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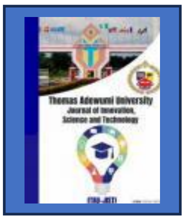

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RESEARCH ARTICLE

DETERMINATION OF GLUCOSE LEVEL IN KUNU SAMPLES COMMONLY CONSUMED IN KANO METROPHOLIS

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ABSTRACT

Knowledge of glycemic response were investigated using kunu samples as source diets which play an important role in making sound advice on recommended calorie intake. Each participant's blood sugar level relative to a particular diet is highly variable due to changes in food intake, socio-demographic background and inflation rate. Therefore, the this study was designed to evaluate kunun Gyada, kunun Aya, kunun Tsamiya and kunun Zaki samples among (84) subject regarding their diet converted to blood sugar at an increased rate compared to D-glucose level. Sixty nine (69) Volunteer persons were recruited for the experiment and served with the kunu samples. The test food forms consists of 50 g refined D-glucose (carbohydrate) obtained from Novo-Med pharmaceutical, Kano with different kunu samples purchased from vendors in Kano metropolis. This study were carried out in an interval of 60 minutes from 0, 60, 120 and 180 minutes respectively. The participants fasting blood glucose sugar were measured using an Accu-chek active glucose meter (glucometer + strip) with an average mean value between 88.0 and 97.0 mg/dl after 0 minutes of the assessment, followed by 100.4 – 139.0 mg/dl after 60 minutes and 92.5 – 121.6 mg/dl in 120 minutes to 97.75 – 99.0 mg/dl with blood glucose level gradually increased from 0 – 50 mg/dl. All the kunu samples had glucose concentrations within the standard glucose levels established by FDA. Therefore, this study showed that kunu sample can be used to assess an individual' blood glucose level, providing adequate energy needed during prolonged fasting which could be recommended for the assessment of blood glucose / sugar level in the brain, especially among low-income families who could not afford a nutritionally balanced diet consistently.

KEYWORDS

S Glycemic, Response, D-glucose, Kunu and Incremental

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Introduction

The concept of glycemic Response (GR) was introduced as a means of classifying different sources of carbohydrates (CHO) and CHO-rich diets (Bjorck, *et al.,* 2015). The classification is based on their effects on postprandial blood glucose, with different carbohydrate foods having different effects on the glycemic response (Evans and Gajere, 2017; Brouns *et al.,* 2005). GI refers to the ranking of foods in their ability to increase blood sugar levels, compared to a standard food (glucose or white bread) (Evans and Gajere, 2017).

According to the Glycemic Task Force (2002), GR is defined as "the additional area under the hyperglycemic curve after ingestion of 50 g of glycemic carbohydrate from the food tested over 2 hours in healthy subjects and in 3 hours for people with diabetes from the start of the test meal, compared with ingestion of the same amount of glycemic carbohydrate from oral glucose with 300 ml of water over a period of 10–15 minutes to 1 hour, consistent with experimental procedure determined in the same individual under the same condition using fasting blood glucose concentration as a reference (Oboh, *et al.,* 2016; Evans and Gajere, 2017).

Glycemic index is the relative ranking of carbohydrates in a food based on their impact on glucose levels. It measures the impact of carbohydrates on blood sugar levels as reported by Landin *et al*., (2019). Carbohydrates with a low glycemic index (55 or lower) are digested, absorbed, and metabolized more slowly, leading to lower and slower increases in blood sugar and therefore insulin levels (Rizkalla *et al*., 2002).

The concept of glycemic index were developed to provide a numerical classification of carbohydrate-rich foods, assuming that such data would be useful in situations where glucose tolerance is impaired (David *et al.,* 2002). The glycemic index concept is an extension of FAO (2000) fiber hypothesis which suggests that food that are absorbed more slowly may have beneficial effects on metabolism, anti-diabetic properties and reduces coronary heart disease (CHD). The concept of diseases related to intra-abdominal fat mass accompanied by insulin resistance is being developed (Landin *et al.,* 2019).

