Effect of Gum Arabic as Dietary Supplement for Type II Diabetes in Jabir Abu Aliz Diabetic Center- (Khartoum State)

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Abstract

Background: Gum Arabic (*Acacia Senegal*) is a water-soluble dietary fiber considered to be safe by the United States Food and Drug Administration since the 1970s.Recent studies showed the therapeutic action of Gum Arabic.

Methods: It was Quasi-experimental study design. The objective of this study was to determine the effects of regular Gum Arabic ingestion as dietary supplement on accumulative blood glucose (HbA_{1c}) and body mass index (BMI) among type II diabetes in Jabir Abu Aliz Diabetic Center in Khartoum. 49 type II diabetes were provided with Gum Arabic at the beginning of the trial and educated to add 60 g/day (divided into two portions 30 gm) to their meals for three months. Food consumption, BMI, and HbA1C were assessed for all the patients before and after the consumption of Gum Arabic for three months. Data was processed using SPSS version (20) and paired t-test was used to determine the effect of Gum Arabic on studied parameters.

Results: It showed that regular intake of 60 g/day of Gum Arabic for three months showed slight reduction in BMI for diabetes (no significant difference), and slight change in HbA_{1c} (no significant difference). This may be due to the fact that majority of the respondents (60%) increased their carbohydrates intake in their daily meals because of winter, also respondents did not abide fully () to consumption of Gum Arabic, where only (32%) of the patients were fully committed to the consumption of Gum Arabic.

Keywords: diabetic patients, dietary fibers, Gum Arabic

1. Introduction

Non-insulin dependent diabetes mellitus (NIDDM) known as type II diabetes is one of the most common chronic diseases in the world. Approximately 90% of diabetes diagnosed as having diabetes has type II, and an additional 4-5 million people meet the diagnostic criteria, but have not yet been diagnosed (Haslett et al., 2002; Eliadarous, 2007; Kumar & Clark, 1998).

Socioeconomic status and urban or rural habitation may influence incidence rates. The most important risk factors for development of NIDDM are increasing age, heredity, and obesity (Davidson, 1998; Bays et al., 2007; Sizer & Whitney, 2008). Glycosylated hemoglobin (HbA_1, or HbA_{1c}) was introduced into clinical practice nearly 15 years ago as an index of long-term diabetic control and now are widely utilized. This test provides an index of the average blood glucose concentration (two to three months). Diabetes should maintain the ratio of HbA1c to less than (7%).

Dietary Fiber has long been known to promote good digestive health and regulatory functions, but those are only two of the many benefits fiber offers. In addition high-fiber diet reduces cholesterol levels, the risk of heart disease, diabetes, and keeps the body weight in check (Mohamed et al., 2015; Anonymous, 2008; Nasir et al., 2012)

Gum Arabic can be used as dietary supplement for diabetes, because some studies showed that it is important in treatment of many diseases like obesity, colon cancer, kidney diseases, hyperlipidemia, and diabetes (Calame et al., 2011; Glover et al., 2009; Karg et al., 2000; Nasir et al., 2008 ;Chiavaroli et al., 2014; Alsuleimani et al., 2015).

Gum Arabic is able to decrease the caloric intake and increase feeling satiated. It could be used in a dietary approach to control body weight development (Calame et al., 2011).

In fact, Gum Arabic is safe for most adults. It may cause gas bloating and loose stools. Some people may be allergic to Gum Arabic particularly skin reaction. It is not advisable to use Gum Arabic during pregnancy and breast-feeding (Anonymous, 2012).

1.1 Hypotheses

1.1.1 Null Hypothesis (H0)

- Consumption of Arabic gum has no beneficial effect on blood glucose of type II diabetes.
- Consumption of Arabic gum has no effect on body weight of type II diabetes.

1.1.2 Alternative Hypothesis (HA)

- Consumption of Arabic gum has a beneficial effect on blood glucose for type II diabetes
- Consumption of Arabic gum has an effect on body weight of type II diabetes.

1.2 Problem Statement

Diabetes is a chronic and incurable disease develops when the body is not producing enough or effective insulin. As a result the glucose remains in the blood and the person's blood sugar levels become too high. This can result in being potentially dangerous, even deadly if left untreated for an extended period of time.

This research may help improving the health and nutrition status of diabetes by using Gum Arabic as dietary supplement for them. This should be very useful for diabetes in Sudan, where Gum Arabic is grown in many parts of the country, and can easily be found at local groceries for a reasonable price (Osman et al., 2011).

1.3 Research Objectives

1.3.1 General Objective

To investigate the potential of using Gum Arabic as dietary supplement for NIDDM diabetes.

1.3.2 Specific Objectives

1). To determine the effect of the addition of Gum Arabic on accumulative blood glucose (HbA_{1c}) of type II diabetes.

