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Quantitative evaluation of sugars in some fruits consumed by patients with type 2 diabetes mellitus in Jos metropolis

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Abstract
Diabetes mellitus is a disease presently ravaging the human race. Many factors are responsible for the cause of the disease, such as genetic malfunctioning of pancreas, hyperglycemia and high sugar intake thereby over laboring the insulin. The need to evaluate the sugar content of commonly consumed fruits by patients with diabetes was imperative in order to enhance proper management of the disease. The fruits were obtained from the Jos environment after considering a questionnaire administered to the patients in Jos, and analyses of the sugars were performed using established standard procedures. The result of the study indicates that garden egg, pawpaw, orange, water melon and apple were relatively low in glucose, while banana, guava and mango fruits were high in glucose. The study therefore lends support to the consumption of some fruits by diabetes mellitus patients.

Keywords: Sugars, Fruits, Diabetes mellitus

INTRODUCTION

Diabetes Mellitus (often referred to as diabetes) is a disease characterized by a high level of glucose (sugar) in the blood due to lack or low level of circulating hormone, insulin, in the blood (Akubue, 2009). Diabetes mellitus is also defined as a group of metabolic diseases characterized by hyperglycaemia resulting from defects in insulin secretion, insulin action or both (Carpenter and Coustan, 1982). It is a hereditary, metabolic diseases characterized by hyperglycaemia and eventual glycosuria (Aguwa, 2004).

Diabetes is a very serious condition, as it can lead to severe illness and even death. Variations in blood sugar level, too low and too high (hypoglycemia and hyperglycemia), can lead to atherosclerosis (fatty deposit build up), neuropathy (loss of nerve function), retinopathy (eye disease and leading cause of blindness) and nephropathy (kidney damage), (Adler *et al*., 2000). Cardiovascular disease could result due to arteriosclerosis. There could be diabetes in pregnancy. Also there could be diabetic comas resulting from diabetic hypoglycemia, nonketotic hyperosmolar and diabetic ketoacidosis (DKA) (Stewart *et al*., 2007).

Ketoacidosis and Hyperosmolar Hyperglycemia are two most serious acute metabolic complications of diabetes. These

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disorders can occur in both types 1 and 2 diabetes. The mortality rate in patients with diabetic ketoacidosis (DKA) is <5% in experienced centers, whereas the mortality rate of patients with hyperosmolar hyperglycemic state (HHS) still remains high at approximately 15%. The prognosis of both conditions is substantially worsened at the extremes of age and in the presence of coma and hypotension, De Fronzo *et al*. (1994).

Glycemic index (GI) is a numerical scale used to indicate how fast and how high a particular food (fruit) can raise blood glucose (blood sugar) level. A food with a low glycemic index will typically prompt a moderate rise in blood glucose, while a food with a high GI may cause blood glucose level to increase above the optimal level, Brand-Miller (2003). An awareness of foods' (fruits') GI can help control blood sugar levels and by so doing help prevent heart insulin resistance and type-2 diabetes, prevent certain cancers, and achieve or maintain healthy weight. A substantial amount of research suggests that a low GI diet provides these significant health benefits (Jenkins *et al*., 2002).

The blood sugar (glucose) that is delivered to the cells throughout our bodies via our bloodstream is partly derived from the carbohydrates in the foods (fruits) that we eat. A food with a low glycemic index typically raises blood sugar. High carbohydrate food (fruits), even wholesome foods that are high in carbohydrates such as satisfying whole grain breads, delicious fruits, starchy vegetables and legumes, can have an effect on blood glucose (Pi-Sunyer, 2002).

The presence of glucose in the bloodstream usually triggers the production of insulin, a hormone that helps glucose get into cells where it can be used for energy. Once immediate energy needs have been met, extra glucose still remaining in the bloodstream can be used. If the muscle and liver stores of glucose are full, and there is extra glucose floating around in the blood, then insulin can help the body store this excess sugar as fat (Broadhurst *et al*. 2000).

Insulin helps glucose get into cells where energy is made. Insulin is vital to fueling the body. However, too much insulin secretion over long periods of time can cause problems. Research shows that prolonged exposure to elevated levels of insulin can cause. The comprehensive care or management of diabetes mellitus patient in the modern age is not based on food stoppage, but on food moderation/restriction (life-style modification), and blood sugar control.

The tendency to prohibit them from eating the foods or fruits they are used to before, may result to complete non-compliance even with their medications. Hence, the need to scientifically evaluate the sugar content of these fruits. The information obtained could be used during counseling and monitoring of the patients

EXPERIMENTAL

Questionnaire was prepared (both structured and unstructured) and administered on the diabetes mellitus patients that visited the diabetic clinic in Jos University Teaching Hospital, Jos, Plateau State, in the months of April and May, 2010. This was done in order to obtain the name of the fruits that are mainly consumed among the diabetes mellitus patient population.

