ORIGINAL RESEARCH PAPER

Treatment of Diabetic Condition in*Streptozotocin* induced Diabetic Wister Rats Using Food Blends From Unripe Plantain, Soybean and Ginger

ABSTRACT

Aims:To investigate the effect of food blends (plantain, soybean and ginger) on the blood glucose, lipid profile and haematologicalindices on*streptozotocin* induced diabetic rats

Methodology:A total of 35 ratsof mean body weight 219.07g separated into7 groups (5 per group) where induced by a single intraperitoneal (I.P) injectionof *streptozotocin* (0.1g dissolved in 5ml of freshly prepared sodium citrate buffer 0.1M, pH 4.5) at a dose of 40 mg/kg body weight after fasting for 12hoursand fedwith flours/blends. The flours were produced from plant materials for different treatments/blends (blendA=100% unripe plantain, B=80% unripe plantain, 14% soybean, 6% ginger, C=70% unripe plantain, 26% soybean, 4%ginger, D= 60% unripe plantain, 38% soybean, 2% ginger, E= 50% unripe plantain, 50% soybean) and the phytochemicals and minerals content were determined. Blood glucose was determined at 5 days interval for 25days.Diabetes was confirmed in rats with blood glucose concentrations $\geq$200 mg/dl. After 25 days rats were anaesthetized with chloroform vapour and blood samples collected by cardiac puncture for haematology and lipid profile determination.

Results: The results showed that unripe plantain, soya beans and ginger in adequate proportion(C=70% unripe plantain, 26% soybean, 4%ginger or D= 60% unripe plantain, 38% soybean, 2% ginger) could help to reduce blood glucose,improve haematological parameters and lipid profile. Significant reduction was observed in the blood glucose level of rats fed blends C and D from 286 to 85mg/dl and 307 to 90mg/dl respectively at the end of experiment. These results also demonstrated that the inclusion of ginger at 6% causes rise in blood glucose level.Total cholesterol (TC) increased in all the blends. However, the lowest concentration of TC was observed in blends C and D. The highest packed cell volume (60%) and Haemoglobin (20g/dl) level observed in rats fed blend C was significantly higher than the normal control fed conventional feeds. The increase in packed cell volume (PCV) (50%) and Hb(17g/dl) in diabetic rats demonstrated that the formulated blend C was able to raise PCV and Hb above 50% and 17g/dl (Normal controlie NC) respectively. Significant increase ($P<0.05$) in low density lipoprotein cholesterol (LDLc)was also observed in all the blends with blend C having the least(4.0mg/dl) close to NC (2.0mg/dl).

Conclusion: From the results it is evident that blend C will manage and improve the health status of diabetic patients.

Key words: Diabetes mellitus, streptozotocin (STZ),haematology, lipid profile, plant materials

INTRODUCTION

Diabetes mellitus has become a major global problem in our world today. It is a common disorder associated with increased morbidity and mortality and can be defined as a group of metabolic diseases characterized by chronic hyperglycemia due to defective insulin secretion, insulin action, or both, resulting in impaired carbohydrate, lipid, and protein metabolism [1].

The combat against diabetes mellitus must be made a matter of top priority by all due to the continual increase in the global prevalence of this social ill. Globally the prevalence was estimated to increase in year 2000 to 2010 from 14.2 million to 17.5 million in North America, 15.6 million to 22.5 million in South America, 26.5 million to 32.9 million in Europe, 9.4 million to 14.1 million in Africa, 84.5 million to 132.2 million in Asia and 1.0 million to 1.3 million in Australia giving a total global increase in prevalence from 151 million people in 2000 to 221 million people in 2010 [2]. This was projected to 324 million by 2025 byZimmet*et al*. [3]and 366 million 2030 [4]. In 2013, 382 million people had diabetes mellitus worldwide and this is expected to rise to 592 million by 2035[5]

The increasing interest in herbal medicine for the treatment of diabetes and many prevailing diseases is not surprising. This may be attributed to the upsurge in cases of drug resistance, cost and several side effects associated with most orthodox medicines. The use of plant materials as spices, condiments and for medicinal purposes has therefore become more popular and as such more plants materials such as plantain and soybean that have low carbohydrate content with high mineral values are being exploited.

