African Yam Beans: A Therapy for the Management of Diabetes Mellitus (Type II)

UDOH MFONISO[1], OPARA D C[2], ARCHIBONG DANIEL[3]
[1, 2, 3] *University of Uyo, Nigeria.*

Abstract- ***This study was aimed at developing African yam beans seed as a primary local food source in the formulation of therapeutic meals and assessing its effect in the management of high blood sugar levels in patients with Type 11 Diabetes Mellitus. The African Yam Beans (AYB) was prepared into flour and its proximate composition was determined using standard methods. The results of the proximate composition showed a significant difference when compared to those of corn flour used as control. High mean protein value of (13.35), lower mean carbohydrate values of (54.78 ±0.03) and a lower fatty acid profile of (1.95 ±0.01) as well as Saponin value of 1.72+/-0.01. The results of the proximate composition and phytochemical analysis are factors presumed to be favorable values in therapeutic meals adopted in the management of Diabetes Mellitus Twelve (12) diabetic patients(32-63years) were involved in the study. The patients were feed with 155gms of Moi Moi prepared from AYB flour as breakfast for 5 consecutive days. Fasting blood sugar and Random blood sugar were determined before and after feeding. The mean random blood sugar level of the patients decreased from 137.26mgd/L to 129.60mg/dL after feeding for five days. Furthermore, the evaluation of the glycemic index of AYB flour (54.78) also revealed lower glycemic index values compared to that of control flour (corn flour = 62.22). In conclusion, the qualifying attributes of lower glycemic index. slower digestibility, slower absorption rate and lower mean fatty acid profile of AYB, suggestively provide a predictive clue for the downward trend of the random blood sugar response curve. This supports the proposition that meals prepared using AYB flour as the primary ingredient could prove effective towards the management of diabetic health conditions.***

Indexed Terms- ***Diabetes, African yam beans, Diabetic patients, Therapeutic meals.***

I. INTRODUCTION

Diabetes Mellitus is a chronic endocrine disorder that occurs when the pancreas ceases to produce sufficient insulin (the hormone that regulates blood sugar) or on the other hand when the body cannot effectively use the insulin it produces. (Gallan, Hume, Limb, 2011; Blair,R 2016).

Diabetes can be classified as either Type 1 (characterized by lack of insulin production requiring daily insulin administration, or Type 11 as a result of the body's inability to use up the insulin produced. (Rosenbloom Silverstein, 2009). The pathophysiology of type 1 diabetes derives from the autoimmune destruction of insulin-secreting pancreatic β-cells, resulting in insulin deficiency and subsequent hyperglycaemia. Type I diabetes accounts for about 10-15% of all diabetics. Type II diabetes is characterized by abnormal insulin secretion due to peripheral resistance and accounts for 85-90% of all persons with diabetes.

The Center for Disease Control and prevention (CDC, 2019) estimates that nearly 500 million people are afflicted with Diabetes Mellitus (DM) world-wide, with a great majority occurring in developing countries. Diabetes Mellitus leads to loss of productivity. If DM is left untreated or poorly managed, which may be the case in resource poor countries. It may also lead to the following; heart disease, kidney disease, retinopathy and other life-threatening conditions (Gallan, Hume, Limb, 2011; Konstantinos et al 2019; Holman et al 2012; Anderson and wooden, 2013).

For people that had once enjoyed the freedom of choosing what to eat, when to eat and how to eat, having diabetes mellitus becomes a nightmare arising from very strong restrictions of food choices. This is made worse by the ignorance of the availability of

some local foods crops from the back yard with low glycemic indices and slow digestibility, which could be included in the diabetic menu is a primary challenge. Diabetes mellitus patients are a vulnerable group, whose diet requires modifications as an integral part of their treatment. Therapeutic diets is often planned to maintain and restore good nutrition in these patients. For any given patient, the nutritional requirements depend upon the nutritional status, modifications in physical activities, increase/decrease metabolic demand made by the illness and the efficiency of digestive, absorptive, and excretory mechanisms.

Diabetic diets should be modified with focus on minimizing high blood sugar and excess glucose in the urine, to attain ideal body weight and to prevent accumulation of lower fatty acids in the blood, and also prevention of insufficient blood sugar in the patient. In these diets, it is common knowledge that carbohydrate proportion should be reduced but not totally eliminated since carbohydrate is the main energy source in the body and the diabetes patients also needs energy to perform their daily routine, instead protein content of the food could be increased (Sainsbury et al 2018; Alkaabi,2011) .

