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Research Article

Comparative Effects of Ipomoea Batata Leaf Extract on Blood Sugar and Relative Body / Organ Weights in Diabetic Wistar Rats

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Abstract

Controversies exist on the changes in the body weight, relative to those of selected organs with administration of potato leaf (*Ipomoea Batata)* extract over a period of time. To this point, current study investigated the comparative effects of *Ipomoea Batata* consumption on the body and selected organ weights, relative to the body in wistar rats. Twenty five healthy Wistar rats weighting between 140-200g were procured from the animal unit of the Ambrose Alli University, Ekpoma, Edo State. The rats were then acclimatized for two (2) weeks and randomly grouped into five (5) groups [1, 2, 3, 4 and 5]; group 1 (Control) received standard rat diets ad *libitum*, whereas, experimental rats (groups 2 through 5) received 20mg/kg, 40mg/kg, 60mg/kg and 80mg/kg doses of *Ipomoea Batata* leaf extract; haven treated group 2 rats with alloxan monohydrate to induce diabetes mellitus (DM). After period of administration of test substances, the rats were weighed on weekly basis, sacrificed via cervical dislocation and selected visceral (Kidney, Liver, Ovary and Testes) harvested (weekly) to ascertain the effect of duration and dose changes on their body and relative organ weights. Fasting blood sugar levels were also obtained and compared between groups. Following statistical analysis (Using the one way analysis of variance – ANOVA and Student t-test), study found a significant difference ($p < 0.05$) in relative body weight among groups (control, high dose, medium dose and high dose) except in low dose groups. There was also a significant ($p < 0.05$) increase in relative liver and testicular weight for medium and high doses groups as compared to control. A statistically significant increase was also observed for blood sugar levels across groups upon comparison with control. This proved however insignificant for low dose treated group. Thus, consumption of *Ipomoea Batata* leaf extract caused a dose and/or duration dependent effect on body and relative organ weights in wistar rats. Further studies aimed at corroborating the findings from this work are recommended.

Keywords: Body weight; Ipomoea Batata; Organ weights; Wistar

Introduction

Native to tropical regions of America, Sweet potato *(Ipomoea Batatas*) is an important food crop that is cultivated in over 100 countries across the globe it is primarily produced in commercial quantities by China, Indonesia, Vietnam, Japan, India, Tanzania and Uganda [1,2]. Limpopo, Mpumalanga (Nelspruit), KwaZulu-Natal and Western Cape provinces are the major production areas in South Africa. Sweet potato is mainly grown in developing countries which account for a 95% of the global output. China accounts for about 65% of the world's sweet potato. In most parts of Africa, production of sweet potato is often done on a small or subsistence level. Nonetheless, there are high productions in Lake Victoria area in East Africa (Rwanda, Uganda, Burundi and Congo), Nigeria, Ghana and Madagascar [3].

In Nigeria, *Ipomoea batatas* (sweet potato) leaf is widely used by local communities as medicinal plant. Sweet potato belongs to the Domain: Eukarya Kingdom: Plantae; Phylum: Magnoliophyta; Class: Eudicotyledons; Order: Solanales; Family: Convolvulaceae; Genus: Ipomoea; and Species: Ipomoea batatas. Sweet potato leaves are cooked as a vegetable in many parts of the world. They are rich in vitamin B, carotene, iron, calcium, zinc and protein, and the crop is more tolerant of diseases, pests and high moisture than many other leafy vegetables grown in the tropics and because sweet potato tops can be harvested several times a year, their annual yield is much higher than many other green vegetables [4].

Taxonomically, *I. batata* belongs to the morning glory family, *Convolvulaceae,* and the only member of the genus *Ipomoea* whose roots are edible. It is speculated to be a native of South America but presently grown throughout the tropical and subtropical regions of the world [5]. It forms a great part of the food of most people in developed countries, and is currently the sixth most important food crop of the world with an annual production of about 126.19 million tons from 9.26 million hectares. Several reports have shown its phytochemicals to possess multifaceted actions, including anti-oxidant, anti-mutagenic, anti-inflammatory, antimicrobial and anti-carcinogenesis and thus are important for several health-promoting functions in humans [6]. It is reported to be rich in carbohydrates, cellulose and beta carotene (an active ingredient of vitamin A). *Ipomoea batatas* is also a great source of vitamins B6 and C with numerous mineral nutrients like Zn^{2+}, K^{+}, Na^{+}, Mg^{2+}, Ca^{2+} and Fe^{2+}.