There is therefore no doubt that orthodox medicine itself appears to be strongly anchored on traditional medicine [6]. The fact that the tropics into which majority of Africa lies is host to about 2/3 of the world's flora and fauna means that a lot of medicinal plants can be found here for both curative and management of diseases [7].

Plantain (*M. paradisiaca*) is a staple food crop in West Africa where its starchy fruits are generally cooked or fried before consumption. During unripe plantain ripening, the starch is changed to reducing sugars and sucrose. The medicinal value of plants have assumed a more important dimension in the past decades owing largely to the discovery that their extracts contain not only minerals but also a diverse array of secondary metabolites with antioxidant potentials [8,9]. These antioxidants have been implicated in the therapeutic effects of several plants and vegetables that are used in traditional medicine [10, 11].Plantain contains a high fiber content, and thus is capable of lowering cholesterol and helps to relieve constipation and hence prevention of colon cancer. Besides, its high potassium content is found to be useful in the prevention of rising blood pressure and muscle cramp [12].Various parts of the plant such as the leaves, root, fruit stalk, bract and fruit have been used for medicinal and domestic purposes.

Soybean is known as the "Golden bean" or the super legume of the twentieth century, because it containsa good proportion of oil more than 20 percent.Soybean is also categorized as oilseed, represents an excellent source of unsaturated fatty acids, high quality proteins and fiber. Soybean contains very small amount of saturated fatty acid but do not contain anyTrans fatty acid. Both omega-6 and omega-3 fatty acids such as linoleic acid (56 % of total fat) and alpha lenolenic acid (7-8 % of total fat) are present in soybean. Cooked Soybeans are rich in iron, phosphorous, magnesium, vitamin B2 (riboflavin) and folate. Kadam*et al.*[13] stated that legumes have been known as "a poor man's meat". They supply protein, complex carbohydrates, fiber and essential vitamins and minerals to the diet, which are low in fat and sodium and contain no cholesterol.

Spices are food adjunct commonly added to food to improve the sensory properties but many spices have been observed to exert medicinal effects. Some spices which have been reported to exert hypoglycemic effect both in laboratory animals and human subjects are: Fenugreek seeds (*Trigonellafoenum*), garlic *(Allium sativum*), Onion (*Allium cepa*), turmeric (*Curcuma longa*), cumin seeds (*Curminumcyminum*), ginger *(Zingiberofficinale*), mustard (*Brassica nigra*), curry leaves (*Murrayakoenigi*) and coriander (*Coriandumsativum*) [14].

Ginger is a perennial plant with narrow, bright green, grass-like leaves. It is cultivated in the tropics for its edible rhizomes and has been found to be useful for both culinary andmedicinal purposes [15, 16]. Fresh ginger contains 80.9% moisture, 2.3% protein, 0.9% fat, 1.2% minerals, 2.4% fiber and 12.3% carbohydrates. The minerals presented in ginger are iron, calcium and phosphorous. It also contains vitamins such as thiamine, riboflavin, niacin and vitamin C. The composition varies with the type, variety, agronomic conditions, curing methods, drying and storage conditions [17].

Several studies have reported the hypoglycemic effect of different forms of ginger in both animals and human subjects. Among the fairly recent reports are: Arablou*et al.*[18]; Mozaffari-Khosravi*et al.*[19] and Mahluji*et al.*[20] used ginger powder in Type 2 diabetic patients; Son *et al.*[21] used 6-gingerol isolated from ginger in obese diabetic mice; Sukalingam*et al.*[22]used 6-gingerol in STZ-induced diabetic rats; Abdulrazaq*et al.* [23] used aqueous ginger extract STZ-induced diabetic rats; while Jafri*et al.* [24] used aqueous extract in alloxan-induced diabetic rats. Very limited studies have reported the hypoglycemic effect of ginger juice while there is abject scarcity of scientific findings on hypoglycemic effect of cooked ginger extract, which is highly needed since the spice is mostly consumed in cooked forms in various cuisines. Hence, the objective of this study is to determine the effect of food blends (plantain, soybean and ginger) on the blood glucose, lipid profile and haematologicalindices onstreptozotocin induced diabetic rats

MATERIALS AND METHODS

Materials

Unripe plantain and ginger roots were bought from Jattu market in Auchi, Edo State; defatted soy bean flour (Variety TGX 1448-2E) was purchased from Benin City in Edo State. Streptozotocin (STZ) Sigma NO SO130 was a product of Sigma-Aldrich chemical company, UK. Every otherchemical used were bought from Promise laboratory in Ekpoma, Edo State.