2). To assess the effect of Gum Arabic on body weight and Body Index.

2. Subjects, Materials and Methods

2.1 Study Design

 It was pre and post quantitative experimental quasi study which designed to conform to the medical literature, reducing confounders and eliminating the need for a control group.

2.2 Study Area

This study was conducted in Jabir Abu Aliz Diabetic Centre (JADC) in Khartoum city. JADC was inaugurated in 1998 by the Khartoum State Ministry of Health as the first multidisciplinary specialized diabetes center in the Sudan. It caters for 40, 000 registered diabetes with a monthly turnover of 450 new patients per month and 200 outpatients per day.

2.3 Study Population

2.3.1 Inclusion Criteria

- Diabetes with Type II Diabetes mellitus (Non-Insulin Dependent Diabetes Mellitus) from Jabir Abu Aliz Diabetic center in Khartoum city.
- Male and female patients who agree to participate were included.

2.3.2 Exclusion Criteria

Pregnant women, children, and those who disagree to participate.

2.3.3 Sample Size Calculation

To satisfy the objectives of the study. Sample size (*n*) is calculated using the following formula:

$$n = \frac{2\left(Z_{1-\frac{\alpha}{2}}Z_{1-\beta}\right)^2}{\Delta^2} + \frac{Z_{1-\alpha/2}^2}{2}$$

$$\Delta = \frac{\delta}{\sigma}$$

Δ is the (standardized effect size)

δ is the difference between two means

σ is the standard deviation

$Z_{1-\beta}$ is the value from the normal distribution related to and representing the power of the test.

Z_{α} is the value from the normal distribution related to and representing the confidence level.

n is the population Size

$Z_{1-\beta/2}$ Equal to 1.96 for 95% confidence level.

$Z_{1-\beta}$ equal to 0.8416 for 80% power from the results of pre-test:

$$\Delta = \frac{18.8}{44.8}$$

Thus Δ = 0. 45

Accordingly

$$n = \frac{2(1.96 \times 0.8416)^2}{(0.45)^2} + \frac{(1.96)^2}{2} \quad = 29 \text{ patients}$$

49 patients were chosen, because of attrition.

2.3.4 Sampling Techniques

Sample of this research was selected by case-finding procedure. Patients were provided with Hashab Gum supplements (*Acacia Senegal*), which produces in Kordofan State to take it as dietary supplement on daily basis for three months. This Gum Arabic produced by Elanan Trading Exports and Imports Company Ltd., Khartoum, Sudan.

The objectives of this research were clearly explained to the patients who agreed to participate in the research. The Gum Arabic supplement was limited to 60 gm/day as recommended by (Chandalia *et al.* 2000). This amount of Gum Arabic was divided into two portions (30 gm) twice or three times a day and it was incorporated with food as recommended by (Ushida *et al.* 2011).The patients were advised to increase their water intake and they were regularly monitored by the health center. Also they were followed by telephone.

2.4 Data Collection

Data collection was carried by using questionnaire which divided into six parts .The first part contains general information (name, age, sex, residence, religion, address, mobile number, medical history and type of treatment).The second part represent social and economic information (educational level, income level and job).The third part represents nutritional information (the number of daily meals and special meals).The fourth part contains anthropometric measurements (weight and height).The fifth part includes lab tests (blood Sugar Level).

2.4.1 Anthropometric Measurements

- Weight (kg) and height (cm) were measured by using height and weight measuring machine type of (seca), made in Mexico, model #7001021009.

- Body mass index:, *C*alculated by dividing the weight of a person (kg) by the square height (m) (Sizer and Whitney, 2008). The formulae universally used in medicine produce a unit of measure of kg/m^2.

A frequent use of the BMI is to assess how much an individual's body weight departs from what is normal or desirable for a person of his or her height .The weight excess or deficiency may, in part, be accounted for by body fat (adipose tissue) although other factors such as muscularity also affect BMI significantly.

WHO (2006) categorized BMI as:

Table 1. Categories of Body Mass Index

Category	BMI range – kg/m2
Underweight	< 18.5
Normal (healthy weight)	18.5-24.9
Overweight	25-29.9
Obese Class I (Moderately obese)	30-34.9
Obese Class II (Severely obese)	35-40
Obese Class III (Very severely obese)	> 40

2.4.2 Biochemical Assessment

Blood sugar level was measured by using HbA1c instrument (Labona Check [TM]A1C HbA1c test kit made in Korea). The results were taken after three months.

2.5 Dietary Intakes

The method of 24 hour-recall was used to collect data about dietary intake of diabetes.

2.6 Data Analysis

Data was analyzed by using Software Package of Social Sciences, SPSS version (20) the following features of SPSS were used:

- Calculation of frequency and percentage.
- Chi Squire Test to determine the correlation between variables.
- Paired Samples T- Test to know the differences in BMI and HbA1c among the respondents before and after intake of Arabic Gum.

