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Evaluation of the Effect of *Albizia zygia* (Stem Bark and Leaf) Extracts on the Glycemic Index of Rice

Oko Augustine Okpani

Department of Biotechnology, Ebonyi State University, Abakaliki, Nigeria

Abstract: The problem high glycemic index of rice as food is a major problem that both diabetics and healthy individuals who prefer rice for their diet stand to contend. In this research, the effect of *A. zygia* (Stem Bark and Leaf) extracts on the Glycemic Index of rice was evaluated in albino rats.Five groups of 5 rats each were used and were treated with glucose solution according to body weight on the first day of the experiment after acclimatization, having been made to fast for 12 hours. In the subsequent *A. zygia* was administered to the rats in different ways and forms to the different groups. The methanolic extract and aqueous extract demonstrated significant decreases ($P<0.05$) in glycemic indices at varied formats (either cooked with rice or as water). The decrease in glycemic level was progressive giving the highest mean value of 77.25% and lowest of 35.5% effect after 2 hours of *Albizia zygia* therapy. A dosage of 200 mg/kg of methanolic extract (Leaf) as water, gave the highest effects after the 2 h. The aqueous extract (Stem bark) reduced the glycemic index, although the reduction was not significant. The phytochemical screening of the methanol extract of the stem bark confirms the presence of alkaloid, tannin, saponin, flavonoid, terpinoid, cardiac glycoside, carbohydrate and reducing sugar, while some components were absent in some of the crude extracts. It could be inferred therefore, that crude extracts of *A. zygia* lowers the glycemic index of high glycemic index foods.

Key words: Glycemic Index · *A. zygia* · Stem Back · Leaves · Rice

INTRODUCTION

It has been known that both the amount of carbohydrates consumed and its source have different effects on postprandial blood glucose and insulin responses in healthy and diabetic subjects depending on the rate of digestion [1] and the rate at which food is passed through the digestive tract or may be slowing the rate of nutrient absorption following ingestion of the diet [2]. Recently, Bjorck and Liljeberg [3] stated that the source (Type) of carbohydrate is of potential determinant of postprandial glucose and insulin responses which is associated with the treatment of diabetes. The extent and duration of the blood glucose response depend on the rate of absorption, which in turn depends on factors such as gastric emptying as well as the rate of hydrolysis and diffusion of nutrients in the gut (FAO/WHO report, 1997). Nowadays, the effect of carbohydrates on blood responses is indicated by a parameter called Glycemic Index (GI).

The Glycemic index is a physiologically based measure of the effects of carbohydrates on blood glucose levels. It is a parameter of the blood glucose change after eating a certain food compared to the change after eating a similar amount of glucose [4, 5]. In human, lower Glycemic index diets reduced both fasting blood glucose and glycated proteins independently of variance in available and unavailable carbohydrate intakes [6]. Furthermore, low-Glycemic index diet, which is high in dairy and fruit but low in potatoes and cereals, is associated with improved insulin sensitivity and lipid metabolism and reduced chronic inflammation [7]. Although, the Glycemic index is a useful tool for classifying the impact of carbohydrates on the body, however it is not useful to get accredited on the Glycemic index values of individual foods, as the overall impact of a meal on Glycemic index is difficult to predict [8]. As far as eating is concerned, the best way to maintain optimal control over the blood glucose is to choose dietary carbohydrates with a lower Glycemic index value and this may be accomplished by mixing the foods to make a new meal [9].

[10] found that the Glycemic index concept applies well to mixed meals containing fat and protein. In order to lower the carbohydrates load of the diets, it is better to raise Intake of low Glycemic index foods such as legumes,

Corresponding Author: Oko Augustine Okpani, Department of Biotechnology, Ebonyi State University, Abakaliki, Nigeria

whole cereals, fruits and vegetables or may be by substituting high Glycemic index foods for lower Glycemic index alternatives. However, the goal is not to eat low glycemic index carbohydrate at the prevention of diabetes, in which people try to include one low glycemic carbohydrate, in combination with some vegetables of choice per meal or to base at least two of their meals each day on low glycemic index of choices [11].