Processing of plantain flour:

Fresh unripe plantain was peeled, sliced using slicer and dried in an oven at 60^{o}C for 48hours. Dried sample was ground into powder (plantain flour).

Processing of soybeansto defatted flour:

Soybean seeds were cleaned and sorted manually to removedirt, leaves and stones. The clean soybean seeds were coarsely milled to separate the coat from the cotyledon. The dehulled seeds were milled to fine soybean flour using an attrition mill. The fine soybean flour was then defatted using cold extraction with n-hexane. The defatted flour was then air-dried and the clumps broken into fine flour, then sieved through a mesh screen.

Processing of ginger powder

Fresh ginger roots were sorted and washed to remove soil and other foreign materials then sliced to thin layers and dried in an oven at 60^{o}C for 24hours before milling to powder.

Formulation of unripe plantain, soybeans and ginger flour blends:

Five samples were prepared from the combinations of unripe plantain, defatted soybean and ginger as blends:

A=100% unripe plantain

B=80% unripe plantain, 14% soybean, 6% ginger

C=70% unripe plantain, 26% soybean, 4%ginger

D= 60% unripe plantain, 38% soybean, 2% ginger

E= 50% unripe plantain, 50% soybean

Induction of Diabetes in Wister rats

A total of 35 adult male albino rats with mean body weight of 219.07g wereobtained from the disease free stock of the animal house, attached to Ambrose AlliUniversity. The rats were separated into seven groups with five rats per groupincluding NC and DC as follows in table 1.

Table 1: Rat Groups and Treatments

Groups	Number of rats	Treatments
A	5	STZ-induced diabetic rats fed with100% unripe plantain),
B	5	STZ-induced diabetic rats fed with 80% unripe plantain, 14% soybean, 6% ginger),
C	5	STZ-induced diabetic rats fed with 70% unripe plantain, 26% soybean, 4%ginger) and
D	5	STZ-induced diabetic rats fed with 60% unripe plantain, 38% soybean, 2% ginger)
E	5	STZ-induced diabetic rats fed with 50% unripe plantain and 50% soybean),
NC	5	Not induced and fed with rat pellet
DC	5	Induced and fed with rat pellet).

Prior to experimentation, the rats were acclimatized to laboratory condition and fed with rat pellet and wateradlibitumfor aweek. Diabetes was induced in rats by a single intraperitoneal (I.P) injection of freshly prepared solution of streptozotocin (0.1g dissolved in 5ml of freshly prepared sodium citrate buffer 0.1M, pH 4.5) at a dose of 40 mg/kg body weight after fasting for 12hours. Good hygiene was maintained by constantly cleaning and removal of faeces and spilled feeds from cages daily.Fasting blood glucose (FBG) was determined usingAccuchek Active glucometer, Roche Germany, with blood obtained from the tail vein of the rats. This test was repeated on day 5, 10, 15, 20 and 25. Diabetes was confirmed in STZ treated rats with blood glucose concentrations $\geq$200 mg/dl.

Collection and analysis of blood

The rats were anaesthetized with chloroform vapour, twelve hours(12 h) after last day of feed administration, and blood samples were collected by cardiac puncture into a set of plain and fluoride oxalate sample bottles.

Hematological parameters

The packed cell volume (PCV) was measured by the micro hematocrit centrifuge. Hemoglobin (Hb) concentration was determined by the cyanomethemoglobin technique [25]. The white blood cellcomponents were also determined.

Lipid Profile Studies

Blood sample was centrifuged to collect plasma which was used to estimate total cholesterol, high density lipoprotein cholesterol (HDL-C), low density lipoprotein cholesterol (LDL-C), and triglycerides (TG) using commercial kits obtained from Randox Laboratories, UK.

RESULTS AND DISCUSSION

Mineral Composition of Formulated Food

Table 2 depicts the composition of the studied minerals. Food blend E had the highest potassiumcontent (1099.42ppm), this was followed by D (944.79ppm) while the lowest potassiumcontent wasobserved in A (704.80ppm). The highest potassium observed in food blend E could be attributed to its high inclusion of soybean (50%) which is known to be a rich source of potassium. Potassium is an important mineral in the body that regulates fluid balance, muscle contraction and nerve signals. High potassium may reduce blood pressure and water retention, protect against stroke and prevent osteoporosis and kidney stones.