Research in this area had been impacted greatly by compilation of comprehensive glycemic index food tables (foods with a high Foster-Powell index and high glycemic index cause blood sugar levels to rise more rapidly) and suitable for recovering energy after rigorous exercise or for people with diabetes (Hu *et al.,* 2012), having hypoglycemia may also indicate greater extraction of carbohydrate digestion products from the liver and periphery (Foster-Powell *et al.,* 2000).

The GR is defined as the additional glycemic zone after the test food, expressed as a percentage of the corresponding zone after the carbohydrate equivalent of the product compared to the reference glucose. GR ranges from less than 20 to about 120 percent (originally the reference food was glucose, but more recently white bread are also used (Bjorck, *et al.,* 2015).

Glycemic response / index may be associated with prevention of hypoglycemia (Hu *et al.,* 2012). In addition, insulin resistance and insulin-like growth factors have been implicated in this phenomenon – known as diet-related cancer: colon, breast and prostate (McKeown-Eyssen, 2019). A sedentary lifestyle combined with a high glycemic response diet increases the risk compared to a sedentary lifestyle with a low dietary glycemic response or compared to an active lifestyle with a low glycemic response (Hu *et al.,* 2012).

An Italian case-control study reported that dietary glycemic response were associated with colorectal risk, meaning that the higher the glycemic index, the more the risk of colorectal disease. A similar relationship between glycemic index and disease had been demonstrated for breast cancer patient (Augustin *et al.,* 2001). Prostate and ovarian cancer, along with other forms of cancer, can be affected by the glycemic variation of diet. In these cases, insulin resistance and insulin-like growth factors are also implicated (Hu, *et al.,* 2012, 2016). Thus, much of the epidemiological literature provides additional evidence supporting the role of dietary glycemic response in disease control and curing.

The glycemic response of carbohydrate-rich foods provides an estimate of how quickly carbohydrates are broken down during digestion and how they are absorbed into the bloodstream (Esfahani *et al.*, 2009). There is consensus on the carbohydrate quality and quantity as a key predictor of glycemic response as reported by Thomas and Elliott, (2010) and low glycemic index and/or low glycemic load have been demonstrated to improve glycemic control especially in patients with type 2 diabetes (Evert *et al.,* 2014).

Foods rich in carbohydrate that are quickly digested and absorbed into the blood are classified as high glucose foods. Foods with a high GR quickly increase blood sugar and insulin responses after eating (Thomas and Elliott, 2010). In contrast, low-GR foods had slow and lesser effects on blood sugar and post-meal insulin response because they are digested slowly. Several factors determine the GR of foods (Arvidsson-Lenner, *et al.,* 2004) which including the type of carbohydrate (amylopectin-rich starches are easily digested and absorbed, while amylose-rich starches are absorbed slowly, as well as protein and fat content and the amount and type of fiber present (water-soluble fiber slows blood sugar levels after meals, while water-insoluble fiber has no effect this), and finally the size and pH of the food particles (Rizkalla, *et al.,* 2002; Di-Nicolantonio, *et al.,* 2017; Bolade *et al.*, 2009).

"Kunu" drink (a non-alcoholic fermented Nigerian traditional beverage widely consumed in northern part of Nigeria) is produced from grains such as; millet, maize, sorghum, wheat and Acha (Gaffa, *et al.*, 2012). The locally produced drinks constitute a great health benefits such and diuretic, choleretic, antipyretic and hypotensive effects, reduce blood viscosity and stimulate intestinal motility. It is a mild and completely natural diuretic (Rose, 2003). However, Kunu drinks are increasingly consumed in southern Nigeria due to their refreshing nature. It has a sweet and sour taste and a creamy consistency (Sowonola, *et al.,* 2015). It is also used as a weaning food consumed by nursing mothers to boast their breast milk (Sowonola *et al.,* 2015). Therefore, this research article aimed at assessing the impact of traditional Nigerian Kunu (gruel) in glycemic response increments of Kunu samples in reference to 50g of glucose.

