Determination of Glycemic Indices of Flour and Starch Components of Selected Maize and Millet Cereal Varieties in Diabetic Rats

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Abstract: *Eighteen (18) male albino rats were used to determine the glycemic indices of flour and starch component of two varieties, each, of maize and millet grains. The flour was obtained by milling the grains while the starch components were extracted from the grains using the method of Signh and Sadh (2009). Steeping, grinding, sieving and several rounds of centrifugation were carried out to obtain the starch component. The rats were administered with alloxan monohydrate (120mg/Kg body weight) to induce diabetes in them. After a twelve hour fast, fasting blood samples were collected by tail tipping and blood glucose analysed. The animals were then fed within fifteen minutes with test feed and further blood samples collected at 30, 60, 90 and 120 minutes from the commencement of feeding and analysed for blood glucose level using portable active accu-check glucometer. Two rats were fed with anhydrous glucose used as refernece feed. The area under the curve (AUC) for all the test and reference feeds were calculated by plotting the graph of blood glucose level in mg/dL against time in minutes. The glycemic indices were calculated by dividing the AUC of the test feed by that of the reference feed and multiplying by 100. The flour components of both the maize and the millet varieties gave lower glycemic index (maize sammez-11 flour gave G.I. of 66.88±1.44 while maize sammez-14 flour gave G.I. of 64.56±3.70. The flour components of finger millet flour gave G.I of 69.61±3.59 and that of pearl millet gave G.I. of 56.54±2.39) than their starch components (maize sammez-11 starch gave G.I. of 82.29±8.68, maize sammez-14 gave G.I of 79.25±2.03, finger millet starch gave G.I of 74.17±4.98 while pearl millet starch gave G.I. of 62.58±3.25). Pearl millet flour gave the lowest glycemic index (56.54±2.39) while sammez-11 maize starch gave the highest glyceimic index (82.29±8.68). In conclusion, cereal starches such as maize starch and millet starch are better consumed in their natural whole form.*

Keywords: *Diabetes, Hyperglycemia, Carbohydrates, Alloxan, Blood*

Introduction:

Diabetes is a condition primarily defined by the level of hyperglycemia giving rise to the risk of micro vascular damage: nephropathy, retinopathy and neuropathy (WHO, 2003). Recent estimates indicate there were 171 million people in the world with diabetes in the year 2000 and this is projected to increase to 366 million by 2030 (WHO, 2003).

Diabetes mellitus is a syndrome typically characterized by disordered carbohydrate metabolism causing abnormally high blood sugar (hyperglcemia). This results from insufficient level or action of hormone, insulin. The symptoms are excessivr urine prodcution (polyuria) due to high blood glucose levels, excessive thirst (polydipsia) and increased fluid intake an attempt to compensate for increased urination (Paparakis, 2002).

Type 1, type 2 and gestational diabetes, which occurs during pregnancy, are the three main forms of diabetes recognized so far by the World Health Organization (WHO, 1999).

All carbohydrates, whether in form of starch or disaccharides such as sucrose and lactose are metabolized to the monosaccharide, glucose. Carbohydrates enter into circulation as glucose, causing a temporary rise in blood glucose levels. This glycemic response is the basis for the increasingly popular measure knwon as the glycemic index, G.I. (Jenkins and Wolever, 1981).

The glycemic index (G.I.) is a numerical scale used to indicate how fast and how high a particular food can raise blood glucose. The glycemic index measures starch digestibility through comparison.

Since the inception of glycemic index, it has been the subject of series of scientific studies and the basis for several popular diet plans (Brand-Miller and Wolever, 2005).

The G.I. value of an individual food can vary widely depending on its type, the manner of processing and preparation. The processing and preparation of cereal based meals in Northern Nigeria for consumption involves such treatment as steeping (soaking), de-husking, or removal of bran and elimination of fibre content, a treatment popularly known as "tsurfe" in Hausa language. These treatments may have impact on the glycemic indices of these staple foods. The aim of this research, therefore, was to determine the glycemic indices of flour and starch components of two varieties of maize (Sammez-11 and Sammez-14) as well as finger millet and pearl millet.

Materials and Methods:

Eighteen (18) male Wister albino rats weighing between 120g-180g were purchased from the animal house of Biological Science Department, Bayero University, Kano. The rats were induced with diabetes by single intraperitoneal injection of alloxan monohydrate (120mg/Kg bw). Two rats were used for determining the glycemic index of the flow and starch components of two varieties, each, of the sample grains. Two rats were fed with anhydrous glucose (control feed). Eight rats were induced per day for a particular crop cereal (two varieties per cereal) in both the flour and starch-fed samples. IN each cage, one of the two rats was marked with 0.12 ml of alloxan monohydrate (Etuk and Muhammed, 2010). After a 12 hour overnight fast, fasting blood glucose samples were collected by tail tipping and their blood glucose level analysed using portable glucometer. The rats were then fed with test feed containing 10g carbohydrate (Eggum *et al*., 1982) and water. The animals ate the test feeds at a comfortable pace within 15 minutes and had further tail tipping blood samples collected and analysed at 30, 60, 90 and 120 minutes after commencement of feeding. The blood samples were analysed for blood glucose using accu-check active glucometer. Incremental Areas Under the Curve (AUC) were calculated from the plotted graphs for each rat (Wolever, 1991). The incremental starch components for the test feed for each rat was expressed as percentage of the mean Area Under the Curve for the two rats fed with control (reference) feed to get the glycemic index (G. I.).