A. zygia also known in English as West African *Albizia* is indigenous to and widespread in, tropical Africa, occurring from Senegal in the west to Kenya in the east and northern Angola and Tanzania in the south. Known locally as *Nyieavu* by the Igbos of Southeast and *Ayinrela*by the Yoruba of Southwest Nigeria, the plant has found wide usage in traditional medicine. The bark sap is instilled in the eyes to treat ophthalmia while the bark decoction is administered to treat bronchial diseases, fever, female sterility and as a purgative, stomachic, antidote, vermifuge and aphrodisiac. Pounded or rasped bark is applied externally to treat yaws, sores, wounds and toothache. Ground roots are added to food to treat cough and as an expectorant. Leaf decoctions are used to treat pain, fever and diarrhea [12]. This study was aimed at evaluating the effectiveness of crude extracts of *A. zygia* to lower the glycemic index of foods (Rice).

MATERIALS AND METHODS

Collection of Plant Material: Fresh stem bark and leaves of *A. zygia* was collected and identified at the Department of Applied Biology, Ebonyi State University, Abakaliki. The Fresh Stem bark and leaf where dried under shade and was milled into coarse powder using a locally fabricated milling machine.

Experimental Animals: Male and female albino rats (100-130) g were used for the study. The rats were purchased from the animal house of the Department of Pharmacology and Toxicology University of Nigeria, Nsukka.

Extraction and Fractionation: About 2 kg of the powder was extracted with 5 L of methanol by cold maceration for 48 hours and filtered. The filtrate was dried in rotatory evaporator to obtain the methanol extract (200 g).

Phytochemical Analysis: The whole methanolic extract and the individual solvent fractions were subjected to phytochemical investigation. The tests carried out were to confirm the presence or absence of alkaloids, saponins flavonoids, tannins, glycosides, resins, triterpenes, steroids, carbohydrates, fats and oil, reducing sugars and acidic compounds.

Experimental Design: Effect of Extract of *A. zygia* on glycemic index mean of fasting blood glucose of rats for 3 days.

Five groups of 5 rats per group were used and were treated with glucose solution according ting to body weight on the first day of the experiment after acclimatization having been made to fast for 12 hours. However, in the subsequent days the rats were treated as follows having been made to fast for 12 hours;

Group 1 received 200 mg/kg of Methanol extract of *A. zygia* (Stem bark) cooked with rice.
Group 2 received 200 mg/kg of Methanol extract of *A. zygia* (Stem bark) as water with rice.
Group 3 received 200 mg/kg of Methanol extract of *A. zygia* (Leaf) as water with rice, Group 4 received 200 mg/kg of Methanol extract of *A. zygia* (Leaf) cooked with rice, Group 5 received 200 mg/kg of Aqueous extract of *A. zygia* (Stem bark) cooked with rice.
Group 6 received 200 mg/kg of aqueous extract of *A. zygia* (Leaf) cooked with rice.

Blood samples were collected from the animal tail vein on the early hours of the day and blood samples are taken on the 0, 30, 60, 90 and 120 mins for each group and the area under the curve calculated. The value for each of the group on daily basis was dived by the standard (Glucose). The average of the values multiplied 100 gave the glycemic index.

Statistical Analysis: Results were given as mean SEM (Standard error of mean). A one-way ANOVA with post hoc LSD multiple comparison tests and Duncan test. P values of 0.05 and less were taken to imply statistical significance between the means. Analysis was done using statistical package for social sciences (SPSS) version 23.