Materials and Method

Sample Collection

The kunu samples used in this study includes; (kunun Gyada, kunun Tsamiya, Kunu Zaki and Kunu Aya) previously prepared by vendors, D. Glucose (Evans Nigerian Limited products) were purchased from Novo Med pharmaceuticals, court road, Kano. The glucometer accu-chek model with active strip where purchased from welfare Nigerian Limited.

Sample Size and Sample Collection

The sample size were drown from the total population size of (84) students studying nutrition and dietetic in Federal college of agricultural produce technology which compresses of male and female without history of diabetes, no glucose metabolic disorders, non-pregnant woman who volunteered to participate in this study were all included.

Sixty nine (69) participants were randomly selected from subset of individuals based on their availability, and medical history and ability to fast from the total population of (84) students in the department were given equal chance of being selected / recruited in this study using a simply random sampling technique described by Yamane, (1976) following the method below:

$$n = \frac{N}{1 + N\,(0.05)^2}$$

$$n = \frac{84}{1 + 84\,(0.05)^2}$$

Where: n = sample size

N = population size

$(e)^2$ = margin of error

1 = constant value

Method of Analysis

Determination of Glucose Response

Prior to this study a clerical consent were presented to all the participants seeking for their willingness to participate in this study through the head of department and the individual subjected. The participants went through an over-night fasting after which their blood sample were collected and analyzed for fasting blood glucose early the following morning (GI Task Force, 2002).

The blood glucose level were determined using a method described by Evans and Gajere, (2017) were area under curve (AUC) were used. Fast blood glucose (FBG) level were determined using Accu-chek digital glucometer, where the participants fasting blood sugar level were taken and analyzed using glucometer strip and accu-chek glucometer device, followed by the test samples administered in an interval of 60 minutes, while the blood glucose sugar level analyzed and the reading recorded in Mmol/dl following a method described Wolever *et al,* (2003).

Fifty grams (50g) of anhydrous glucose were administered to each of the participant and their blood specimen taken every half an hour that is (60 minutes interval) for four (4) consecutive times. The participants were divided into four groups before administering the fifty grams (50 g) of the kunu samples i.e. seventeen persons per group and their blood sugar level were monitored every half hour for five times as described (Wolever *et al,* 2003).

The glycemic index were calculated geometrically using the method described by Evans and Gajere, (2017) as the incremental area under the blood glucose response curve of a 50g carbohydrate portion of the test food.

$$GR = \frac{IAUC}{IAUCS} X\ 100\ \%$$

Where:

The GR classifications are grouped into high (70-100%), moderate (50-70%) and low glycemic response (<50%) CHO foods.

IAUC= Incremental area under curve for test food,

IAUCS= Incremental area under curve for standard (glucose-D).

Statistical Analysis

The results generated in this study were analyzed using (Minitab 17) statistical software for analysis of variance (ANOVA). The results were analyzed for mean and standard using one way analysis of variances and least significantly different (LSD) was obtained using Turkey's test at (P ≤ 0.05) as described by (Onwuka, 2018).

Results And Discussion

Glucose and Kunun Gyada Responses to Blood Glucose Levels

Glucose and Kunun Gyada Responses to Blood Glucose Levels in Table 1. Shows the results of the glycemic response and ascending blood glucose level for the Kunun Gyada sample in a healthy subject were performed over a 60 minute period by sampling from 0, 60, 120, and 180 minutes, respectively. The results showed that the respondents' fasting blood sugar at 0 minutes showed an average value of 98.0 mg/dl, followed by the blood sugar level of 139.0 mg/dl at 60 minutes with a significant increase in blood sugar of 42 mg/dl, While the Kunun Gyada sample had an average mean value of 100.5 mg/dl at 120 minutes with a significant decrease in blood glucose level at increasing levels 3.5 mg/dl and the least blood glucose level was 97.75 mg/dl over 180 minutes responded with a mean value 0.75 mg/dl with an incremental blood glucose levels. Meanwhile, Kunun Gyada' blood sugar response showed a significant increase (89.0 - 105.4 mg/dl) from 0 to 180 minutes with a gradual increase from (10.8 - 18.6) from the lowest 0 minute to the highest blood sugar increase after 180 minutes respectfully.

