



FIBER AND SUGAR CONTENTS IN VEGETABLES PRESCRIBED AND CONSUMED BY DIABETICS IN KISANGANI

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KEYWORDS

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Vegetable consumption

Dietary fiber

Sugars

ABSTRACT

Consumption of high fiber foods such as fruits and vegetables is beneficial in stabilizing blood sugar. Therefore present study has been conducted to evaluate and determine the fiber and total sugar contents in leafy vegetables prescribed to diabetics in Kisangani. Fifty Nine participants (aged between 30 to 79 years) suffering from diabetes mellitus were interviewed on consumption of leafy vegetables that health workers prescribe for them. Result of the study revealed that 41.1% of the respondents consumed vegetables at least once in a day while 30.5% respondents consumed vegetables twice in a day. The most consumed vegetables were *Manihot esculenta* (84.8%), *Amaranthus hybridis* (55.9%) and *Ipomoea batatas* (41.1%). The fiber content ranges from 1g / 100g (*Bracica oleracea* & *Solanum nigrum*) to 3.6 g / 100 g (*Amaranthus hybridis*) while the sugar content was reported from 2.5g / 100g (*Abelmoschus esculentus*) to 15.5 g / 100 g (*Manihot esculenta*). Results of the study identified some leafy vegetables which are rich in dietary fiber and consumption of these would be beneficial for the diabetics.

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1 Introduction

Diabetes mellitus is a result of chronic insulin resistance and loss of pancreatic beta cells. Strategies to retain these cells are required in the prevention and treatment of this devastating disease (Gilbert & Liu, 2013). Prevalence of type 2 diabetes has increased all over the world (Kobayashi et al., 2013) and is considered as a growing threat to global health it is the most current endocrine disease (Tol et al., 2013). Dietary factor plays an important role in controlling blood sugar in diabetics (Gurukar et al., 2013). Thus, having a healthy diet basically a considerable intake of dietary fiber, antioxidants, including carotenoids, vitamins A, C, E, minerals such as selenium and phytochemical compounds would be a better source to overcome this disease. Vegetables and fruits are considered the main sources of these substances (Kaczmarczyk et al., 2012; Tabesh et al., 2013; Boeing et al., 2012; Isao et al., 2013). Dietary fibers of these suggested vegetables and fruits stimulate the secretion of glucagon like peptide-1 (GLP-1) hormone, this hormone is responsible for increasing the secretion of insulin and prevents the destruction of beta cells in the pancreas (Ramon, 2009). Similarly Gilbert & Liu (2013) reported the presence of a flavonoid Genistein from soy; this flavonoid has similar effects in reducing the effect of diabetic. Antioxidant nutrients can reduce chronic disorders and diabetes complications by inhibiting the oxidation reactions of organic molecules (Savini et al., 2013).

In the Democratic Republic of Congo (DRC), the consumption of vegetables is influenced by dietary habits and culture. Kisangani has some native vegetables whose consumption would be more beneficial for diabetics but their fiber and sugar contents are poorly documented. The aim of this study is to assess the consumption frequency of vegetables prescribed to diabetics by the health care workers and to determine the fiber and sugar content of some of these vegetables.

2 Materials and Methods

2.1 Study area

Study was conducted in the general reference hospital Makiso-Kisangani (HGR / Makiso-Kisangani), general reference hospital Kabondo (HGR/Kabondo), University Clinics of Kisangani (CUKIS) and two associations of diabetics of Kisangani. The determination of fiber and sugar contents in vegetables was carried out in chemistry laboratory of the faculty of Science of the University of Kisangani (UNIKIS).

2.2 Respondents

This cross-sectional study was conducted from March 24 to June 29, 2014, in diabetic patients who consulted the above health facilities and those who participated in nutrition education sessions in their associations. The selection of patients was done only occasionally. All patients who had been included in this study were consulted by a caregiver and had

received advice on leaf vegetable consumption and agreed to answer the questions of surveyors. Amongst the selected 63 respondents 59 respondents were agreed on the basis of said criteria while the rest four were not agreed. Amongst the selected fifty nine respondents 33 were found in the associations of diabetics, 11 in HGR / Kabondo, 10 in HGR / Makiso- Kisangani and 5 in CUKIS. All the required data were extracted by interview technique supported by a survey. The investigated variables were age, sex, health personnel consulted, the consumption of prescribed vegetables. Data were analyzed for percentage and the arithmetic mean. The chi-square test for single sample was used to compare different means observed on prescribed, non prescribed, consumed and non consumed vegetables for significance level of 0.05 using SPSS 20 software

