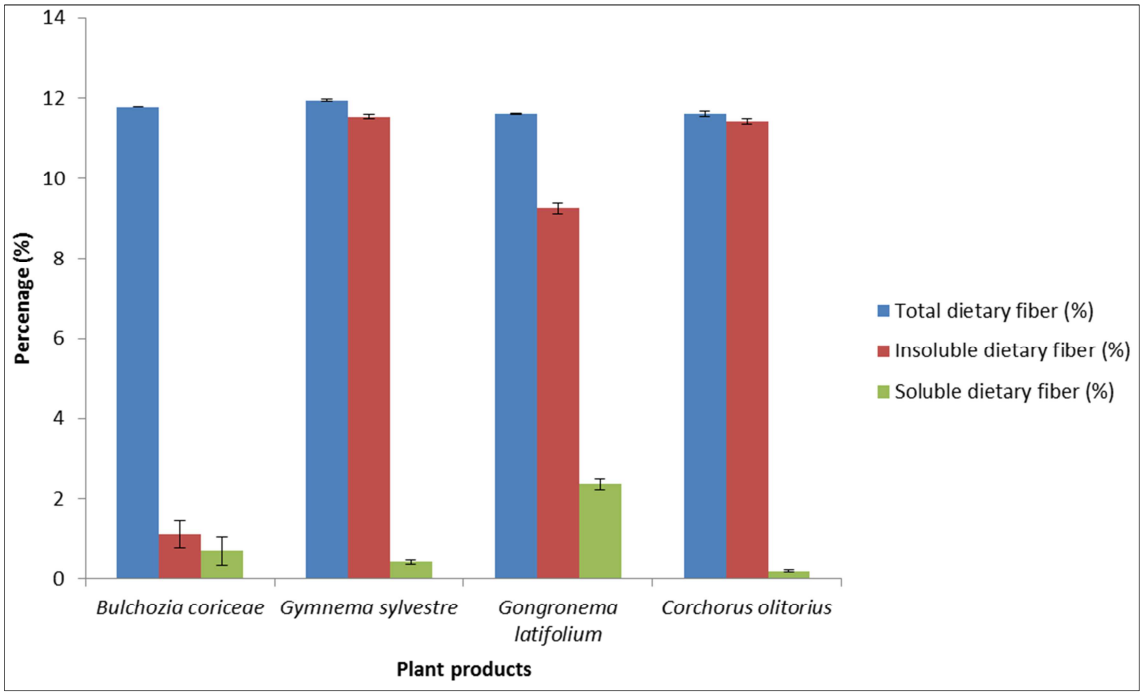

Fig. 1. *Dietary fibre content of plant products.*

Figure 1 shows the dietary fibre content of the dried plant products. Total and insoluble dietary fibre contents were significantly higher ($p<0.05$) in *G. sylvestre* while soluble dietary fiber was significantly higher in *G. latifolium* (2.35%). *Corchorus olitorus* contained the lowest soluble dietary fibre. Insoluble dietary fibre content of *Bulchozia coriceae* was much lower than that of other plant products ($p<0.05$)