Table 1: Glucose and kunun Gyada responses to blood glucose level

Time (min)	GLUCOSE Blood Glucose mg/dl	Incremental blood glucose (mg/dl)	KUNUN GYADA Blood Glucose (mg/dl)	Incremental blood glucose (mg/dl)
0	97.0±14.70	0.0	89.0±4.98	0.0
60	139.0±43.50	42	107.6±3.67	18.6
120	100.5±16.44	3.5	99.8±4.53	10.8
180	97.75±16.09	0.75	105.4±9.22	16.4

Table 2, shows the results of Blood Glucose and Kunun Aya response and the increase in blood glucose level of the respondents. The results showed that at 0 minutes, the average blood sugar level was 90.4 mg/dl, the Kunun Aya sample taken had a blood sugar value of 89.2 mg/dl, continued followed by 129.6 mg/dl after 60 minutes with a significant increase of 39.2 mg/dl until the blood glucose level in the kunu Aya sample was 104.0 mg/dl with the blood glucose level slightly decrease to 14.8 mg/dl at 120 minutes, blood glucose and sugar levels obtained from kunun Aya samples were significant with mean values of 100.2 and 99.8 mg/dl with a corresponding increase of 9.8 and 10.6 mg/dl for glucose and kunun Aya samples after administration for a period of 60 minutes, which shows that the carbohydrate content of kunun Aya significantly increased blood sugar levels at 180 minutes, blood sugar level decreased slightly and increased as blood sugar level increased and kunun Aya samples had a mean value of 98.4 and 105.2 mg/dl with incremental blood glucose level ranged from 8.0 – 14, mg/dl.

Table 2: Glucose and kunun Aya blood glucose responses

Time (min)	GLUCOSE Blood glucose mg/dl	Incremental blood glucose (mg/dl)	KUNUN AYA Blood glucose (mg/dl)	Incremental blood glucose (mg/dl)
0	90.4±14.1	0.0	89.2±6.88	0.0
60	129.6±25.1	39.2	104.0±6.90	14.8
120	100.2±15.9	9.8	99.8±15.3	10.6
180	98.4±15.8	8.0	105.2±13.01	14.0

Glucose and Kunun Tsamiya Response in Blood Glucose

Table 3 shows the result of commercial glucose samples and kunun Tsamiya on superficial blood glucose level response with blood glucose level increasing significantly after a period of time. An increase in blood glucose due to glucose consumption and kunun Tsamiya had a mean value of 88.0 and 98.0 mg/dl with a significant increase after 60 minutes and 130.0 and 133 mg/dl with an increase in blood glucose level of 50.0 and 32.0 mg/dl over a period of 120 minutes.

The blood sugar level of kunun Tsamiya sample was higher than that of commercial D-glucose. However, the amount of glucose increased significantly compared to the kunun Tsamiya sample an average value 121.6 – 113.6 mg/dl), contributing to the increase in incremental blood glucose level of 15.6 – 33.6 mg/dl of glucose in blood after consumption. While at 180 minutes, the results showed an average value of (95.0 and 103.0 mg/dl) as shown in Table 3 with a significant increment from 27.4 – 61.5 mg/dl.