2.3 Prescribed Vegetables

Information regarding all the prescribed vegetables was collected from various sources and total eleven vegetables viz *Spinacia oleracea* (spinach), *Cucurbita pepo* (pumpkin sheet) *Brasica oleracea* (cabbage), *Solanum nigrum* (black nightshade), *Ipomoea batatas* (sweet potato leaf) *Abelmoschus esculentus* (dongo dongo) *Hibiscus acetosella* (Sorrel of Guinea), *Colocasia esculenta* (Taro leaf) *Manihot esculenta* (cassava leaf) *Amaranthus hybridis* (amaranth), *Gnetum africanum* (fumbwa) were cited and all were analyzed for fiber and sugar content.

Fresh vegetables were purchased from the central market of Kisangani and immediately brought to the laboratory for further analysis. Hundred grams fresh sample from edible portion of the each vegetable has been collected and dried in an oven at 37°C. After drying, the sample was converted into powder using a mortar. This powder was used for the determination of fiber and sugars.

Total fiber content was determined by the method described by Association of Official Analytical Chemists (AOAC, 1990). Indeed, Five grams of dry matter were introduced into a cartridge of the soxhlet extractor adapted to a tarred flask containing 250ml of petroleum ether. The flask was heated until the complete clarification of the solvent. After the extraction the content of the cartridge was recovered and placed in an Erlen Meyer flask containing 200 ml of 1.25% sulfuric acid. The content of flask was boiled for 30 minutes, cooled and filtered through a filter paper and then washed three times with 50 ml of hot water. The residue is returned into the Erlen Meyer flask while adding 200ml of 1.25% NaOH and heated for 30 minutes. It is then cooled, filtered again and washed three times with 50 ml of hot water and finally with 25ml of ethanol. The residue was then dried at 130°C in an oven to constant weight, cooled in a desiccator and transferred to oven dried previously weighted porcelain crucible. The crucible is then heated for 2 hours in an oven at 550°C then cooled and weighed. The percent fiber is equal to the difference between the weight of the cake after the extraction

of lipid and the weight of the sample after calcinations divided by the weight of the sample before the extraction of lipid multiplied by one hundred.

The determination of sugars was made according to the method described by Dubois et al. (1956). To 0.5 g sample powder is added 10 ml of 1.5N H₂SO₄ and mixed properly. This mixture was boiled at 100°C in a water bath for 15 minutes, and cooled it at room temperature. 10 ml of 70% ethanol, 0.5 ml of ZnSO₄ and 0.5ml of potassium ferrocyanide were added in this cooled mixture. The suspension was filtered on Whatman paper and the filtrate was collected in a 50 ml flask and brought to the volume with distilled water. 0.5ml of the filtrate was taken in flask and 1.5ml ml of distilled water, 1ml of aqueous phenol and then 5ml of concentrated H₂SO₄ were added in this mixture; keep it for 10 minutes and optical densities were taken at 490 nm. For the blanc, to 2 ml of distilled water were added 1ml of aqueous phenol and 5ml of concentrated H₂SO₄.

A standard solution of glucose (0.5mg / ml) was prepared from which were prepared the 5 solutions of various concentrations viz 0mg / ml, 0.025mg / ml; 0.050mg / ml; 0.075 mg / ml and 0.100mg / ml. The total sugars were obtained by the following formula:

$$Q = \frac{D.o.in}{0,0072} \times 10^{-3} \times 160$$

Where Q = amount of sugar in the sample in g / 100 g
D.o.in = optical density of the unknown (sample)
0.0072 = constant

3 Results

3.1 Respondents characteristics and health personnel consulted

Table 1 shows the age, sex and other personal information of the respondents and the health staff consulted. Results of the study revealed that 30.5% of respondents belonged to the age group 50-59 years, this was followed by the age group of 70-79 years (23.7%). The mean age of the studied respondents was 51.2 years. Among the selected respondents 59.9% of the respondents were female while rests were the male. Only 61% of the respondents had consulted with doctors.

3.2 Prescribed and consumed vegetables

All the consumed and prescribed vegetables were enlisted. Results presented in table 2 show the actual status of the vegetables prescribed to respondents and its actual consumption.