RESULTS

Phytochemical Constituents of *Albizia zygia*: The phytochemical screening of the methanol extract of the stem bark confirms the presence of alkaloid, tannin, saponin, flavonoid, terpinoid, cardiac glycoside, carbohydrate and reducing sugar. Tannin and reducing sugar were absent in the methanol extract of leaf. Aqueous leaf fractions lack alkaloid, flavonoid and saponin while saponin, terpenoid, tannin and flavonoid were not detectable in the aqueous stem bark fraction.

Table 1: Quantitative Phytochemical Analysis of *A. zygia*

Unit of measurements	Methanol leaf extract	Methanol stem extract	Aqueous leaf extract	Aqueous stem
Tannin	---	0.57±0.006[a]	0.613±0.01[b]	----
Flavonoid	1.37±0.006[a]	1.17±0.009[b]	---	
carbohydrate	18.31±0.01[a]	13.4±0.0[b]	13.53±0.1[c]	16.73±0.08[d]
Glycoside	0.023±0.009[a]	0.032±0.007[b]	0.38±0.0[c]	0.111±0.008[d]
Saponin	0.15±0.009[a]	0.22±0.004[b]	---	-----
Terpenoid	0.35±0.009[a]	0.43±0.006[b]	0.029±0.005[c]	-----
R. sugar	---	2.88±0.1[a]	0.78±0.1[b]	3.24±0.002[c]

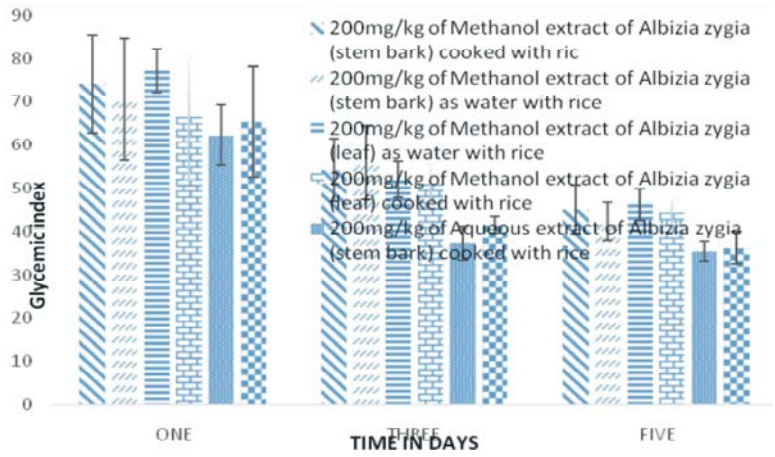

Fig. 1: Bar Chat of Mean Glycemic Index

Results of Glycemic Index in Food Screening: After 7 days' treatment, the Methanol and Aqueous extract of *A. zygia* cooked with rice caused a significant (P<0.05) decrease in the glycemic index level of the rice when compared to the untreated control group. Figure 2.3 shows the effect of the extract on diabetic rats.

The methanol leaf and aqueous stem bark and leaf fraction reduced the glycemic index of the food when given as water to the rice, when compare with control.

DISCUSSION

The GI is defined as the incremental blood glucose area following the test food, expressed as the percentage of the corresponding area following a carbohydrate equivalent load of a reference product. GI ranges from less than 20 to approximately 120 percent (Initially, the reference food was glucose) according to [13]. Carbohydrates that broke down quickly during digestion, releasing glucose quickly into the blood have the high GI. Carbohydrates that broke down slowly, releasing glucose gradually into the blood have low GI. Foods with high GI are rapidly digested, absorbed and result is marked fluctuation in blood sugar level [14].