Food blend A had the highest sodium content (75.65ppm), this was followed by B (67.19ppm) while the lowest content(47.80ppm) wasobserved in E. sodium is essential for life. It helps to control the body's fluid balance. It send nerve impulses and affects muscle function.

Food blend E had the highest calcium content (804.02ppm), this was followed by D (626.91ppm) and C (435.71ppm) while the lowest calcium content(236.16ppm) was observed in food blends A. calcium plays an important role in muscle contraction, transmitting messages through the nerves and the release of hormones. Calcium is also important mineral in the formation of teeth and bones

Food blend E had the highest iron content (141.49ppm), this was followed by D (121.42ppm) and C (114.64ppm) while the lowest content(28.60ppm) was observed in food blends A. Iron is an important component of haemoglobin, the substance in red blood cell, responsible for carrying oxygen and transports it throughout the body.

The mineral content (potassium, calcium and iron except sodium) of the blends, increased with increasing soybean inclusionlevel (Table 2), depicting that soybean is rich in these minerals.

Table 2:- Mineral composition of formulated food blends

	Minerals (ppm)			
Blends	Potassium	Sodium	Calcium	Iron
A	704.80^{a}	75.65^{a}	236.16^{e}	28.60^{e}
B	931.82^{b}	67.19^{b}	430.77^{d}	92.89^{d}
C	942.17^{c}	66.00^{b}	435.71^{c}	114.64^{c}
D	944.79^{b}	62.08^{c}	626. 91^{b}	121.42^{b}
E	1099.42^{a}	47.80^{d}	804.02^{a}	141.49^{a}
SEM	0.05	0.54	0.06	0.05

Means with the same letters down the column are not significantly different (P>0.05)

A=100% unripe plantain

B=80% unripe plantain, 14% soybean, 6% ginger

C=70% unripe plantain, 26% soybean, 4%ginger

D= 60% unripe plantain, 38% soybean, 2% ginger

E= 50% unripe plantain, 50% soybean

SEM= Standard error of mean

Phytochemical Properties

Table 3 shows the phytochemical compositions of the blends. Thelowest tannin content (tannin 0.27mg/100g) was observed in food blend A and was followed by blend B (0.55 mg/100g). Blends C, D and E had the same tannin content (0.61mg/100g).

The highest alkaloid content (6.43%) was observed in blend A and was followed by B (6.23%), C (5.99%), D (5.75%), and E (4.84%) in that decreasing order.

Blends B and C had the same flavonoid content(0.42 mg/100g) which was higher than the other blends. The lowest flavonoid content (0.11mg/100g) was observed in blend A; this was followed by E(0.31mg/100g) and D (0.35mg/100g).

Blend A (0.16 mg/100g) had thelowest saponin content and was followed by B (2.39mg/100g), C (3.99mg/100g), D (4.22mg/100g), and E (6.33mg/100g) in that decreasing order.

Saponins are known to possess both beneficial(cholesterol lowering) and deleterious (cytotoxicpermeabilization of the intestine and paralysis of thesensory system) properties [26]. Flavonoids, alkaloids and tannins are polyphenoliccompounds with antioxidant properties. In addition,phenolic compounds existing in plants are alsoresponsible for their contribution to colour, sensory andantioxidant properties of food [27].

The low phytochemical values (Table 3) recorded in this studyare significantly lower than ($P<0.05$) the results of Eleazu*et al.*[28]who recorded significant values(saponin1.827, flavonoid 0.981 and tannin 1.577) in unripe plantain flour.However, he further reported that the levels of saponin in the flour are quite too low tocause any deleterious effects.

Table 3:- Phytochemical Properties of formulated food blends

	Phytochemicals			
Blends	Tannin (mg/100g)	Alkaloids (%)	Flavonoids (mg/100g)	Saponin (mg/100g)

A	0.27^{c}	6.43^{a}	0.11^{d}	0.16^{e}
B	0.55^{b}	6.23^{b}	0.42^{a}	2.39^{d}
C	0.61^{a}	5.99^{c}	0.42^{a}	3.99^{c}
D	0.61^{a}	5.75^{d}	0.35^{b}	4.22^{b}
E	0.61^{a}	4.84^{e}	0.31^{c}	6.33^{a}
SEM	0.008	0.014	0.005	0.008