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Phytochemicals such as flavonoids and related phenolic compounds which are generally present in sweet potatoes have been reported to have multiple biological effects, such as antioxidant activity. Purple-fleshed variety has been reported to contain anthocyanins, which possess antioxidant activity. Antioxidants act as scavengers of free radicals reactive oxygen species inside the cell. Many evidences suggest that degenerative diseases such as cancer, asthma, diabetes, senile dementia and eye disease have their origin in deleterious free radical reactions [7,8].

Sweet potatoes are rich in complex carbohydrates, dietary fiber and beta carotene (a precursor of vitamin A), vitamin B6, and vitamin C. In addition to this, various parts of the crop have been reported to also contain mineral nutrients such as zinc, potassium, sodium, manganese, calcium, magnesium and iron [9]. According to Food and Agricultural Organisation (FAO), sweet potato leaves and shoots are good sources of vitamins A, C and B2 (riboflavin) and lutein. Orange sweet potato varieties have higher beta carotene content than those with light colored flesh and their increased cultivation is being encouraged in Africa where Vitamin A deficiency is a challenging health issue. On the other hand, purple-fleshed sweet potato has been reported to contain anthocyanins, which possess antioxidant activities. Although the protein content of sweet potato is low (~2%) as in most tropical root and tuber crops, sweet potato still contains more protein than cassava and plantain [10,11]. The leaves have relatively high protein content (25-30% of dry matter) compared to other leafy vegetables. The leaves also have higher levels of polyphenols than any other commercial vegetables. Polyphenols have a strong role in the prevention of degenerative diseases especially cancer and cardiovascular diseases through their antioxidant activities [12,13]. The aim of this study was to investigate the comparative effects of aqueous extract of *I. Batata* leaf on the body and relative organ weights of wistar rats. Specifically, study;

i. Examined the effect of *I. Batata* extract on body weights
ii. Determined the effect of administration of *I. Batata* extract on the Liver, Testicular, Ovary and Kidney weights
iii. Determined the effect of administration of *I. Batata* extract on selected organ weights of diabetic rats

Material and Methods

Study location

The study was carried out in Pharmacology department of the faculty of clinical sciences, Delta State University, Abraka, Delta State.

Study design

A total of twenty five wistar rats of approximately the same age and an average body weight of between 140 -250g were purchased from the animal unit of the Ambrose Alli University, Ekpoma, Edo State, Nigeria. The rats were then acclimatized for two (2) weeks and randomly grouped into five (5) [Groups 1, 2, 3, 4 and 5]; group1 (Control) received standard rat diets ad *libitum*, whereas, experimental rats (groups 2 through 5) received 20mg/kg, 40mg/kg, 60mg/kg and 80mg/kg doses of *Ipomoea Batata* leaf extract. After period of administration of test substances, the rats were weighed on weekly basis, sacrificed via cervical dislocation and selected visceral (Kidney, Liver, Ovary and Testes) harvested (weekly) to ascertain the effect of duration and dose changes on their body and relative organ weights.

Procurement, preparation and identification of plant

Before experiment proper, sweet potato (*Ipomoea batatas*) leaf extract was obtained from local farms within Abraka. The leaf was then taken to the Department of Botany for identification by experts. Next, leaf was macerated and made into extract through sun-drying, crushing (in pestle and mortar) and dissolution in distilled water.

Preparation of stock solutions of *Ipomoea Batata e*xtract

After weighing 2g of *Ipomoea Batata* with electronic balance, the substance was then homogenized in pestle and mortar using 10ml of distilled water and then filtered with Wattmann filter paper in accordance with the methods stipulated by Okonkwo *et al*., (2009) [13]. This gave a 200mg/ml stock solution.