To analyze the sugar concentration in the various fruits, the Lane and Eynon method in which the reaction is followed titrimetrically using a redox indicator was used, (Ogbonna, 2010).

Determination of invert sugar (reducing sugar-glucose) in the fruits. The juice was expressed out of the fruit, 20g of the fruit juice was transferred into 200ml volumetric flask, then 100ml of distilled water, 5ml of zinc acetate (Zinc acetate is a clarifying agent which form insoluble, complexes with interfering substances that can be removed by filtration or centrifugation) and 5ml of potassium ferrocyanide (potassium ferrocyanide is also a clarifying agent which chelate interfering substance) were added and mixed thoroughly. The precipitate was filtered off and a clear sugar solution was obtained.

The burette was filled with the sugar solution obtained. 15ml of the sugar solution from the burette was added into the titration flask containing 10ml of mixture equal volumes of Fehling's solution I and II. This solution was boiled whiled the sugar solution from the burette in 1ml at a time at about 10 seconds interval was added until the blue colour was about to be discharged; then 4 drops of 1% methylene blue indicator was added and titration continued until the blue colour of the indicator was completely discharged and the supernatant liquid become orange-red in colour. Then, the volume of sugar solution in the burette used for the titration, to obtain the orange-red colour was recorded.

In another titration flask containing 10ml of mixture of equal volumes of Fehling's solution I and II, the titration was repeated, but this time there was no addition of 15ml of sugar solution from the burette. After having boiled for 2 minutes, 4 drops of 1% methylene blue indicator was added and the titration was completed, such that the total boiling time was within 3 minutes. The end point was reached at which the entire blue colour was discharged and the liquid became Orange-red in colour; then the titre value was recorded also.

Using the sugar table, the quantity of sugar (Glucose) in mg present in the titrated volume of the sugar solution, when 10ml of Fehling's solution was used, was determined; and the percentage of the Glucose (invert sugar) in the sample was calculated taking into consideration, the addition of 15ml (dilution factor) of the sugar solution from the burette.

Determination of sucrose (non-reducing sugar) in the fruits. 50ml of the clarified neutral solution was pipetted from the determined invert (glucose) into a 200ml volumetric flask, then 20ml of 10% conc. HCl was added and left overnight. The following day the inverted sugar solution was neutralized with 50% NaOH, then a few drops (2drops) of 1% phenolphthalein indicator was added and made up to 200ml mark with distilled water.

Lane and Eynon titration was performed with the inverted sugar solution using 10ml mixture of equal volumes of Fehling's solution I & II. The titre volume was recorded and the percentage of total sucrose was calculated. The total % sucrose was obtained by multiplying the total invert sugar by a factor of 0.95.

% sucrose – invert sugar x 0.95
(Lane and Eynon method).

Each of the nine fruits analysed was treated in the same way as stated above and the results were obtained.

RESULTS AND DISCUSSION

From figure 3.1.1, it is shown that out of about fourteen varieties of fruits taken by the diabetic patients' population, about nine of these fruits are most commonly taken by the group; and these nine fruits were analyzed to evaluate their estimate sugar levels. Among the 100 respondents, 85 respondents eat garden egg (*Solanum melongena*), followed by 70 respondents who take orange (*Citrus sinensis)*. Most of the diabetic patients go for these two fruits, probably because of the believe that the sugar level in it is low, or they are mostly available and cheap, or they were advised to take. Equal number of respondents takes Banana (*Musa* species) and pawpaw (*Carica papaya* L.). 61 respondents eat mango (*Mangifera indica*) while 58 respondents eat guava (*Psidium guajava*), and 57 respondents eat water melon (C*itrullus lanatus L.)*. This could be due to the fact that, these fruits are not commonly available throughout the seasons of the year. They are seasonal fruits and were of the believe that they contain high sugar level. This could be due to advice from someone or the sugary taste of these fruits in their mouth.

Pineapple (*Ananas sativus)* and apple (*Malus pumila* or *M. domestica*), have the least number of respondents that is 31 and 34 respectively among the nine fruits. This could be because of the cost of these fruits which is on the high side especially in the northern part of Nigeria where the 100 respondents were drawn from. Another reason could be because of the sugary taste of these fruits in their mouth.

Figure 3.1.2, gives the result of the assay of percentage concentration of sugar (*Glucose)* in the selected nine fruits with the dilution factor. Banana (*Musa species)* has the highest % concentration of sugar (*glucose*) at 20.4%, while Garden egg (*Solanum melongena),* has the least % concentration of sugar (*glucose*) at 5.8%.

Analysis of variance (ANOVA) performed, using Fisher's PLSD for concentration, shows that, the sugar (*glucose*) concentration between orange and apple, apple and pineapple, pawpaw and water melon were insignificant, that is there was no much difference. That is the P-value is (P > 0.05).