Means with the same letters down the column are not significantly different (P>0.05)
A=100% unripe plantain
B=80% unripe plantain, 14% soybean, 6% ginger
C=70% unripe plantain, 26% soybean, 4%ginger
D= 60% unripe plantain, 38% soybean, 2% ginger
E= 50% unripe plantain, 50% soybean
SEM= Standard error of mean

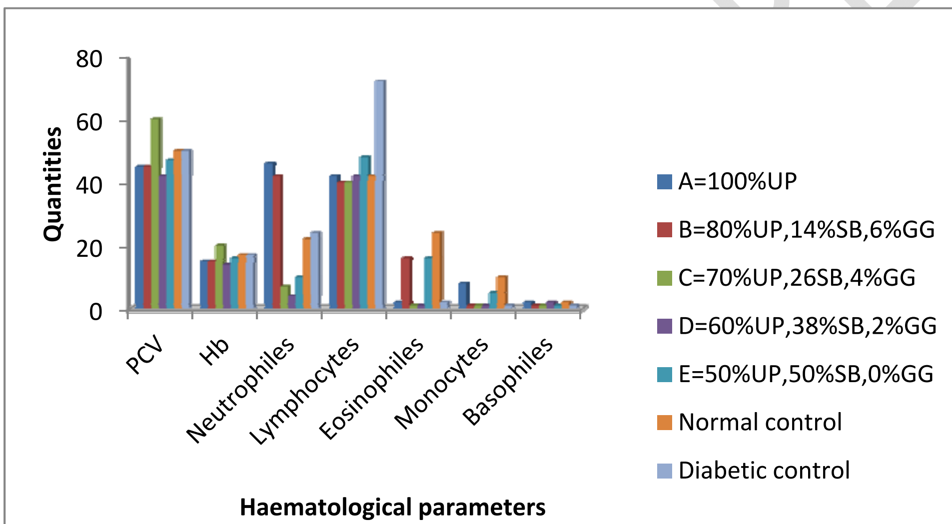

Figure 1: Haematological Quantities

Food and nutrients play vital role in the normal functioning of the body. In this study, plant materials such as unripe plantain, soybean and ginger were used to formulate food blends with the aim of studying its effect on the haematological parameters, lipid profile andblood glucose level of diabetic rats.

The analysis of variance showed significant difference (P<0.05) in the packed cell volume (PCV) andhaemoglobin(Hb) level of the diabetic rats (Figure 1). The highest PCV and Hb level (60%, 20g/dl respectively) were observed in rat fed blend C that contains 70% unripe plantain, 26% soybean and 4% ginger. This was significantly higher (P<0.05) than the normalcontrol (not induced) (50%, 17g/dl) fed conventional feeds. The increase in PCV and

Hbin diabetic ratsshowed that the formulated blends were able to raise the PCV and Hb above 50% and 17g/dl.

The degree of anemia in diabetic patients can be associated with a number of factors such as glomerular filtration rate andglycated h (HbAlc) level. Thomas *et al.*[29] reported that anemia is due to diminished erythropoietin production by failing kidneys and increased non enzymatic glycosylation of red blood cell (RBC) membrane protein. In this study, increase in PCV and Hb level of some of the diabetic rats does not depict occurrence of anemia rather shows its potency in the management of the ailment (diabetes). This could be attributed to the phytochemicals and mineral present in the blends. The antioxidant properties of these phytochemicals especially flavonoids have been reported in several studies. Onat*et al.*[30] reported the anti-sickling properties. This according to Palaciouse*t al*. [31] it prevents oxidation of RBC and Hb that often lead to haemolysis. According to Egunyomi*et al.* [32] it may also stimulate formation or secretionof erythroprotein in the stem cells of the animals as evidenced by the increased level of PCV and Hb. There is no significant difference ($P < 0.05$) in the lymphocytes of the formulated blends (A and D) from the normal control. The diabetic control rat had lymphocytes (72%) significantly higher ($P<0.05$) than every otherrat. The high lymphocytes level could be attributed to unknown infection.The values of Neutrophiles, Ecsinophiles, Basophiles and Monocytesobtained in rats fed with blends C, D and E were significantly lower ($P<0.05$) than the normal control rats.