According to John and Vladimir [15] plants are well known in traditional herbal medicine for their hypoglycemic activities and there are more than 800 plant species showing hypoglycemic activity. This study investigated the hypoglycemic activity of *A. zygia* leaves and stem bark extracts and fractions used as food. The significant decrease in the glycemic index of the groups; group 1 which received 200mg/kg of methanol extract of *A. zygia* (Stem bark) cooked with rice, group 2 which received 200 mg/kg of methanol extract of *A. zygia* (Stem bark) as water with rice, group 3 received 200mg/kg of methanol extract of *A. zygia* (Leaf) as water with rice, group 4 which received 200mg/kg of methanol extract of *A. zygia* (Leaf) cooked with rice, group 5 which received 200mg/kg of aqueous extract of *A. zygia* (Stem bark) cooked with rice and group 6 which received 200mg/kg of aqueous extract of *A. zygia* (Leaf) cooked with rice when compared to other groups (In days) suggests that the extract *A. zygia* has effect in the progressive decrease of the blood glucose level, which could be due to the delayed absorption of the glucose from the gastrointestinal tract caused by the extract as suggested by [16].

The *A. zygia* at 200 mg/kg was found to further reduce blood glucose level significantly (P<0.05) indicating that *A. zygia* at 200 mg/kg, may possess possible hypoglycemic activity. These results may identify the concentration 200 mg/kg as effective and optimum concentration for the study of severely hyperglycemic models in rats.

Also, the result of the glycemic index shown on Figure 1 shows there were significant differences (P<0.05) of the groups with the extract as the days progresses. The decrease in glycemic index level shown in Figure 1 shows the blood glucose progression giving the highest mean value 77.25% and lowest of 35.5% effect after 2 hours of *A. zygia* therapy. The result obtained on Day 1, group 5 shows that there were a significant difference (P<0.05) of the group fed with 200 mg/kg of aqueous extract of *A. zygia* (Stem bark) cooked with rice was significant with group 3 fed with 200 mg/kg of methanol extract of *A. zygia* (Leaf) cooked with rice was significant at (0.077) this was in correlation to what Wolever and Jenkins discovered in their publication in (2001) on Glycemic index finding where they discovered similar results while working with bread. Although there were no significant differences (P<0.05) when compared with other groups of the same day. Day 3 which is the second day shows there were significant decrease (P<0.05) between group one fed with 200 mg/kg of methanol extract of *A. zygia* (Stem bark) cooked with rice was significant at (0.000), group 2 fed with 200mg/kg of methanol extract of *A. zygia* (Stem bark) as water with rice was significant at (0.000), group 3 fed with 200 mg/kg of methanol extract of *A. zygia* (Leaf) as water with rice was significant at (0.001) and group 4 fed with 200 mg/kg of methanol extract of *A. zygia* (Leaf) cooked with rice was significant at (0.003). Although there were no significant difference (P<0.05) when compared to that of group 6 fed with 200 mg/kg of aqueous extract of *A. zygia* (Leaf) cooked with rice. Day 5 which is the third day shows there were significant difference (P<0.05) between group 5 of day 5 with group 1 fed with 200 mg/kg of methanol extract of *A. zygia* (Stem bark) cooked with rice was significant at (0.03), group 2 fed with 200 mg/kg of methanol extract of *A. zygia* (Stem bark) as water with rice was significant at (0.027), Group 3 fed with 200 mg/kg of methanol extract of *A. zygia* (Leaf) as water with rice was significant at (0.001) and group 4 fed with 200 mg/kg of methanol extract of *A. zygia* (Leaf) cooked with rice was significant at (0.005). Although there was no significant difference (P<0.05) when compared to that of group 6 fed with 200 mg/kg of aqueous extract of *A. zygia* (Leaf) cooked with rice. However, the significant differences and the progressive reduction in the glycemic index shown on Figure 1 corroborate with the work of Maries and Farnsworth [17] and WHO publication on anti-diabetic drug and food on (2015).

Although the exact mechanism of action of the extract is unknown, the effect of the extracts can be related to the rate at which glucose is absorbed from the small intestine. A reduced rate of glucose absorption can be caused by the extracts phytochemicals after the consumption of the foods which will reduce the postprandial rise in gut hormones (e.g. incretions) and insulin. The prolonged absorption of this carbohydrate rich food seen over time will maintain suppression of the free fatty acids (FFA) and the counter regulatory responses, while at the same time achieving lower glycemic concentration [18]. Over time, with the reduction in FFA concentrations and the rise in the respiratory quotient with tissue insulinization, glucose is withdrawn from the circulation at the faster rate. Consequently, glycemic concentration returns toward baseline despite continued glucose absorption from small intestine. The rise in peak postprandial blood glucose is therefore reduced together with the incremental glycemic area above baseline [19].