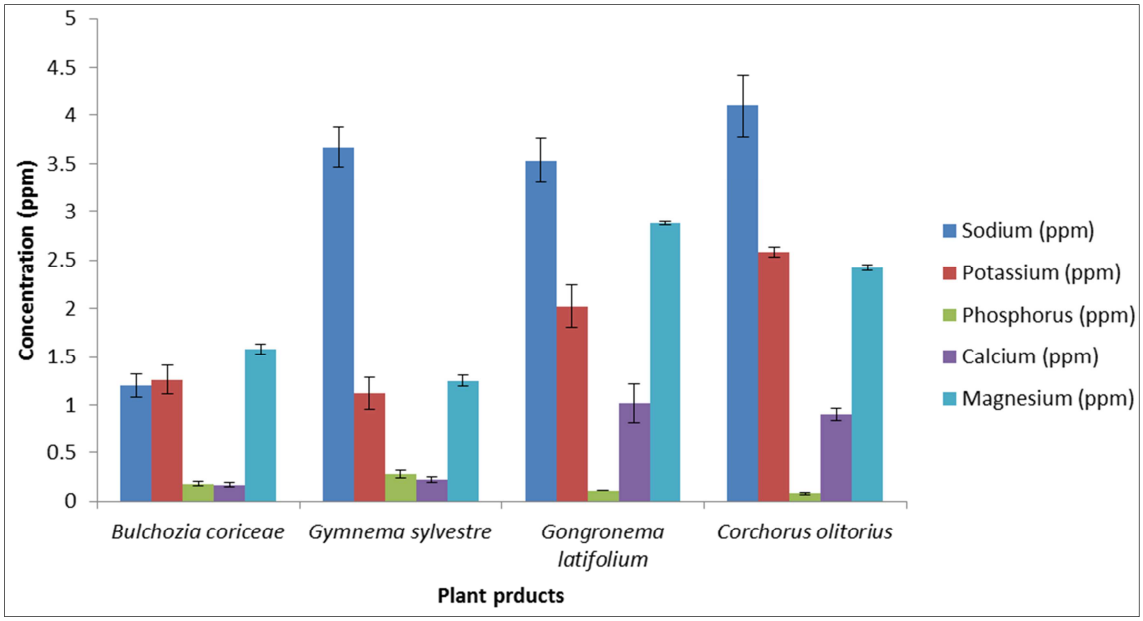

Fig. 2. *Mineral composition of plant products.*

Figure 2 shows the mineral content of the dried plant products. *C. olitorius* contained the highest concentrations of Na and K while *G. latifolium* contained Calcium and Magnesium in the highest amount. *G. sylvestre* had the highest quantity of phosphorus.

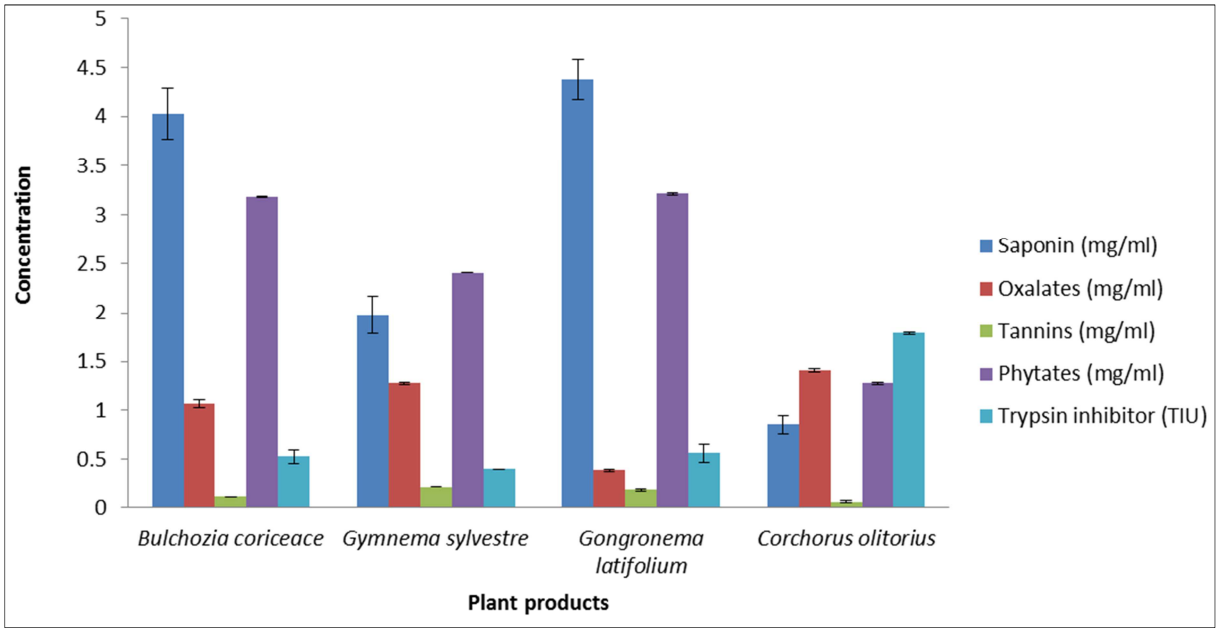

Fig. 3. *Antinutrient content of plant products.*

Figure 3 shows the antinutrient content of the dried plant products. *B. coriceae* and *G latifolium* were particularly rich in saponins (4.03% and 4.38% respectively) while *C. olitorius* contained significant amounts of oxalates (1.41%).