Changes in Blood Glucose and Body Weight of *Streptozotocin*induced Wister Rats

Table 4: Blood glucose of *Streptozotocin* rats

Food blends	Days 0	5	10	15	20	25	SEM
A	104.40^{mno}	272.00^{h}	334.00^{e}	504.00^{b}	409.00^{c}	413.20^{c}	
B	93.00^{nop}	245.00^{i}	301.00^{f}	562.00^{a}	559.00^{a}	506.00^{b}	
C	107.00^{lmn}	286.00^{g}	73.00^{q}	99.00^{lmno}	$101.00^{mno\ p}$	85.00^{p}	
D	103.00^{lmno}	307.00^{f}	99.00^{mno}	114.00^{lm}	103.00^{lmno}	90.00^{op}	4.15
E	109.00^{lmn}	247.00^{i}	370.00^{e}	392.00^{d}	375.00^{e}	402.00^{cd}	
NC	108.00^{lmn}	110.00^{lmn}	133.00^{k}	109.00^{lmn}	106.00^{mno}	103.00^{lmno}	
DC	120.00^{l}	229.0^{j}	184.00^{k}	214.00^{k}	225.00^{jk}	283.00^{gh}	

Means with same superscript down the column and along the row are not significantly different ($P>0.05$)

A=100% unripe plantain
B=80% unripe plantain, 14% soybean, 6% ginger
C=70% unripe plantain, 26% soybean, 4%ginger
D= 60% unripe plantain, 38% soybean, 2% ginger
E= 50% unripe plantain, 50% soybean
NC= Normal control, fed conventional feed (not induced)
DC= Diabetic control, fed conventional fed (induced)

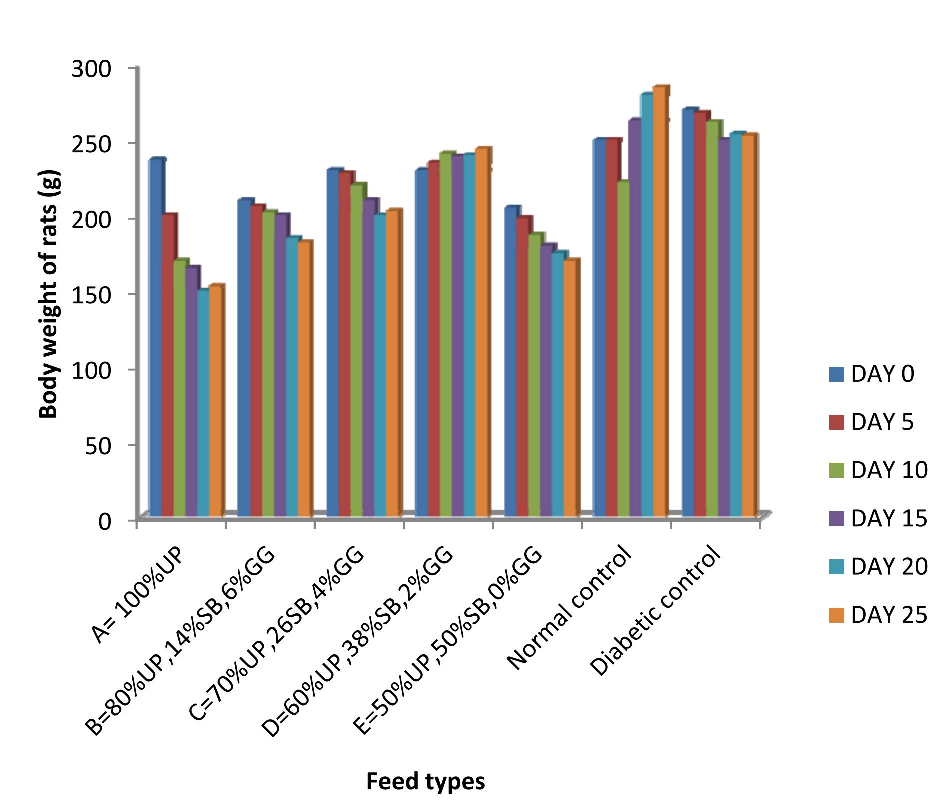

Figure 2: Body weight of rats fed formulated and commercial feeds (g)

Blood glucose and body weight were monitored for total duration of 25 days. At 5 days interval blood glucose level and body weight were determined. The initial measurements were taken before induction at day 0 for glucose level and body weight. The various rat groups had blood glucose level between93-120mg/dl and body weight between 205-270g (day 0). They were induced and fed formulated food blends and water adlibitum.