Sherma *et al*. [20] stated that a wide range of phytochemicals have been found to slow down the hydrolysis of starch to oligosaccharides thereby retarding the glucose absorption in the small intestine. The result of the phytochemical screening of the extract and fractions was in agreement with the work of [21] [22] which stated that flavonoids, saponin and terpenoids present in the plant extract is known to possess anti-diabetic activity. [23] reported the health beneficial properties of medicinal plant extracts are due to secondary metabolites such as phenolics, flavonoids, glycosides, alkaloids, tannins, saponins, etc., present in them. These bio-components are known for their versatile biological effects and are implicated in treatment of variety of diseases. Saponins are reported to enhance glucose utilization by regulating glucagon [24] and insulin secretion thus implicating its role in hypoglycemic action in medicinal plants [4].

Flavonoids may improve altered glucose and oxidative metabolisms of diabetic states as suggested byFreeman and Lyons [8] stated that the two active compounds, namely, (-)-3-O-galloylepicatechin and (-)-3-Ogalloylcatechin, a sub-class of flavonoid demonstrated significant dose dependent enzyme inhibitory activities against rat intestinal-glucosidase which in turn increase the secretion of insulin when the blood glucose level is high to maintain the glycemic index. One way of controlling the glycemic index is by regulating some carbohydrate metabolizing enzymes like α-amylase and α-glucosidase. α-amylase enzymes primarily act on starch molecules and hydrolyze them to oligosaccharides like maltose while α-glucosidase are responsible for absorption of glucose in the intestine. Delayed hydrolysis of carbohydrate in the early stages of metabolism and retarded absorption of glucose into the blood by the

intestine, has been a strategy to manage PPHG which might be the reason of the significant decrease in the glycemic index shown on Fig. 1.

From the results, it could be inferred that crude extract of *A. zygia* can be a good candidate for curtailing the high glycemic index of rice and other foods with similar characteristics.