The effect of the plant product diets on blood glucose and electrolytes of experimental animals is shown in Table 2. There was a dose-dependent decrease in blood glucose concentration in all the groups of experimental animals. Blood sodium concentration decreased in a dose-dependent manner in all the experimental animals fed different diets. The *G. sylvestre* diets gave a dose-dependent reduction in blood potassium concentration while *B. coriceae* diet gave a dose-dependent increase. Blood phosphorus concentration was increased with increasing concentration of the *G. latifolium* diet.

Table 3. *Effect of dried plant Products on Blood glucose and Electrolytes of experimental Animals.*

Group	Blood glucose (mg/dl)	Sodium (mg/dl)	Potassium (mg/dl)	Phosphorus (mg/dl)
GL_1	124.32 ±7.54	151.44± 5.09	5.10± 0.02	2.85± 0.01
GL_2	119.28 ±2.75	152.31 ±2.92	4.78 ±0.43	3.10± 0.01
GL_3	115.50± 5.62	120.66 ±2.09	3.03± 0.02	3.96± 0.01
GL_4	100 48 ±4.83	96.16 ±2.98	2.23± 0.04	4.48 ±0.05
NC	142.16 ±9.81	230.03 ±4.07	4.15 ±0.04	1.93 ±0.06
PC	101.50 ±2.30	144.80 ±4.40	4.07± 0.09	3.03 ±0.01
GS_1	107.11 ±5.79	156.69 ±7.70	4.44± 0.12	2.84± 0.01
GS_2	101.52 ±7.77	149.59 ±4.77	4.83 ±0.18	3.11± 0.0
GS_3	98.61 ±7.55	145.34 ±9.26	4.64 ±0.24	3.38 ±0.06
GS_4	90.52 ±7.80	138.85 ±4.89	4.34± 0.19	3.11± 0.0
CO_1	109.87 ±3.46	157.02 ±3.60	3.26± 0.04	3.38± 0.06
CO_2	101.07 ±4.60	146.74 ±4.16	3.61± 0.04	2.68 ±0.0
CO_3	97.27 ±7.36	136.34 ±7.55	3.60± 0.08	2.92 ±0.01
CO_4	82.68 ±4.93	112.14± 4.76	4.59± 0.11	3.04± 0.01
BC_1	86.21 ±7.53	150.61± 2.49	3.83± 0.00	2.53± 0.02
BC_2	83.05 ±3.17	147.79± 3.64	4.04± 0.04	2.80± 0.0
BC_3	82.00± 4.33	144.66 ±3.88	4.27± 0.05	3.03± 0.05
BC_4	78.61± 2.45	133.20 ±2.69	4.97± 0.22	3.25 ±0.01
Normal range	65-100 mg/dl	135-155 mg/dl	3.4-5.3	2.7-4.5 mg/dl
$LSD_{0.05}$	16.55	13.98	0.43	0.42