Figure 3.1.3, shows the result of the analysis of % concentration of glucose in the selected nine fruits without the dilution factor. Banana (*Musa species*) also has the highest percentage concentration of sugar (*glucose)* at 20.4, while the Garden egg (*Solanum melongena)* has the least % concentration at 5.8

Analysis of variance performed, using Fisher's PLSD for concentration also shows that the difference in glucose concentration between orange and apple, apple and pineapple, pawpaw and water melon as compared among the selected nine fruits was insignificant. Hence the P-value is (P>0.05). The similarities between the result of the assays of % concentration of glucose in the fruits with the dilution factor and the % concentration of glucose in the fruits, without the dilution factors indicates that the sensitivity of the copper sulphate to the presence of glucose was not affected by the dilution factor.

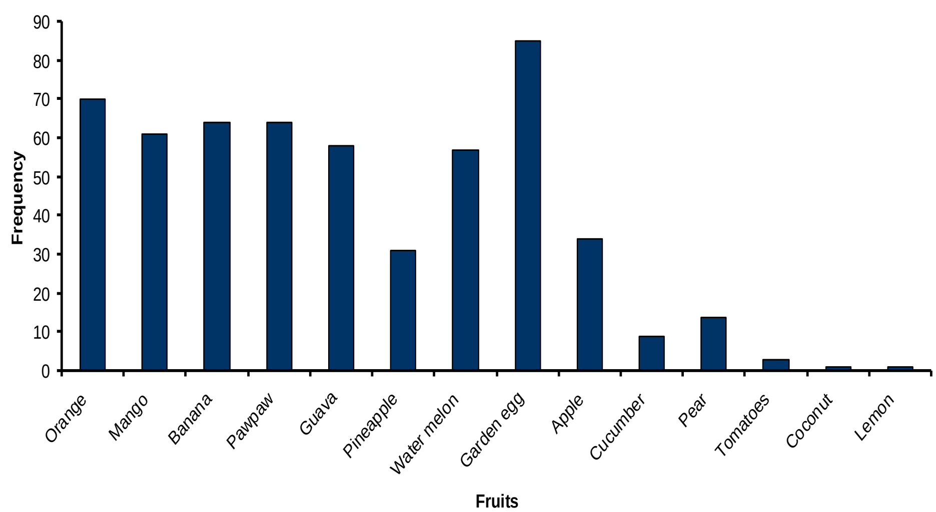

Figure 3.1.1: Frequency of fruits consumed among the (100) *diabetes mellitus* patient respondents in Jos University Teaching Hospital, Jos.

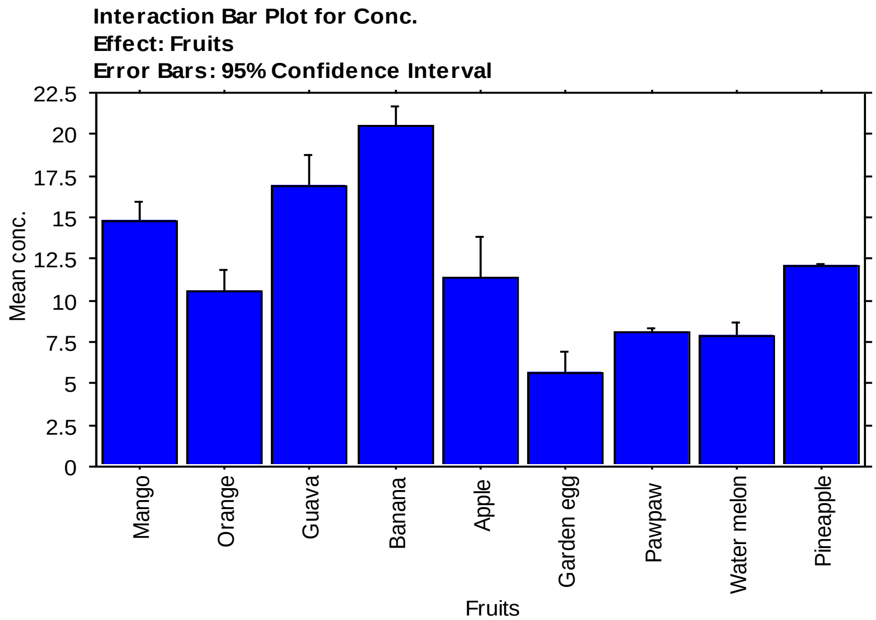

Fig. 3.1.2: % Concentration of sugar (Glucose) in the fruits with the dilution factor