On the 5^{th} day, all the induced groups had significant increase (P<0.05) in glucose level>200mg/dl(Table 4) with corresponding decrease in body weight(Figure 2). Thus the rats were considered diabetic at ≥200mg/dl.The rat fed blend D had the highest blood glucose level 307mg/dl. NC rats had the lowest blood glucose level (110.0 mg/dl) and showed no significant (P>0.05) change throughout the period of experiment.

There was steady significant increase (P<0.05) in the blood glucose of group A, B, E and DC throughout the period of this experiment. The results showed that at 0% and 6% inclusion of ginger in blends A and B respectively, the rat were hyperglycemic. This demonstrated that the inclusion of ginger at 6% causes rise in BGL.Significant reduction (P<0.05) was observed in the blood glucose level of rats fed with blends C and D from 286 to73mg/dl and 307 to 99mg/dl from day 5 to 10respectively. This same trend was observed in blood glucose level for 15, 20 and 25 days with rat fed blends C (99, 101 and 85mg/dl) and D (114, 103 and 90mg/dl) respectively, having normal blood glucose <200mg/dl. This shows the potency of the blends C (70% unripe plantain, 26% Soybean and4% ginger) and D (60% unripe plantain, 38% soybean and 2% ginger) in the management of the ailment (diabetes). This could be attributed to the combination levels of the plant materials particularly the inclusion of ginger at 4% and 2%in blend C and D respectively. Ginger provides an amount of potassium that could help stroke and diabetesand adult requires 2000mg of potassium each day. Potassium is important for diabetic patients and those at the risk of it. The findings of recent study published by researchers from university of Sydney in 2012 revealed that ginger extract helps to increase cell absorption of glucose even independent of insulin *(www.naturlnews.com)*. The predominant pungent compound in ginger is responsible for its benefit to humans [33]. According to Andallu*et al.*[34] ginger has a therapeutic benefit of lowering fasting serum blood glucose level in Type 2 diabetes. According to Singh *et al.* [35] many of the putative activities of ginger (antioxidant,anti-inflammatory, hepatoprotective, antiobesity) are often associated with the etiology and pathophysiology of Type 2 diabetes, which suggest the possibility that ginger may not have a direct effect on diabetes but acts indirectly by suppressing factors that lead to impaired glucose control. Thus, was supported by a study showing that ginger root powder (200mg/kg body weight) in type 2 diabetic rat model reversed symptoms of metabolic syndrome, blood glucose, blood lipid and decreased oxidative stress [36]. Although blend B had ginger inclusion at 6%, the glucose level was >200mg/dl throughout the period of this experiment. This shows that ginger inclusion at 6% could result in hyperglycemic condition. However at day 10, a rise was observed in the glucose level of rats fed blend A (272-334mg/dl), B (245-301mg/dl) and E (247-370mg/dl) with corresponding decrease in body weight (Figure 2). Thus this indicates that the formulation for A, B and E could not control the diabetic condition. The DC rats fed with conventional rat feed increased inblood glucose level and body weight steadily throughout the period of experiment, while the body weight decreased from 228 to 220g and increased from 235 to 241g in rats fed blends C and D respectively.