Administration of *Ipomoea batatas* Solution

Graded doses of *I. batatas* [high, medium, low and very low] were estimated from previously established lethal dose (192mg/kg). About 1.6g, 1.2g and 0.8g and 0.4g were dissolved in 200ml of distilled water making the aforementioned stock solutions respectively. The body weights of the animals were then taken and the dose of test drugs in millilitre to be administered was calculated.

Inducing Diabetes Mellitus (DM)

After the two (2) weeks of acclimatization, Alloxan monohydrate was used to induce type I diabetes mellitus in experimental animals. Intraperitoneal administration of 100mg/kg body weight of Alloxan monohydrate was administered once. A mild pressure was then applied at the spot of injection to enhance absorption. After 3 days of administration animals' fasting blood glucose levels were checked, using the glucose monitoring device (Acu-check) [10].

Sample collection

At the end of experimental administrations, the wistar rats were anesthetized in a desiccator containing cotton wool soaked with chloroform. After they had attained deep anesthesia, they were brought out of the desiccator and a laparotomy was carried out (by making a V-shape incision in the abdominal region with the aid of a surgical scissors) and the visceral organs [Liver, Kidney, Ovary and Testes] were then exposed and harvested and weighed from each group.

Ethical clearance

Animal handling was performed with regard to CPCSEA guidelines, and the University's research ethics. Procedures were performed in strict accordance with the recommendations in the guide for the care and use of laboratory animals of the Delta State University Animal Ethical Committee and the protocols were appropriately approved. Study was also conducted in accordance with the Current Animal Care Regulations and Standards approved by the Institute for Laboratory Animal Research [11].

Statistical analyses of data

Results from study were presented as mean ± Standard Deviation (SD). Using the one way analysis of variance (ANOVA), Average values of obtained data were statistically compared. Here, p-values < 0.05 was considered to be statistically significant.

Discussion

This study explored sweep potato leaf consumption in human health. Firstly, the study investigated whether the leaf extract can modulate the changes of weight on human health. Secondly, whether it can affect reproductive outcome via possible changes on selected organs (ovary and testes) of the reproductive system.

Findings from this study demonstrated that consumption of *I. Batata* leaf extract (aqueous) may have the potentials of decreasing body weight (Table 1). From our result, there was no significant change in weight ($p < 0.05$), showing that the weight decrease due to treatment must have been counterbalanced by weight gain due to growth and adequate feeding over the duration of experiment. This closely agrees with Okonkwo *et al.,* (2009) that reported a reduction in body weight and also with Osime *et al.,* (2008) that reported an increase in body weight that is inversely associated with weight gain [14,15]. More so this agreed with Montejo *et al*., 2015 who opined that the significant loss in body weight could be attributed to the diuretic effect of *I. Batata* and its role in enhancing fat metabolism [16]. The findings observed from this study may indicate that the effect of *I. Batata* could be due to presence of osmotically active ingredients as reported by Kennedy and Burlingame (2003) [17]. Overtime, sweet potato herbal extracts have been suggested to be potent in blood glucose lowering [10]. In some animal and human studies, different forms of sweet potato have been reportedly helps to maintain blood sugar levels and lowering insulin resistance. For instance, 'Caiapo', a dietary supplement and a crude extract of white skinned sweet potato has been sold and consumed for a long time in Japan as a remedy for diabetes. 'White star', a sweet potato cultivar; indigenous to Pakistan and 'Beauregard' is also known to lower glucose blood level in diabetic humans [11]. Again from this study, a blood glucose lowering effect of sweet potato may have significantly caused an increase in body weights of wistar rats with duration across groups (with the exception of group III) when compared with control. In humans, available reports have shown that subjects with poorly-regulated insulin metabolism and insulin insensitivity resulting to DM have lower body weights, and individuals with healthier insulin metabolism tend to have higher weights on the average. Generally, results from current study re-enforces available literatures on the anti-diabetic property of sweet potato as seen in the result of table 2. Contrary to result of this study however, Zhao *et al* had isolated flavone from the leaves of sweet potato and evaluated its effects on different markers of diabetes; there, they reported a statistically significant decrease in the fasting plasma insulin and blood glucose level and significant increase in the insulin sensitive index in non-insulin dependent diabetic rats [12,13].