The glycemic index (GI) measures how a carbohydrate containing meal raises blood sugar (glucose level) by ranking it on a scale from 0 to 100 according to the extent to which they raise blood sugar after eating. According to Chiavaroli, Ahmed, Cheung,Khan(2021); Ojo et al(2018) Alkaabi, (2011), meals with high GI are those that are readily absorbed into the cells after digestion and they bring about drastic increase in the blood sugar levels of the patient. There are foods with lower glycemic indices, slower digestibility and slower absorption rate, which could be adopted as therapeutic meals for diabetic patients to create food varieties and make meal times exciting. In vegan diets, beans are not easily digested and this characteristic is advantageous as the delayed digestion creates a continuous feeling of fullness, delay hunger and help to regulate plasma glucose and insulin levels after meals (Rudolf *et al.*, 2004; Anderson and Woodend, 2013).

African Yam Bean (AYB) (*Sphenostylis stenocarpa*) is one of the much neglected and underutilized leguminous plant with genetic resource related to the subfamily Faboideae, family Fabaceae and a small genus represented by only seven species. It is often cultivated for its edible tubers and seeds which are known to possess high nutritional values (Jeff-Agboola ,2007). The amino acid (lysine and methionine) has been reported to be higher in value than those of pigeon pea and cowpea. According to Okpara and Omaiko (1997), AYB protein can substitute for meat, fish, and even poultry. AYB seeds are high in vitamin C, dietary fiber, vitamin B6, potassium, and manganese; while being low in saturated fat, sodium, and cholesterol (Adamu et al, 2015). African Yam Bean (AYB) generally have a glycemic index lower than other legume products, which means that it could provide a more sustained form of energy (Emiola, 2011) suggesting it to be a good source of meal for diabetic patients.

Several attempts have been made with great success towards the formulation of therapeutic meals for diabetic patients using different kinds of local farm crops. This is often geared towards adding to the meal menu list and providing the dietary needs of the patients. Toritisirin,K (2014) proposed that cooked AYB seeds have high fibre content, high protein digestibility, higher amino acid, metabolized energy and good fatty acid profile. Therefore, the present study was aimed at developing African yam beans seed as a primary local food source in the formulation of therapeutic meals for diabetic patients and assessing the effect on the blood sugar level.

II. MATERIAL AND METHODS

2.1. Study Area

The study was carried out in the University of Uyo Health Centre (UUHC). The University of Uyo Health Centre is a secondary Health care facility with 21 beds located along Ikpa road, in Uyo Local Government Area of Akwa Ibom State Nigeria, situated between Latitudes 4-140N and Longitudes 2-160E. The Health Center serves the whole of The University of Uyo staff , staff dependents as well as students of the institution. The facility is well equipped, frequently inspected and has been given accreditation by the following bodies; National Health Insurance Scheme (NHIS), Pharmaceutical Council of Nigeria (PCN) and the National University Commission (NUC).

2.2. Processing of African Yam Beans (AYB) (*Sphenostylis stenocarpa*)

African yam beans were harvested at the mature but unripe stage and the pulp peeled and the seeds collected. The seeds were then soaked overnight in water so as to enable easy removal of the coat. The seeds were sprouted and the coat removed. The uncoated seed were oven-dried at the temperature of 50°C for 12hrs.

Fig. 1: Whole seeds of African Yam Bean

Fig. 2: dehulled and sprouted seeds of African Yam Bean

2.3 Proximate Composition of African yam Beans

The proximate composition of the African Yam Beans flour was analysed and determined using the method of Association of Official Analytical Chemist (AOAC, 1990).

2.4. Sample size

Twelve (12) diabetic patients in the UUHC who gave informed consent participated in the study.

2.5. Assessment of the therapeutic Efficacy of AYB Using Fasting blood Sugar and Random blood sugar measurements

Each of the 12 study participants was fed with one hundred and fifty (150) grams of the Moi-Moi prepared using the AYB flour. The AYB Moi -Moi was given as breakfast for 5 consecutive days. On each day the fasting blood sugar levels were determined before the AYB meals. After the meals, the random blood sugar levels were determined to establish the post prandial effect of the AYB meals on blood glucose levels were determined at intervals of 30mins, 60mins, 90mins and 120mins, using the standard procedures for the determination of Fasting Blood Glucose (FBG) and Random Blood Sugar (RBS) test.

A fasting blood sugar level of less than 100 mg/dL (5.6 mmol/L) is normal. A fasting blood sugar level from 100 to 125 mg/dL (5.6 to 6.9 mmol/L) is considered prediabetes. If it is 126 mg/dL (7 mmol/L) or higher on two separate tests, then a diagnosis of Diabetes Mellitus is made.

