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Full Length Research Paper

Effect of Processed Acha (*Digitaria exilis*) grain on glycemic index of diabetes induced Wistar Rat model

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Effects of variable process acha grain on glycemic index have been evaluated in Wister rat models. Rats were initially fed with diet made of dehulled grounded cooked acha (A); dehulled ungrounded cooked acha (B); dehulled grounded uncooked acha (C) undehulled grounded cooked acha (D); undehulled ungrounded cooked acha (E); undehulled, grounded uncooked acha (F). Postprandial glucose index was measured from tail tip with the aid of glucometer. The result revealed that glucose index was elevated in rats fed with dehulled acha (61.3%,52.7% and 53.18% in group A, B and C) compared to those fed with undehulled acha (51.98%, 46.04% and50.50% group D, E and F). This finding discloses that undehulled ach has the ability to control blood sugar level and can be recommended to individuals suffering with diabetes.

Keywords: Acha, Biochemical, Cooked, Glucose, Glycemic index, Wistar rat.

INTRODUCTION

Acha (*Digitariaexilis* and *Digitariaiburua*) is a small annually herbaceous plant (forest seed/grain) commonly found in Nigeria, Sierraleon, Ghana, Guinea Bissau, Togo, Mali, Benin republic, and Ivory Coast(Jideani and Jideani, 2011). Scientist has reported the crude protein content of the grain to be similar to that of maize and complementary to legumes in methionine and cysteine contents (Glew *et al.,* 2013). Acha grain belongs to the group of lost crops of Africa and has been neglected due insufficient knowledge of it nutritional value by nutritionist and other researchers (Chivenge *et al.*, 2015). The English name of the seed grain “Hungry Rice” was believed to have been named by European’s which was considered misleading by some authors (Ukim *et al.,* 2013).Out of about 300 species of acha grown as fodder, only 4 species are commonly grown as cereal for human consumption (Van Cauwenberghe and Janssen, 2014).

In West Africa, the common species cultivated are *Digitariaexilis* (white acha), and *Digitariaiburua* (black acha) (Dansi et al., 2010). The plant is characterized with height of 0.5–3 feet and many them are small long grains usually yellow and dark in color (Ukim *et al.,* 2012).Acha is now gradually being used as feed due to it nutritional value and high yield during cultivation (Li *et al.,* 2017). Recent discovery revealed that farmers are making effort in improving acha production due to it nutritional content, test and adaptation to natural climate (Below *et al.,* 2012). With all the present effort, the abilities to produce enough acha to meet the growing demand of the population all over the world remain a great challenge (Philip and Itodo, 2006). Research institutes in developing countries are working tirelessly in partnership to enhance it production through it distribution and genetic modification (Olu-Owolabi *et al.,* 2014). Proximate analysis of the nutritive value of acha revealed the following; 7.7% protein, 1.8% fat, 71% carbohydrate and 6.8% fibre(Oburuoga and Anyika, 2012). The protein content of the grain is rich in methionine and cystein which are vital for human health and lacking in most cereals (Sarwar, 2013).

Diabetes mellitus is a metabolic disorder, where animals are unable to utilize the available glucose resulting in elevation of blood glucose level beyond threshold limits(Yadav et al., 2015). Nearly 347 million

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people are affected globally with diabetes mellitus and it is predicted to reach 592 million people by (Gupta et al., 2015).It is categorized into two types, Type 1 diabetes which results from insulin deficiency and type 2 diabetes that result from insulin resistance (Esser et al., 2014). The increased prevalence of diabetes is due to various reasons such as life style, obesity, population, ethnicity and genetic predisposition (Sivaprasad et al., 2012). Although many synthetic oral hypoglycemic agents and insulin are available for the treatment of diabetes, they do have some major disadvantages like incompetent oral consumption of insulin, side effects and toxicity caused due to synthetic agents(Surya et al., 2014).There is dearth of knowledge on the effect of acha grains on glucose index, therefore the present study was design to evaluate the effect of process variables (acha) on glycemic index.

MATERIAL AND METHOD

Sample collection

Acha was obtained from Research Centre of National Cereal Research Institute (NCRI), Bageggi, Niger State, Nigeria.

Sample Preparation

Acha was processed into six different forms as follows: dehauled, grounded and cooked (A); dehauled, ungrounded and cooked (B); dehauled, grounded and uncooked(C) undehauled, grounded and cooked (D); undehauled, ungrounded and cooked (E); undehauled, grounded and uncooked (F). Group g and H consist of diabetic control that received unaltered commercial feed and normoglycemic control that received unaltered commercial feed.