It is very clear from this table that the most consumed vegetable was *M. esculenta* leaves (84.8%) and it was followed by *A. hybridis* (55.9%) and *I. batatas* leaves (41,1%). Results of this table also suggested that *S. oleracea* (44.1%) and *H. acetosella* (40.7%) were the vegetables which were prescribed to the diabetic but not frequently eaten by the patient. Furthermore *C. esculenta* (79.7%), *A. esculentus* and *C. pepo* (74.6%) vegetables were less prescribed but more eaten by the diabetics. Table 3 shows the frequency of vegetables consumption by diabetics. Result of this table shows that 41.1% of respondents use recommended vegetables at least once in a day while 30.5% respondents consumed vegetables twice in a day.

3.3 Fiber and sugar contents of the selected vegetables

Fiber and sugar contents of the selected vegetables are presented in Table 4. Fiber content of the analyzed vegetables ranged from 1g / 100g (*B. oleracea* & *S. nigrum*) to 3.6 g / 100 g (*A. hybridis*) while the sugar content ranged from 2.5g / 100g (*A. esculentus*) to 15.5g / 100g (*M. esculenta*).

Table I Age and sex of the patient and health personnel consulted (N = 59).

Characteristics	F _o	%	P-val
Age Group (years)			
30-39	11	18.6	
40-49	8	13.6	
50-59	18	30.5	
60-69	8	13.6	
70-79	14	23.7	
Sex			
Male	26	44.1	<0.001*
Female	33	59.9	
Health staff consulted			
Nurse	16	27,1	<0.001*
Doctor	36	61	
Nutritionist	7	11,9	

* Chi-square test single sample; F_o =number of patients

Table 2 Prescribed vegetables and vegetables actually consumed by respondents.

Vegetables		Not Prescribed	Prescribed & consumed	Prescribed not consumed	P-val
Scientific and Vernacular Names	N	F _o	F _o	F _o	
<i>Abelmoschus esculentus</i> (Dongo dongo)	59	44(74.6)**	3(5.1)	12(18.6)	<0.001*
<i>Amaranthus hybridis</i> (Amaranth)	59	4(6.8)	33(55.9)	22(37.3)	<0.001*
<i>Bracica oleracea</i> (Cabbage),	59	28 (47.5)	11 (18.6)	20 (33.9)	0.025*
<i>Colocasia esculenta</i> (Taro leaves),	59	47 (79.7)	3 (5.1)	9 (15.3)	<0.001*
<i>Cucurbita pepo</i> (Pumpkin sheets),	59	44 (74.6)	6 (10.2)	9 (15.3)	<0.001*
<i>Gnetum africanum</i> (Fumbwa)	59	28(47.5)	14 (23.7)	17 (28.8)	0.063*
<i>Hibiscus acetosella</i> (Sorrel of Guinea)	59	18(30.5)	17(28.8)	24(40.7)	0.482*
<i>Ipomoea batatas</i> (Sweet potato leaves)	59	8 (13.6)	26(41.1)	25(42.4)	0.005*
<i>Manihot esculenta</i> (Cassava leaves)	59	6 (10.1)	50(84.8)	3 (5.1)	<0.001*
<i>Solanum nigrum</i> (Morelle, bilolo)	59	33 (55.9)	17 (28.8)	9 (15.3)	0.001*
<i>Spinaccia oleracea</i> (spinach)	59	15 (25.4)	18 (30.5)	26(44.1)	0.193*

* Chi-square test single sample ; F_o =number of patients concerned for this vegetable; ** Numbers in parenthesis represent percentage

Table 3 Status of the daily consumption frequency of recommended vegetables.

frequency	F _o	%	P-val
Once in a day	26	44.1	0.193*
Twice in a day	18	30.5	
Thrice in a day	15	25.4	

* Chi-square test single sample F_o =number of patients

Table 4 Fibers and sugar contents of analyzed vegetables.