2.9. Data Analysis

The IBM statistical software SPSS version 20 software was used to determine the Least Significant Difference (LSD) of the blood sugar fluctuations of the patient and the result was presented using graphical illustration.

III. RESULT AND DISCUSSION

3.1 Proximate Composition

The result of the proximate composition of African Yam Beans (AYB) (*Sphenostylis stenocarpa*) shows a significant difference between all the proximate compositions of AYB flour when compared to those of corn flour used as control. High and low crude protein values of (13.35 ±0) and (10.23 ±0.01) were observed for AYB flour and corn flour respectively. High and low carbohydrate values of (54.78 ±0.03) and (62.22 ±0.02) were also observed for corn flour and AYB flour respectively (table 1). This implies that AYB flour has lower glycemic index compared to corn

flour. Other nutrients compositions of African Yam Bean flour which makes it an ideal therapeutic food for towards the management of diabetes Meletus.

Table 1: Proximate Composition (%) of African yam beans flour and corn flour (control)

Proximate Composition	AYB Flour	Control Flour
Crude Protein	13.35 ±0[b]	10.23 ±0.01[c]
Fat	1.95 ±0.01[d]	2.53 ±0.01[c]
Crude fiber	2.45 ±0.001[a]	1.51 ±0.01[b]
Ash	6.59 ±0.03[c]	2.67 ±0.03[b]
Moisture	9.85 ±0.001[c]	9.88 ±0.001[b]
Carbohydrate	54.78 ±0.03[c]	62.22 ±0.02[a]

Means with different superscripts along the same row are significantly different (Duncan's test) $p<0.05$

Glycemic Index of African Yam Bean

The result of the analysis on table 2 revealed that African Yam Bean (AYB) had a lower glycemic index of 44.31+/- compared to a value of 62.22 observed for the control (corn) flour. This observation corroborates with proposition of Emiola, (2011) that African Yam Beans generally have a low glycemic index which is even lower than other legume products. This implies that food prepared from African Yam Bean flour could be suspected to have blood sugar reduction capabilities for diabetic patients.

Table 2: Glycemic Index (GI) of African yam beans flour and Corn flour (Control)

Flour	Carbohydrate	Glycemic Index (GI)
AYB flour	44.31	Low
Corn flour (Control)	62.22 ±0.02	Intermediate

3.3. African Yam Bean therapeutic feed performance on Diabetic Patients

The result of the mean difference in the time-response variations in random blood sugar (RBS) level of diabetic patients as presented in fig 3 shows that after being fed with the therapeutic meals (Moi-Moi) for 5 consecutive days, there was a significant downward trend in the collective blood sugar levels of the patients. The results also showed that mean blood sugar level of the patients decreased from 137.26mgd/L to 129.60mg/dL after 120mins of feeding. From observation, the random blood sugar responded with a marked decrease in value the suggesting that meals prepared from AYB flour could be considered as therapeutic meals towards the management of diabetes mellitus. This observation corroborates with the propositions by Emiola L A (2011) that African Yam Bean (AYB) generally have a lower glycemic index which also provides a more sustained form of energy for the patient. Cooked AYB seeds have high fibre content, high protein digestibility, higher amino acid, metabolized energy and low fatty acid profile. All these qualities of cooked AYB could be assumed as nutritional factors which helps in correcting the metabolic errors in the diabetic patients, thereby reducing the blood sugar levels due to its probably low glycemic indices, slower digestibility, slower absorption rate and lower mean fatty acid profile of 1.95±0.01. These qualifying attributes can sufficiently suggest AYB flour as a therapeutic meal alternative for diabetic patients (Brand-miller et al. 2014).

The evaluation of the glycemic index of AYB flour (44.31) which reveals an even lower glycemic index values compared to that of control flour (corn flour = 62.22) explain the relative down trend of the blood sugar response curve. This fact also provides a predictive clue that meals prepared using AYB flour as the primary ingredient could prove effective towards the management of diabetic health conditions.