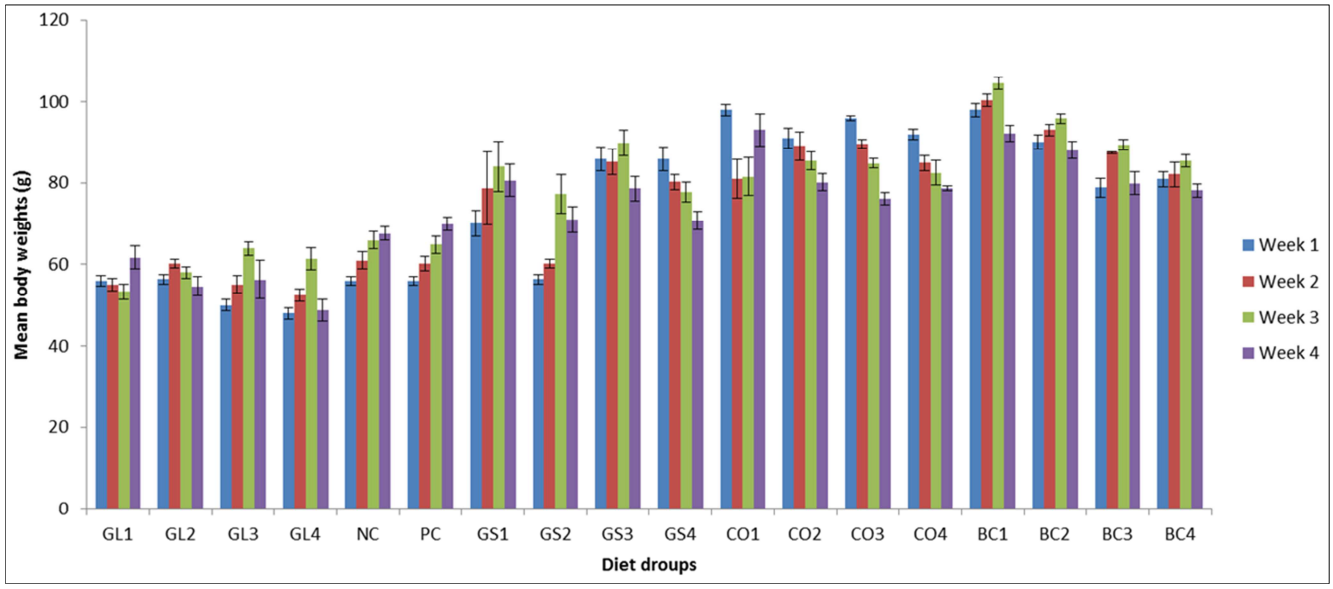

Fig. 4. *Mean body weights of experimental diets.*

Figure 4 shows the mean body weights of the experimental animals. Mean body weights of experimental animals decreased as the concentration of plant products increased. *G. latifolium* had the most significant effect in weight reduction when compared with the other plant products

4. Discussion

The high level of crude protein and ash content in *G. sylvestre* indicates that it could be a good source of cheap and affordable dietary proteins and minerals. Proteins are essential for the biosynthesis of vital body structural components such as antibodies, hormones and so on [27]. The low moisture content of all the plant products indicates that the samples are in a dry state.

Ingestion of foods rich in dietary fibre has been reported to modulate diabetes by reducing appetite and enhancing weight loss [28]. Post *et al.* [29] reported that foods rich in fibre are good modulators postprandial hyperglycaemia. High insoluble fibre diets have also been reported to reduce diabetes risks by enhancing insulin sensitivity [2]. The dietary fibre content of these plants could be responsible for their use in diabetic control in ethnomedicine.

Minerals play vital physiological roles in human nutrition [30]. Sodium is necessary for maintenance of acid-base balance, nerve and musces activity [31]. Potassium, phosphorus and calcium are needed for growth and development of bones and muscles, while magnesium aids calcium metabolism in bones [32]. The result indicates that *C. olitorius* is a good source of sodium and potassium.

Certain phytochemicals or antinutrients such as tannins, oxalates and phytates present in plant products limit bioavailability and minerals and proteins in diet [33]. They combine with minerals to form complexes. The levels of antinutrient in the plant products in this study is relatively low and can be eliminated by processing methods such as cooking [34].

The overall dose dependent reduction in blood glucose concentration in all the diet groups may be due to the presence phytochemicals such as tannins and saponins as well as dietary fibre that have been reported to exhibit hypoglycaemic effect [35]. Our finding also corroborates the work of Post *et al.* [29] who reported decrease in fasting blood glucose following high fibre diet. The result suggests that all the plants used in this study have good blood glucose lowering effect.

Decreased blood sodium and potassium concentration observed in all the *G. latifolium* levels of diet in contrast to the other plant diets has suggested its potent anti-diabetic activity. In diabetic conditions, the increased excretion of electrolytes and metabolites from the kidney alters the normal body homeostasis [36].

Mean body weights of the animals fed *G. sylvestre* diets was significantly increased compared to the other plants. This could be due to its ability to stimulate appetite in contrast to the other plant diets. Tanko *et al* [36] reported increase in mean body weights of experimental rats due to increase food intake.

5. Conclusion

All the plant products showed significant antihyperglycaemic effects. This may have been contributed by the fibre and mineral contents of the plants. Further research is needed to extract as well as characterize the bioactive ingredients of this plant for possible new drug formulation.

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