Analyzed vegetable	Fibers g/100g	Sugar g/100g
<i>Abelmoschus esculentus</i>	1.7	2.5
<i>Amaranthus hybridis</i>	3.6	9.7
<i>Bracica oleracea</i>	1.0	7.8
<i>Colocasia esculenta</i>	2.1	7.6
<i>Cucurbita pepo</i>	1.5	10.0
<i>Gnetum africanum</i>	2.9	2.7
<i>Hibiscus acetosella</i>	1.3	7.4
<i>Ipomoea batatas</i>	1.9	13.3
<i>Manihot esculenta</i>	1.7	15.6
<i>Solanum nigrum</i>	1.0	6.8
<i>Spinaccia oleracea</i>	1.29	4.7

4 Discussions

More and less consumption of the vegetables can be justified by the food habits of the patients as well as the availability of same vegetables. The non prescription of vegetables like *C. esculenta* (79.7%), *A. esculentus* and *C. pepo* (74.6%) may be due to the scarcity of these products in the market or may be the limited knowledge of the prescriber on the vegetable. Only 41.1% of respondents used vegetables at least once in a day while 30.5% consumed twice. According to Ramon (2009) consumption of vegetables up to five servings and fruit a day is quite useful to overcome the diabetes. Some studies on the increase of the consumption of fruits and vegetables by diabetics 2 (≥ 6 servings / day) showed an increase in the

carotenoids content and enzymes associated with antioxidant properties of HDL (Daniels et al., 2014) and a decrease in glycosylated hemoglobin (HbA_{1c}) (Jenkins et al., 2011). A good nutritional profile (more fruits and vegetables, less meat, legumes and white bread) has favorable effects on plasma biomarkers associated with greater protection of type 2 diabetes (Heidemann et al., 2005).

The low frequency of consumption of vegetables by respondents associated with the effects of cooking expose the patient to deficiencies in some nutrients essential for the prevention of diabetes complications (vitamins and phytochemicals, pro-vitamin carotenoids A). Greater consumption of fruits and vegetables is recommended to cover

the needs in pro-vitamin A carotenoids (Marie Jo Amiot Carlin et al., 2007). The most effective as a free radical scavenger is lycopene, followed by α -carotene, β -cryptoxanthin, zeaxanthin and β -carotene, lutein. Carotenoids definitely have a complementary role or act synergistically with other antioxidants such as vitamins C and E. It appears that green leafy vegetables are among the foods with the highest carotenoids content, watercress being the richest. Indeed, it is, with the parsley and spinach, a major source of β -carotene and lutein. Tomato and its derivatives are important sources of lycopene. The vegetarian diet has been shown effective in cardiovascular disease management, weight problem, and diabetes (Barnard et al., 2009).

Analyzed vegetables showed 1 - 3.6 g / 100 g fibers and 2.5g - 15.5g / 100g sugar contents and these contents are almost similar to the findings of Tandu (2001). Slight difference was reported between the results of present study and Tandu (2001) for some vegetables and could be explained by the difference in environmental conditions, difference in the sample processing.

Fiber increases satiety (Mello & Laaksonen 2009) and slows down the digestive absorption of sugars and improves the glycemic index. Thus the presence of fibers plays an important role in reducing the glycemic index (Ford & Mokdad 2001). As in diabetics, sugar consumption should take into account its glycemic index, so it is important to involve a fiber rich vegetable in daily menu to cover the minimum daily intake of 25 g (Mello & Laaksonen 2009) or 15 to 28 g of fiber per 1000 kcal (De Natale et al., 2009). Vegetables such as *A. hybridis*, *G. africanum*, *C. esculenta*, *C. pepo*, *A. esculentus* and *S. oleracea* would be more recommended.

Contrarily vegetables such as *M. esculenta*, *I. batatas* and *B. oleraceae* should be consumed moderately by diabetics because their fiber content is not so high to cover the total sugars in a meal although they contain other essential nutrients. In the intervention study involving fiber supplementation in type 2 diabetes, it has been proved that this diet reduces fasting blood glucose and HbA1c (Kaczmarczyk et al., 2012), and the minimum recommended intake of fiber was based on consumption of fruits and vegetables.

Conclusion

This study allowed us to identify some leafy vegetables rich in dietary fiber, consumption of which is beneficial for the diabetic but is not consumed. Vegetables such as *A. hybridis*, *G. africanum*, *C. esculenta*, *C. pepo*, *A. esculentus* and *S. oleracea* should be more consumed. On the contrary vegetables such as *M. esculenta*, *I. batatas* and *B. oleraceae* should be eaten with moderation due to their sugar content compared to their fiber content, given that they are accompaniment foods that should bring much fiber of the daily ration.

Conflict of interest

Authors would hereby like to declare that there is no conflict of interests that could possibly arise.

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