Diabetes Induction and Experimental Groups

Eight groups of albino rats with (five rats in each group) were label for identification, caged separately and used for the experiment. Initially, Blood glucose level of all animals in each group was also measured with the aid of glucometer by cutting the tail tip with sterile blade at 30 minutes interval after feeding the animals with different form of process acha for two weeks followed by intra-peritoneal administration of 40% glucose.

The animals were then fasted for 12 hours after fed with different form of process acha for two weeks. Chemically diabetes was induced through an intraperitoneal injection of streptozotocin (50 mg/kg) (STZ, Sigma). The STZ solution was prepared immediately prior to injection by dissolving the drug in a fresh, cold citrate buffer, pH 4.5. After 72 hours, blood glucose levels were measured using a portable glucose meter (One Touch II; Johnson and Johnson, Milpitas, CA). For such, the distal part of the tail was gently snipped; the first blood drop was discarded and the second was absorbed by a test strip inserted in the glucose meter. Rats were considered diabetic when the blood glucose level was at least 250 mg/dL. The glycemic index of all animals in each groups were evaluated at 30 minutes interval.

RESULT

The result of blood glucose levels from the rat that were injected with 40% glucose followed after feeding with different form of process acha was presented in figure 1. There was increase in blood glucose level at 30 minute post administration of 40% glucose to 114 (g/dL), 122(g/dL), 137(g/dL) and 175(g/dL) in group F, A, E and D respectively. Group g shows hyper glycemia glycemic index of 249.7 (g/dL). The glycemic index then drop to 122 (g/dL) in all the groups but increase to 338.2 (g/dL) at 60 min, 466.7(g/dL) at 90 min and slightly drop to 463 and 445.8 (g/dL) at 120 and 150 mins in group g.

The result of blood glucose levels from the rat that are experimentally exposed to streptozotocin (50 mg/kg) followed by feeding with different form of process acha was presented in figure 2. There was increase in blood glucose level at 30 min post administration of streptozotocin to 170 (g/dL) in all group that were feed with different form of process acha apart from group f (those that were fed with undehauled, grounded and uncooked) which shows 210 (g/dL) at 30 minutes. The blood glucose level was maintained for 60 to 90 min and later drop gradually to 189.3 in group f at 120 min and elevated to 183.3 at 150 min. The remaining group's shows low glycemic index compare to group f and g. High blood glucose was recorded in group g (diabetic control that received unaltered commercial feed) for up to 399 (g/dL) at 30 mins post administration streptozotocin to 436 (g/dL) at 150 min,

DISCUSSION

Metabolic disorders including diabetes mellitus are characterized with deleterious effect on body health and wellbeing of individual, prognosis of patients as well as health care system in the modern world(Zatalia and Sanusi, 2013). It is a chronic disease associated with high blood glucose level due to deficiency of insulin and/or impaired beta cells of the pancreas function. Type 2 diabetes is the most common among the majority of the world population which is accompanied by characteristic long term implications(Litmanovitch et al., 2015). There is global increase of diabetes burden with estimated

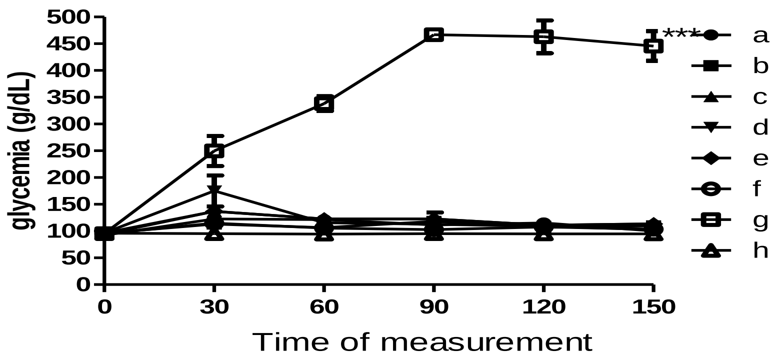

Figure 1: Effect of 40% glucose solution on the glycemic index of rats model (dehauled, grounded and cooked (A); dehauled, ungrounded and cooked (B); dehauled, grounded and uncooked(C) undehauled, grounded and cooked (D); undehauled, ungrounded and cooked (E); undehauled, grounded and uncooked (F). Group g and H consist of diabetic control that received unaltered commercial feed and normoglycemic control. Measurements were taken three times a week for 4 weeks. Values are mean of 5 animals. The first measurement is prior to the initiation of the experiment (time zero). *** On lines indicates statistically significant differences among all groups (p<0.001) ANOVA + Durnet test).hat received unaltered commercial feed) Percentage of glycemic index (mean ± SD).