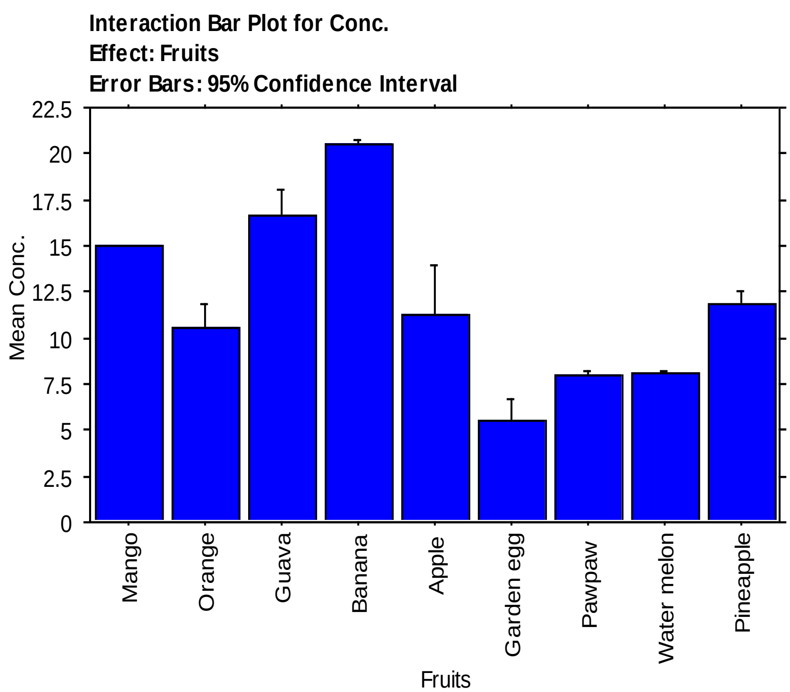

Fig. 3.1.3: % sugar (Glucose) concentration in the fruits without dilution factor.

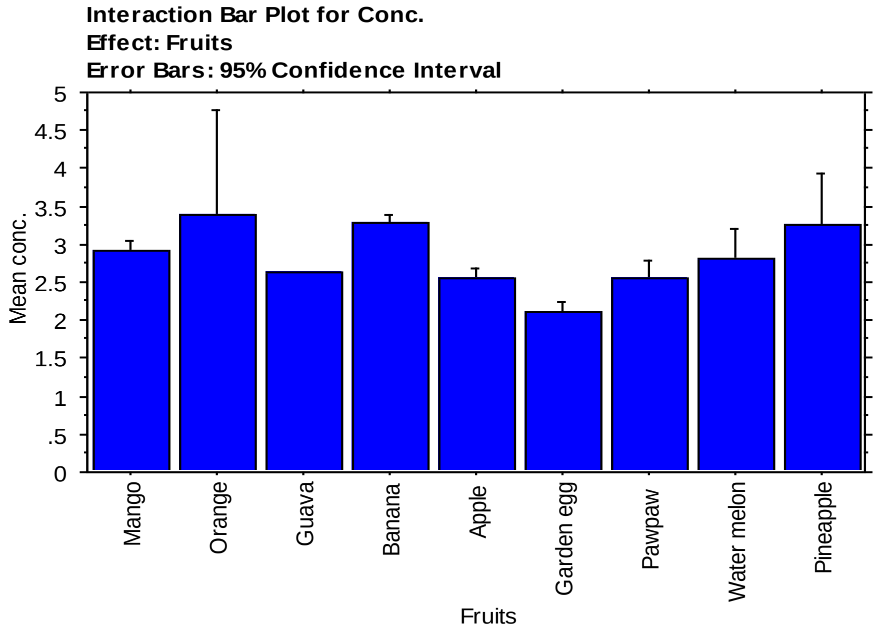

Fig. 3.1.4: % concentration of sugar (Sucrose) in the fruits.

Hence the reaction takes place between the copper sulphate and glucose during the filtration to give the end point, which shows the quantity of glucose that had completely reacted with all the copper sulphate solution in the flask (Bruyn and Keulen, 2004).

The result of the assay of % concentration of sugar (sucrose) in the fruits in fig. 3.1.4 showed that pineapple has the highest % sucrose concentration, at 3.42%, while garden egg has the lowest % sucrose concentration at 2.07%, among the nine selected fruits.

Analysis of variance conducted using Fisher's PLSD, shows that there was no significant difference of % sucrose concentration between mango and the following fruits, guava, apple, pawpaw, water melon, pineapple, orange and the following fruits: Banana, pineapple. Guava and the following fruits: apple, pawpaw, water melon., banana and pineapple. Apple and the following fruits: pawpaw, water melon; then pawpaw and water melon. Hence their P-values are ($P > 0.05$).

Conclusion

From the study it could be seen that, the nine selected fruits most frequently consumed by the diabetic patients have varying concentrations of sugars and could therefore be of public health issue to the government, clinicians and care givers.

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