Table 3: Glycemic response of Kunun Tsamiya and D-Glucose

Time (min)	GLUCOSE Blood glucose mg/dl	Incremental blood glucose (mg/dl)	KUNUN TSAMIYA Blood glucose (mg/dl)	Incremental blood glucose (mg/dl)
0	88.0±6.67	0.0	98.0±12.08	0.0
60	133.0±24.8	50	130.0±14.6	32.0
120	121.6±11.0	33.6	133.6±16.1	21.0
180	95.0±13.3	7.0	103.2±15.0	5.2

D-Glucose and Kunun Zaki response in Blood

The results of this article presented in Table 4 shows the results of the glycemic response of D-glucose and Kunun Zaki as it contribute to blood glucose level where glucose was taken during fasting period and the Kunun Zaki administered in an interval of 60 minutes from 0 - 180 minutes to monitor the degree of hyperglycemia after consuming the kunun aya samples.

The results showed that D-glucose intake had an average mean value of 92. 2 - 100.4 mg/dl, in which blood sugar was high at 60 minutes with an increase in blood glucose level with 7.9 mg/dl while at zero minutes with the lowest average mean value of 92.2 mg/dl without a significant increase in the subject's blood sugar level. Meanwhile, the kunun Zaki samples administered to the subjects had average mean value of 77.4 – 104.8 from 0 minutes to 180 minutes, respectively.

The results showed that the minimum blood sugar level assessed at 0 minutes with a mean value of 77.4 and increased at 60 minutes 109.2 mg/dl, 120 minutes had a blood glucose level of 98.4 mg/dl and lastly at 180 minutes had an average mean value of 104.8 mg/dl corresponding results showed that blood sugar levels increased significantly from the lowest to highest levels of the administered subjects with mean values ranging from 21.0 to 31.8 mg/dl, this implies that the consumption of kunun Zaki may contribute significantly to an individual's blood sugar levels over a period of time.

Table 4: Glucose and kunun Zaki responses in blood glucose level

Time (min)	GLUCOSE Blood glucose mg/dl	Incremental blood glucose (mg/dl)	KUNUN ZAKI Blood glucose (mg/dl)	Incremental blood glucose (mg/dl)
0	92.2±15.8	0.0	77.4±11.8	0.0
60	100.4±26.1	7.9	109.2±7.0	31.8
120	92.5±22.9	0.25	98.4±19.2	21.0
180	99.00±20.1	6.5	104.8±14.2	27.4

Discussion

A large number of participant's dietary patterns falls within high glycemic response categories, with a variation in blood glucose largely depending on the type of diet consumed due to amylose content of the samples and the processing methods involved. Carbohydrate content of the kunu samples evaluated includes: kunun Gyada, kunun Aya, kunun Tsamiya and kunun Zaki, which had different blood sugar levels and glycemic response values depending on the chemical structure, composition, particle size and portion size served and the absorption rate plays a significant role blood glucose level increments, were this article agreed with the findings report of (Brouns *et al.,* 2005; Vonk *et al.,* 2005). The digestion and absorption of different kunu samples depends on the structural differences of the food molecule and the rate at which the enzyme amylase hydrolyzes glucose sugar molecules which enhance their absorption rate into the blood stream (Omoregie and Osagie, 2008).

Kunun Gyada sample is a delicacy consumed by indigenous people of Nigeria, blood sugar levels increased rapidly reaching maximum levels after 30 minutes of diet consumption which increase significantly after 180 minutes with a significant blood glucose increments which implies that kunun Gyada samples increase the glucose level rapidly thereby providing the needed glucose to the brain and other tissue. This means that kunu Gyada were quickly digested and absorbed into the bloodstream rising the blood glucose level above the glucose increments level altering carbohydrate adequate to shifts postprandial glucose levels and blood insulin responses to short-term peaks (Wong and O'Dea, 1983).