Results:

According to Hamilton (2005), a glycemic index of less than 55 is considered low, 56-69 is considered medium and greater than 70 is high. The glycemic indices of the tested maize varieties are given below.

Table 1: Glycemic Indices for Flour and Starch Components of Sammaz-11 and Sammaz-14 Maize Varieties.

Cereal Variety	Glycemic Index
Maize (Sammaz-11) flour	66.88±1.44
Maize (Sammaz-11) starch	82.29±8.68
Maize (Sammaz-14) flour	64.56±3.70
Maize (Sammaz-14) starch	79.25±2.03

Values are three determinations ± SEM

The resulting glycemic indices for the tested millet varieties are given below

Table 2: The Glycemic Indices for Flour and Starch Components of Finger and Pearl Millets.

Cereal Variety	Glycemic Index
Millet (Finger) flour	69.61±3.59
Millet (Finger) starch	74.17±4.98
Millet (Pearl) flour	56.54±2.39
Millet (Pearl) starch	62.58±3.25

Values are three determinations ± SEM

Discussion:

From table 1 above, Summaz-14 flour has the lowest glycemic index of 64.56±3.70 while Summaz-11 starch has the highest glycemic index of 82.29±8.68. The factors that contribute to the resulting difference in glycemic indices between the flour and starch components of both varieties of maize may be fibre content, amino acid content, and amylose: amylopecting ratio, which is in agreement with the work of Wolever (2006). Flyod *et al* (1968) established that amino acid stimultes insulin secretion and insulin lowers postprandial blood glucose concentration. In a similar vein, Bornet *et al* (1987), in their study of glycemix index (G. I.), protein and fats were added to carbohydrate meal from six different carbohydrate foods in subjects with type 2 diabetes. They asserted that the addition of protein and fat reduced the glycemic response of the six foods. Summaz-14, also known as Quality Protein Maize (QPM), is richer in protein than Sammaz-11 because of the higher levels of lysine and tryptophan contents. The higher level of protein in Sammaz-14 may have contributed to lower glycemic index of Sammaz-14 maize variety, compared to Sammaz-11 variety.

The fibre content in the flour may have played a role in lowering the glycemic index of flour component in comparison to the starch component. The fibre contained in carbohydrate foods may block the activities of amylase enzymes, thus contributing to reduction in glucose absorption (Thorbun *et al.,* 1987).

The differences between the glycemic indices of Sammaz-14 and α-1,6-glycosidic bonds in amylopectin component of the starch. Amylose has only α-1,4-glycosidic bonds and, therefore, undergoes less hydrolysis than amylopectin which has both α-1,4- and α-1,6-glycosidic bonds. The α-1,6-glycosidic linkages make the hydrolysis of amylopectin to glucose faster during digestion process because of easy access by amylase enzymes. Therefore, the higher glycemic index observed in Sammaz-11 starch may have resulted from higher α-1,6-glycosidic bonds in its amylopectin starch component.

From table 2, finger millet flour has glycemic index of 69.61±3.51, while pearl millet flour has glycemic

index of 56.54±2.39. The starch component of finger millet gave glycemic index of 74.17±4.98, while that of pearl millet was 62.58±3.25. Therefore, pearl millet flour has the lowest glycemic index of all the millet components and finger millet starch has the highest glycemic index.

Becka and Lorenz (1987), in their work titled "characteristics of of isolated starch of sorghum and millet", reported that the protein component of 100g pearl millet is 11g while the protein content of 100g finger millet is 7.3g. They also gave the fat contents per 100g of pearl millet to be 4.8g and that of 100g finger millet to be 1.3g. It can therefore be deduced from these findings that the lower glycemic index of pearl millet in the present study may be due to higher protein and fat content in Peral millet.

Becka and Lorenz (1987) observed also that the amylose: amylopectin ratio in pearl millet is 21.19% to 78.90% while that of finger millet is 16.60% to 84.00%. Since hydrolysis of amylopectin is faster than that of amylose because of branched α-1,6-glycosidic bonds, the higher amount of amylopectin in finger millet (84%) may have led to higher and faster postprandial blood glucose concentration from finger millet meal (flour and starch) and therefore higher glycemic index.

In conclusion, cereal starches such as maize starch and millet starch are better consumed in their natural whole form. Such treatments like removal of bran, steeping and other processes that remove fibre and other natural compositions of grains before consumption, as commonly practiced in most parts of Northern Nigeria, enhance hyperglycemia after consumption. It is also clear from the present research that glycemic index may also vary even among varieties or species of the cereal crop.

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