Effect of Food Blends (Diet) on Serum Lipid Profile

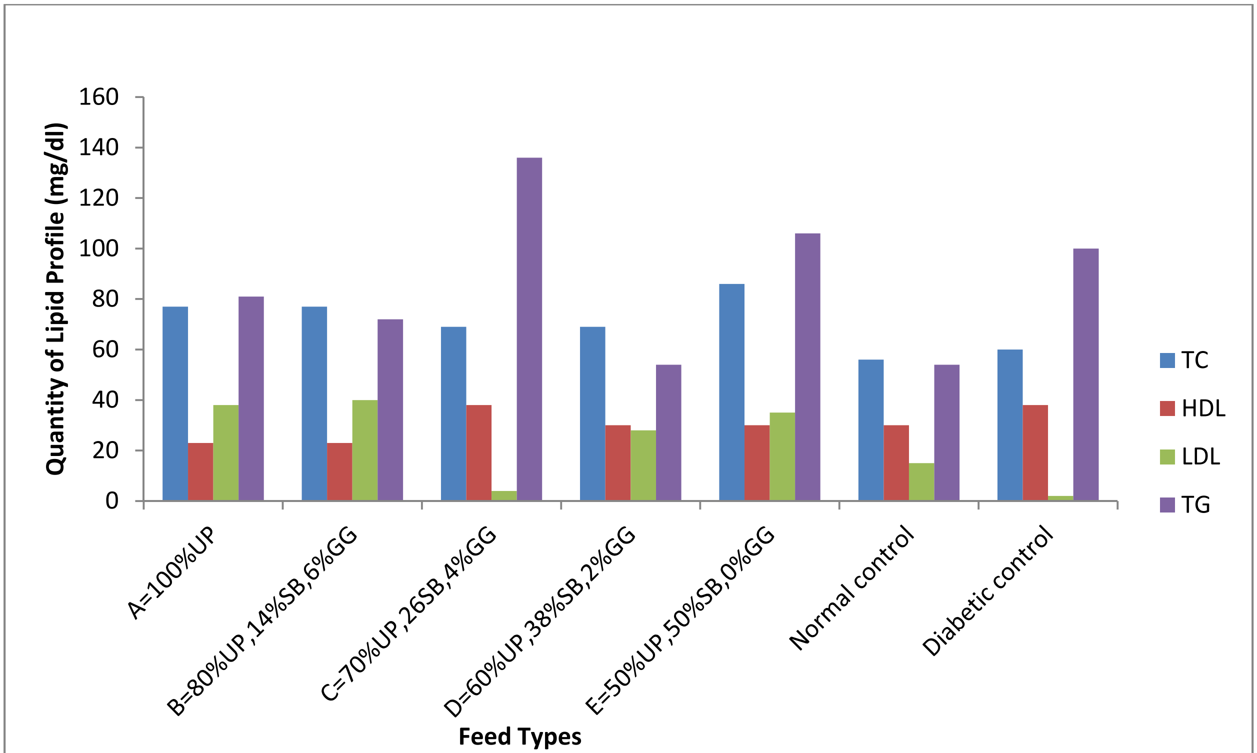

Figure 3: Lipid Profile of Streptozotocin Induced Wister Rats

Serum lipid concentration of streptozotocin induced rats fed with food blends and conventional feed in this study is shown in figure 3. From the results, serum high density lipoprotein cholesterol (HDLc) concentration in rats fed blends C (38mg/dl) and NC (38mg/dl)were same buthigher and significantly different ($P<0.05$) from HDLc of rats fed with other blends.

Total cholesterol (TC) increased in all the blends. However, the lowest concentration in TC was observed in blends C and D (Figure 3). Thus this depicts that blends C(69mg/dl)and D (69mg/dl)are better having lower cholesterol concentration.

For low density lipoprotein cholesterol (LDLc) significant increase ($P<0.05$) was observed in all the blends. However, blend C (4.0mg/dl) was next to NC (2.0mg/dl) while the highest was observed in blend B (40.0mg/dl).

The increased in LDLc, TC, and decreased in HDLc agrees with the findings of Adaramoye*et al.*[37] for diabetic rats. Besides, the formulated diets are plant materials containing phytochemicals. [38] reported that action of plant extract in reducing plasma cholesterol concentration could be due to the ability of one or more of the phytochemicals in the plant to activate the functioning enzymes of the rats responsible for cholesterol absorption.

CONCLUSION

In this research work, it was observed that the blends of unripe plantain, soya beans and ginger in adequate proportion(C=70% unripe plantain, 26% soybean, 4%gingeror D= 60% unripe plantain, 38% soybean, 2% ginger) could help to reduce blood glucose, improve haematological parameters and lipid profile.The mineral content (potassium, calcium and iron except sodium) of the blends increased with increasing soybean inclusion level, depicting that soybean is rich in these minerals.Significant reduction ($P<0.05$) was observed in the blood glucose level of rats fed blends C and D from 286 to 85mg/dl and 307 to 90mg/dl respectively. The lowest concentration of TC was observed in blends C and D. This depicts that blends C (69mg/dl) and D (69mg/dl) are betterand preferred to the other blends.In addition, blend C also had the least value (4.0mg/dl) of low density lipoprotein cholesterol (LDLc).Hence,blend C ismost preferred to prevent and control diabetesas well as improve the health status of diabetic patients.

Ethical Approval:

As per international standard or university standard ethical approval has been collected and preserved by the authors.

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