3. Results

Result in Table 2. Showed the classification of diabetes (Type II) according to sex & age. Females to males represented by (60%) and (40%) of patients respectively. (64%) of them age above 50 years.

Table 2. Classification of Diabetes (Type II) According to Sex and Age Groups

Age (years)	Sex				Total	
	Males		Females		No.	(%)
	No.	(%)	No.	(%)		
(30-40)	0	0.0	1	6.7	1	4.0
(41-50)	3	30.0	5	33.3	8	32.0
Above 50	7	70.0	9	60.0	16	64.0
Total	10	100.0	15	100.0	25	100.0
Chi squire value	0.78		P value		0.7*	

* No significant difference between males and females in age.

Table 3 showed that (36%) of patients have high school education. while university, primary, and illiterate level represented by (28%), (32%), and (4%) of patients respectively.

Table 3. Classification of Diabetes (Type II) and Educational Level

Level of Education	Sex				Total	
	Male		Female			
	No.	(%)	No.	(%)	No.	(%)
Illiterate	0	0.0	1	6.7	1	4.0
Primary School	3	30.0	5	33.3	8	32.0
High School	1	10.0	8	53.3	9	36.0
University Education	6	60	1	6.7	7	28.0
Total	10	100.0	15	100.0	25	100.0
Chi squire value		11.4			P value	0.02*

* There is significant difference between males and females in education.

Table 4 showed that (68%) of the study group were unemployed, (12%) were governmental employed, and (20%) were self-employed.

Table 4. Classification of Diabetes (Type II) According to Occupation

Occupation	Sex				Total	
	Males		Females		No.	(%)
	No.	(%)	No.	(%)		
Unemployed	5	50.0	12	80.0	17	68.0
Government employed	3	30.0	0	0.0	3	12.0
Self-employed	2	20	3	20	5	20
Total	10	100.0	15	100.0	25	100.0
Chi Squire value		5.4			P value	0.1*

* No significant difference between males and females in occupation.

Table 5.Indicated that (44%) of the patients have middle income, (36%) and ((20%) of them have high, and low income respectively.

Table 5. Classification of Diabetes (Type II) According to Income Levels

Levels of Income/month	Sex				Total	
	Males		Females		Number	(%)
	Number	(%)	Number	(%)		
Low	2	20.0	3	20.0	5	20.0
Middle	5	50.0	6	40.0	11	44.0
High	3	30.0	6	40.0	9	36.0
Total	10	100.0	15	100.0	25	100.0
Chi squire value		1.1			P value	0.8*

* No significant difference between males and females in their income.

Results with patients follow up indicated some of them suffered from side effects of Gum Arabic, represented by (26.6%) of them suffered from nausea, while (6.1%) of the patients suffer from chronic diarrhea and the same percentage of them suffer from constipation. So that not all patients were fully committed to Gum Arabic consumption.

Table 6 showed pared t-test for patients BMI before and after Gum Arabic consumption for type II diabetes .The mean of BMI of the respondents before consumption of Gum Arabic was (29.8±2.4) compared to (29.6±5.9) after consumption of Gum Arabic with mean difference (0.2). T-value was 0.31 which is not significant at probability value (P =0.7).

The mean of HbA_{1c} of the respondents before consumption of Gum Arabic was (7.5±1.3) compared to (7.7±1.8) after consumption of Gum Arabic with mean difference (-0.2). T-value was -0.95.

Table 6. Pared T-test of BMI & HbA1c for type II Diabetes Before and After Gum Arabic Consumption

Variables	Groups	Mean	±SD	Mean difference	T value	DF	P value
BMI	Before	29.8	2.4	0.2	0.31	24	0.7*
	After	29.6	5.9				
HbA1c (%)	Before	7.5	1.3	-0.2	-0.95	24	0.5*
	After	7.7	1.8				

* No significant difference between values before and after Gum Arabic consumption.

Table 7 shows the changes in CHO intake among those who fully committed to Gum Arabic consumption. (75%) of patients increased their carbohydrates intake, while (25%) decreased their intake. Significant differences reported between males and females who fully committed to consumption of Gum Arab**.**

Table 7. Change in CHO Intake among Diabetes who fully committed to Gum Arabic Consumption

Change in Dietary Habits	Gender				Total	
	Males		Females		Number	(%)
	Number	(%)	Number	(%)		
Patients who increase their CHO intake	2	50.0	4	100.0	6	75.0
Patients who decrease their CHO intake	2	50.0	0	0.0	2	25.0
Total	4	100.0	4	100.0	8	100.0
Chi squire		12.9			P value	0.04*

*Significant difference between males and females in change of CHO intake.