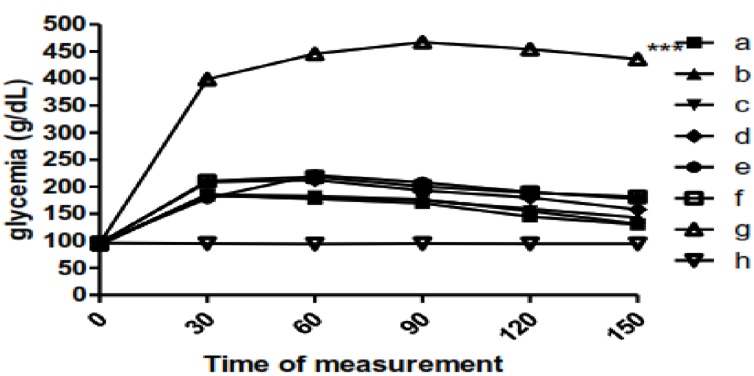

Figure 2: Effect of process acha grain variable on the glycemic index of diabetes induced rats model (dehauled, grounded and cooked (A); dehauled, ungrounded and cooked (B); dehauled, grounded and uncooked(C) undehauled, grounded and cooked (D); undehauled, ungrounded and cooked (E); undehauled, grounded and uncooked (F). Group g and H consist of diabetic control that received unaltered commercial feed and normoglycemic control. Measurements were taken three times a week for 4 weeks. Values are mean of 5 animals. The first measurement is prior to the initiation of the experiment (time zero). *** On lines indicates statistically significant differences among all groups (p<0.001) ANOVA + Durnet test).hat received unaltered commercial feed) Percentage of glycemic index (mean ± SD).

population of 346 million people having diabetes according to WHO stats(Lozano et al., 2012). Many synthetic drugs are being currently used for the treatment of diabetes but associated with several complications(Miller et al., 2014). Though, these drugs are efficient in treating diabetes, continuous usage results in various side effects such as liver toxicity and intestinal disorders(Holman et al., 2014). This increases the necessity for the search of antidiabetic medicines.

Present of bioactive compounds in plants such as grain, fruits and vegetables can have anti-oxidant, anti-inflammatory, anti-carcinogenic effects and can be protective against various diseases and metabolic disorders(Oh and Jun, 2014). The potential of these bioactive compounds make them good candidates for the development of new functional supplement with effective protective and preventive properties for type 1 and type 2 diabetes(Mirmiran, 2014). Compound like flavonoids, vitamins, and carotenoids are bioactive compounds found in most grains, fruits and vegetables that act as anti-oxidants, anti-inflammatories, anti-carcinogens, and protective agents against metabolic syndromes such as diabetes and coronary disease(Shashirekha et al., 2015). Polyphenolic compounds such as flavonoids and isoflavonoids are commonly found in fruits and plants(Ahmad et al., 2015). They fulfill many roles in plant physiology, including nitrogen fixation and flower pigmentation(Maleka et al., 2013). Because of their abundance, they make up a significant proportion of the human diet(Candrawinata et al., 2013). Flavonoids are antioxidants and have anti-inflammatory and protective effects on metabolic diseases(Zhang and Tsao, 2016).

There is little literature on the analysis of proximal analysis of acha grain. However, it has been reported that the total lipid content of acha grain is higher than that of polished and unpolished rice, wheat and barley but lower than that of maize, millet and sorghum (Macauley, 2015). The protein content of acha (106.0 g kgG for white variety and 125.0 g kgG for brown variety) is high compared to that of rice, millet, maize and sorghum (Rurinda et al., 2014). Total ash content for acha (36.0-42.0 g kgG) is higher than that of sorghum and maize(Chiremba et al., 2012). Acha is richer in calcium, magnesium, iron and copper than most cereals but poorer in potassium, sodium, lead and manganese(Rybicka and Gliszczyńska-Świgło, 2017). With the exception of methionine the essential amino acid content of acha is lower than in maize, rice, sorghum, millet, wheat, barley and oats (Cervantes-Pahm et al., 2014). The leucine, methionine and cysteine values in acha are slightly higher than the values in the FAO reference protein (Elshorbagy et al., 2011).There was no available literature or finding on bioactive component of acha grain. As such it will be very difficult to predict whether the antidiabetic activities of the grain are due toavailability of phenolic compound such as flavonoids or not

Conflict of Interests

The authors declare that there is no conflict of interests regarding the publication of this paper.

CONCLUSION

We prove in this study that acha grain reduces the blood glucose levels compare to commercial feed. As a result of its safety and low cost, especially its fewer side effects, acha grain has high potential in regulating glucose metabolism. There is need for the *in vivo* and *in vitro* evaluation of it antioxidant potential as well as identification and or isolation of bioactive compound.

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