	Body Weights (g)				Remark
Groups	IBW (g)	Week 1 (g)	Week 2 (g)	ANOVA (p-value)	
1	160 ± 8.09	130 ± 4.37	120 ± 2.83	0.01363	Significant
2 (Diabetic)	160 ± 8.09	120 ± 2.83	130 ± 4.37	0.01363	Significant
3	130 ± 4.37	125 ± 3.96	126 ± 2.36	0.34384	Insignificant
4	110 ± 2.29	125 ± 3.96	130 ± 4.37	0.04942	Significant
5	120 ± 2.83	140 ± 7.39	135 ± 5.56	0.03842	Significant
ANOVA	0.00013*	0.00293*	0.00316*		

Table 1: Comparative Effect of Extract on average Body Weights of Wistar Rats.

*= statistically significant at p-value < 0.05, IBW = Initial Body Weight. Result is presented as Mean ± Standard Deviation.

	Body Weights (g)	Remarks			
Groups	Male	Female	t-Cal	t-test (p-value)	
1	136	92	-1.383	0.00234	Significant
2 (Diabetic)	136	123	-2.463	0.00373	Significant
3	127	128	2.233	0.10336	Insignificant
4	122	133	1.393	0.00332	Significant
5	132	125	1.452	0.06273	Insignificant
ANOVA	0.30393#	0.00284*			

Table 2: Comparative Effect of extract on body weights changes of male and female rats.

* = statistically significant at p-value < 0.05, # = statistically insignificant at p-value > 0.05.

Results from this study also show a decrease in the relative weight of testes for low, medium and high doses (Tables 2-4). There was significant reduction in the relative weight of testes of both low and medium dose when compared to control. The finding suggests that coffee decreases testicular weight from this work. This is in agreement with Legua *et al*., (2012) work on heterogeneous pattern of spermatogenic impairment who worked on stereological analysis of human testes; stating that coffee decreases testicular weight. This could be as a result of the reduction of the sizes of the seminiferous tubules. A decrease in testicular weight is a biomarker of damages to the reproductive organs. More also, results seen in table 5 shows significant ($p < 0.05$) reduction in relative testes weight of medium dose and low dose groups when compared to control. Relative testes weight of medium dose was significantly ($p < 0.05$) lower than that of high dose. This is in agreement with Legua et al., (2012) that *I. Batata* decreases testicular weight. A decrease in testicular weight is a biomarker of damage to the reproductive organs [18].

Groups	Male	Female
1 (Control)	0.59	0.02
2 (Diabetic)	0.61	0.05
3	0.62	0.03
4	0.66	0.03
5	0.62	0.02

Table 3: Comparative effect of extract on kidney weights (g) of male and female rats.

Groups	Male	Female
1 (Control)	3.17	0.13
2 (Diabetic)	3.23	0.08
3	3.63	0.14
4	3.82	0.14
5	3.62	0.08

Table 4: Comparative effect of extract on liver weights (g) of male and female rats.

Also, the extraction of *Ipomoea Batata* leaf is thought to be more beneficial than usually prepared sweet potato because its mode of extraction retains more biologically active components such as alpha tocopherol (Vitamin E) and polyphenols. For the effect of *Ipomoea*

Batata extract treatment on body weight (g) of Wister rats, Result shows a significant loss in body weight (g) for all experimental groups when compared with control. This implies that treatment with *Ipomoea Batata* at all doses with Vitamin E and separately does not improve body weight (g) in alloxan induced diabetes.

Groups	Testes	Ovary
1 (Control)	1.28	0.1
2 (Diabetic)	1	0.09
3	1.08	0.08
4	0.96	0.02
5	0.72	0.02

Table 5: Comparative effect of extract on testicular and ovarian weights (g) of male and female rats.

Conclusion

From this study, treatment with *Ipomea batata* extract showed a dose-dependent effect on most parameters measured, with more significant outcomes in higher than lower doses over a period of time. It is also noticed that *I. Batata* posed a significant increase on body and relative organ weights in a dose dependent and duration dependent fashion. These discoveries were orchestrated by a cascade of events within various mechanisms germane to physiological outcome. These effects on weight changes are possibly achieved via multiple reversal effects sufficient enough to counter balance complications in reproductive system of experimental animals.

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