Kunun Aya drinks increase the blood glucose response from moderate to high after 60 minutes of drinking which act faster. “Kunun Zaki” always maintained high blood sugar levels for long periods of 60, 120 and 180 minutes Table 4 which may be attributed due to the preparation method that undergoes a partial fermentation thereby increased malt content in cereal in the grain used due to the filtration and sun drying leading to loss of water content with gradual re-association of starch molecules resulting into slow digestion / metaboslism (FAO/WHO, 2000). Re-association of starch molecules in kunun Gyada and Tsamiya would reduce the digestibility of kunu, as it had been noted in similar findings by (Pisunyer, 2002).

“Kunun Aya” consistently maintained low blood sugar levels compared to other kunu samples assessed over a long period of time. Kunun Aya may be a popular local beverage for weight control and other health benefits, such as diabetes, cancer management etc as reported by (Oboh, *et al.,* 2010). Kunun Tsamiya porridge peaked at 0 minutes which implies that Kunun Tsamiya slight increase in blood glucose levels and peaked at 60 and 120 minutes which is said to be suitable for diabetics because glucose molecules are slowly absorbed into the blood and are believed to effective controls the insulin secretion in type 2 diabetes, as recommended by (Oboh *et al.*, 2010).

Kunu zaki samples showed high blood glucose level with low incremental glycemic response, peaked at 0 minutes and increasing significantly at 60 and 120 minutes, respectively. These types of diets help regulate blood glucose levels and insulin secretion.

Kunun Gyada had low glycemic response due to its high content of fat and absorbed protein, so it is resistant to amylase digestion and releases glucose into the blood slowly (Ramdath *et al.,* 2004).

Kunun Zaki drinks peak after 60 minutes of drinking and Kunun Aya slowly increased blood glucose levels and peaks after 45 to 120 minutes compared with the results of Kunun Tsamiya and Kunun Zaki which are easy to digest and provide blood glucose higher than the D-glucose administered products containing starchy seed less susceptible to gelatinization (Wolever *et al.*, 1996).

Kunu patterns such as Kunun Gyada, Kunun Tsamiya, Kunun Aya and Kunun Zaki are forms of food that increase blood sugar levels slowly but for a short period of time and are described as good glycemic index diets, which can be observed as an important tools in controlling hyperglycemia and other related diets and metabolic diseases. These food forms play a potential role in dietary control strategies aimed at preventing and treating diabetes and obesity as reported by (Oboh et al., 2010).

Ludwig *et al.,* (2022) observed that kunu patterns have the ability to influence how food is digested and absorbed into the blood as a major component of dietary fibre, thereby rapidly increasing blood sugar levels. These samples of kunu produced compared to commercially refined glucose are classified as sources with a high glycemic index and cause significant increases in blood sugar levels as a result, counter regulatory hormones such as insulin are secreted to regulate blood sugar levels (Gilberston *et al.,* 2001). Therefore, the results of this study could serve as a guide for dietitians and nutrition in tailoring dietary recommendations for patients who require specific calorie intake during diet from a light food such as kunu based on their glucose incremental level in the blood.

Conclusion

The results of this findings provide relevant information on the glycemic response to kunu, a traditional Nigerian gruel. The study contributes to the understanding of how different kunu variants affect blood glucose levels. It can be concluded that high glycemic response of the studied kunu samples as a source of diet for regulating blood glucose levels resulted in a significant increase when consumed for a period of 60 minutes or more, which serves as a good source of blood glucose sugar and hence, recommended for consumption between meals, after long starvation or fasting. The variant kunu samples assessed showed that, it increases blood glucose levels thereby increasing the insulin level and also regulate supplies to the brain and other part of the bodies. Cereals base kunu makes up a significant proportion of Nigerian diet patterns had a high blood glucose sugar content from 60 minutes of consumption showed a significant impact on increment when compared with D-glucose. The practical implication of this study suggests that kunu samples is associated with oxidative stress when consumed excessively. Therefore, there is a need to improve the consumption of kunu as a source of rapid blood glucose sugar supply.

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