REFERENCES

1. Bailey, C.J. and C. Day, 1989. Traditional plant medicines as treatments for diabetes. Diabetes Care, 12: 553-564.
2. Batista, S.M. and E. Teixeira, 2008. Food glycemic index, satiety and chronic diseases, British Food Journal, 110(10): 965-976.
3. Bjorck, I. and H. Liljeberg, 2003. The glycemic index: importance of dietary fibre and other food properties, Proceedings of the Nutrition Society, 62: 201-206.
4. Brand-Miller, J., 2012. Diets with a low Glycemic Index: From theory to practice. Nutrition today march 1999. Designed for Health, Essential Nutrition Information.
5. Burkill, H.M., 2014. The Useful Plants of West Tropical Africa. 2nd Edition. Families J-L. Royal Botanic Gardens, Kew, Richmond, United Kingdom, 3: 857.
6. Coutinho, M., H.C. Gerstein, Y. Wang and S. Yusef, 2007. The relationship between glucose and incident cardiovascular events. A meta regression analysis of published data from 20 studies of 95, 783 individuals followed for 12.4 years. Diabetes Care, 22: 233-240.
7. FAO/WHO, 1997. Food and Agriculture Organization. Carbohydrate in human nutrition. FAO Food and Nutrition Paper – 66. Report of a joint FAO/WHO Expert Consultation, Rome, pp: 14-18.
8. Freeman, J. and L. Lyons, 2008. The use of continuous glucose monitoring to evaluate the glycemic response to food. Diabetes Spectrum, 21(1): 134-137.
9. Jenkins, D.J., T.M. Wolever, R.H. Taylor, H. Barker, H. Fielden, J.M. Baldwin, A.C. Bowling, H.C. Newman and A.L. Jenkins, 2007. Glycemic index of foods: a physiological basis for carbohydrate exchange. American Journal of Clinical Nutrition, 34: 362-366.
10. Jenkins, D.J., W.C. Kendall, S.A. Augustin, S. Franceschi, M. Hamidi, A. Marchie, A.L. Jenkins and M. Axelsen, 2008. Glycemic index: overview of implications in health and disease. American Journal of Clinical Nutrition, 76: 266-273.
11. Jenkins, J.A., M.S. Wolever and R.H. Taylor, 1981. Glycemic Index of food a physiological basis for carbohydrate exchange. American Journal of Clinical Nutrition, 34: 362- 366.
12. Jenkins, D.J. and W.C. Kendal, 2005. Glycemic index: over view of implications in health and disease, American Journal of Clinical Nutrition, 76: 266-273.
13. Jenkins, J.A., M.S. Wolever, R.H. Taylor, H. Ghafari, A. L. Jenkins, H. Barker and J.A. Jenkins, 1980a. Rate of digestion of foods and postprandial glycaemia in normal and diabetic subjects. British Medical Journal, 2: 14-17.
14. Jenkins, J.A., M.S. Wolever, R.H. Taylor, H.M. Barker, H. Fielden, J.M. Baldwin, A.C. Bowling, H.C. Newman, A.L. Jenkins and D.V. Goff, 1981a. Glycemic index of foods: a physiological basis for carbohydrate exchange. American Journal of Clinical Nutrition, 34: 362-366.
15. John, L.S. and V. Vladimir, 2013. Glycemic Index in the treatment of diabetes. Journal of American College of Nutrition, 23: 1-4.
16. Liljeberg, H. and I. Bjorck, 2010. Delayed gastric emptying rate may explain improved glycaemia in healthy subjects to a starchy meal with added vinegar. European Journal of Clinical Nutrition, 52: 368-371.
17. Maries, R.J. and N.R. Farnsworth, 2006. Antidiabetic plants and their active constituents. Phytomedicine, 2: 137-189.
18. Park, H.J., D.H. Kim, J.W. Choi, J.H. Park and N.A. Han, 1998. Potent antidiabetic agent from Kalopanaxpictus. Archives of Pharmacal Research, 21: 24-29.
19. Rajapogal, K. and S. Sasikala, 2008. Anti-hyperglycemic and antihyperlipidaemic effects of Nymphaca stellate in alloxan induced diabetic rats. Singapore Medical Journal, 49: 137-141.
20. Sherma, R.D., D.K. Sarkhar and M.B. Hazra, 2010. Toxicological evaluation of fenugreek seeds: a long term feeding experiment in diabetic patients. Phytotherapy Research, 10: 519-520.
21. Sikarwar, M.S. and M.B. Patil, 2010. Antidiabetic activity of Cratevanurvalastem bark extracts in alloxan-induced diabetic rats. Journal of Pharmaceutical and Bio resource Science, 2: 18-21.
22. Sundaram, R., R. Naresh, P. Shanthi and P. Sachdanandam, 2012. Antihyperglycemic effect of iridoid glucoside, isolated from the leaves of *Vitexnegundo*in streptozotocin-induced diabetic rats with special reference to glycoprotein components. Phytomedicine, 19(3-4): 211-216.

23. Tembhurne, S.V. and D.M. Sakarkar, 2010. Protective effect of *Murrayakoenigii* (L) leaves extract in streptozotocin induced diabeticsrats involving possible antioxidant mechanism. Journal of Medicinal Plants Research, 4(22): 2418-2423.

24. Wolever, T.M.S. and D.J.A. Jenkins, 2001. The use of the glycemic index in predicting the blood glucose response to mixed meals. American Journal of Clinical Nutrition, 43: 167-172.