Table 8 showed Pared Sample T-test the mean BMI and (%) HbA1c of patients who fully committed to Gum Arabic consumption. The mean BMI of the respondents was (28.9±4.39) compared to (29.2±5.73) after consumption of Gum Arabic with mean difference (-0.7). T-value was -0.31 which is not significant at probability value (P = 0.7). HbA1c was (7.3%) before and after Gum Arabic consumption.

Table 8. Pared T-test of BMI among Fully Committed Diabetes to Gum Arabic Consumption

Variables	Groups	Mean	±SD	Mean difference	T value	DF	P value
BMI	Before	28.9	4.39	-0.7	-0.31	7	0.7*
	After	29.2	5.73				
HbA1c (%)	Before	7.3	1.65	0.01	0.02	7	0.9*
	After	7.3	1.94				

* No significant difference in HbA1c means values before and after Arabic Gum consumption.

4. Discussion

Classification of diabetes Type II according to sex and age. Most of patients were female that means type II diabetes mellitus effect females more than males. Also it was common among those who were above 50 years old.

More than half of patients have high school and university education levels. That's means majority of the respondents were educated.

Most of the study group were unemployed, that's means type II diabetes mellitus causes low productivity. A bout half of the patients have middle income, and few of them have low income.

Many of the patients were not fully committed to the Gum Arabic consumption because the experienced side effects including possible allergies in some patients towards Arabic gum. This agrees with result of Babiker *et al.* (2012) and Vinik & Jenkins (1988). They reported that Arabic gum caused gastrointestinal side effects for some of the respondents.

The mean BMI before and after Gum Arabic consumption for type II diabetes in the two periods indicated that it was slightly higher before than after consumption of Gum Arabic but there was no significant difference. Similar result was obtained by Ahmed (2007) who found that weight gain was significantly depressed for rabbits that consumed Gum Arabic in the first week of the experiment but effect on weight gain was recovered thereafter. This result is in contrast with results of Ushida (2011) and Babiker *et al.* (2012). The former done a research in Gum Arabic and its anti-obesity effect; on the other hand, the latter concluded that ingestion of Gum Arabic caused significant reduction in body mass index on adult females.

The percentage mean Hb A_{1C} of the study group before the consumption of Gum Arabic was slightly less than after consumption; however there were no significant differences in the two periods. The two means fall within more than (7%). As all diabetes should maintain their HbA_{1c} level below (7%) as recommended by Davidson, (1998). This result similar to results by (Wadood et al., 1989) who stated that Gum Arabic did not produce Signiant hypoglycemic effect in diabetic rabbits. In contrast to the results of (Post, 2012 et al., 2011) who found that dietary fibers can both reduce fasting blood glucose and improve glycosylated hemoglobin (Hb $A_{1C)}$ in type II diabetes mellitus patients.

Among those who fully committed to Gum Arabic consumption, there was change in their carbohydrates intake. Significant differences were reported between males and females ($p<0.04$).All females increased their carbohydrates intake .Similar result obtained by Burger et al., (2012) and Salmeron et al., (1997). The former found that the patients increased the carbohydrate intake, and the latter found that diets with a high glycemic load and a low cereal fiber content increase risk of type II diabetes diabetes. This result in contrast with results of Ushida (2011) who showed that diets of the respondents at the end of the study had lower caloric density than at the beginning.

Although males reported more reduction in BMI than females after consumption of Gum Arabic with full commitment to consumption, no significant differences in BMI in the two periods. Similar result obtained by Ahmed (2007). This results is in contrast to results of (Ushida, 2011; Babiker et al., 2012). The mean percentage of HbA_{1c} before the consumption of Gum Arabic was slightly less than after consumption; however, the two means fall within greater than (7%).

This result similar to results by (Ross et al., 1983; Ahmed, 2007; Eunice & Gerard, 2013). In contrast to the results of (Chandalia et al., 2000; Ebeling et al., 1988; Mclntosh & Miller, 2001; Tabatabai & Li, 2000; Riccardi & Rivellese, 1991; & Khatun et al., 2011) who stated that food rich in soluble and insoluble fiber can improve glycemic control among patients with type II diabetes.

5. Conclusions and Recommendations

The results of this study didn't confirm the hypothesis, where we found that Arabic gum did not reduce blood glucose level and body mass index for type II diabetes. So that further study should be conducted to another group of patients and to be more committed with their Arabic Gum consumption.

As this study was conducted in the winter the researcher found that the majority of the respondents increased their carbohydrate intake, which might be a reason why there were no reduction in the BMI and HbA_{1c} of the patients, so that further study should be conducted in the summer to compare it with this study to know the effect of seasons on dietary patterns of type II diabetes. Also researchers should encourage type II diabetes to abide full commitment to Arabic Gum consumption and not to change their dietary systems.

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