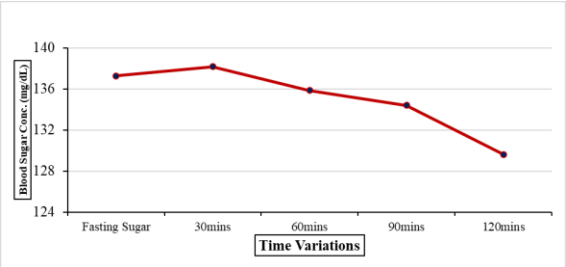

Fig. 3: Response curve of African Yam Bean therapeutic meal administered to by diabetic patients (Duncan test at $p<0.05$)

CONCLUSION

Prior to this research, there was ignorance of the availability and under-utilization of low glycemic index and slow digestibility of this local food crop from our backyard gardens namely African Yam Bean, which could be included in the diabetic menu list. This study sought to reveal that apart from the costly food and regular drug administration, Diabetes Mellitus (type II) can also be managed with some common underutilized indigenous food such as African Yam Beans. Therefore, this information can be of great help in the management of the Diabetes Mellitus (type II) among different strata of the society, such as employers of labour, workers in schools, hospitals, churches and families. The resultant effects will include optimum health and increased economic performance in any particular community in the developing countries with such as Nigeria, where African Yam Bean is grown as an indigenous crop readily available as a low-cost farm crop.

RECOMMENDATION

It is therefore recommended that seminars, workshops and media enlightenments should be carried out to educate and inform our different communities on the possible therapeutic remedy towards the management diabetes mellitus (type II) condition with specific indigenous food crop such as the African Yam Bean (*Sphenostylis stenocarpa*) flour for optimum result.

REFERENCES

[1] Adamu1, G. O L, O. T. Ezeokoli2, A. O. Dawodu3, A. O. Adebayo-Oyetoro4 and L. N. Ofodile1 (2015), Macronutrients and Micronutrients Profile of Some Underutilized Beans in South Western Nigeria. *International Journal of Biochemistry Research & Review 7(2): 80-89, 2015, Article no.IJBcRR.2015.057 ISSN: 2231-086X* SCIENCEDOMAIN *international p*

[2] Anderson, J. W. Konz, and Jenkins, D. J. (2000): Health Advantages and disadvantages of weight-reducing diets. A computer analysis and critical review J. Am Coll. Nutrition 19:578-390.

[3] AOAC (1990): Official method of Analysis, 15th edn, Association of Analytical chemist, Washington D. C, USA.

[4] Blair R(2016) Diabetes Mellitus Review. Urologic Nursing 6(1)

[5] Brand- Miller, J.M; Foster-powell K. M.,and Mcmillan-price, J(2014) The low GI diet revolution;the efinitive Gience-based weight loss plan. Da Capo Press, Boston, MA

[6] Chaiavaroll, D.Ell,A: Ahmed; A Cheumg: TA Khan (2021) Effect of low glycaemic index or Load dietary pattern on glyceamic control and cardiometabolic risk factors; Systematic review and meta analysis BMJ 2021-bmj.com.

[7] CDC (2019) Morbidity and Mortality after lifestyle intervention for people with impaired glucose tolerance: 30 year results of Da Qing Diabetes prevention outcome study. Lancet Diabetes Endocrinol, 2019

[8] Emiola I.A (2011): Processed African yam bean (*Sphenostylis stenocarpa*) in broiler feeding: performance characteristics and nutrient utilization. *Journal of Environmental Issue and Agriculture in Developing Countries*, 3(3), 123-131.

[9] Gallen IW, Hume C, Lumb A. Fuelling the athlete with type 1 diabetes. Diabetes

[10] Jeff- Agboola(2007) Nutritional value of African Yam beans. https://www.researchgate.net

[11] Konstantinos, P ; Maciej B; Elleni B ; Manfredi R and Michael E(20190 Complications of DM 2019. Journal of Diabetes research.

[12] Ojo; O O Ojo; F. Adebowale; XH Wang (2018) The effect of dietary glyceamic index on glyceamia in patients with Type 11 Diabetes : A systemic review and meta -analysis of randomized controlled trials. Nutrients 10(3) 373

[13] Okpara, D. A., and Omaiko Ope (1997), Response of African yam bean (Sphenostylis Styenocarpa) to sowing date and plant density, Indian, J. Agric. Sci. 67 (50): 220-221 Olusanya, J. C.; Eyisi, O; Anfani, J. E; Ogunyide, L. O. and Ebuchulam, (1990) Food and Nutrition for Senior Secondary Schools 1-3 Published by University Press Plc.

[14] Sainbury, E; Nathalie V Kizirian; Staphanie R Partridge; Timothy Gill; Stephen Colagiuri; Alice Gibson (2018) Effects of Dietary carbohydrate restrictions on glceamic control in adults with Diabetes; A systematic review and Meta – analysis. Diabetes Research and clinical practices Vol (139) pages 239-252

[15] Toritisirin, K (2014) Promotion of underutilized food resources for food security and nutrition in Asia and in the Pacific. ISBN9742-92-95-108273-9 www.few-org/publications.