Effect of Regular Khat Chewing on Serum Fasting Sugar Level in Diabetic patients versus Healthy Individuals; A comparative study

Nutrition and Metabolic Insights
Volume 14: 1–11

DOI: 10.1177/11786388211035220

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ABSTRACT

BACKGROUND: Khat chewing is a long standing social-cultural habit in several countries. Even though many people chew khat simply for its pleasurable and stimulatory effect, evidence showed widely-held belief among khat chewers in Ethiopia and other part of the world that khat helps to lower blood glucose while some studies are contradicted on the effect of khat. There is limited data about khat's effect on blood glucose especially in our setting, Harar estern Ethiopia.

OBJECTIVE: Primarily the present study aims to compare fasting blood sugar level among khat chewer diabetic and healthy individuals, and to asses risk factors associated with poor glycemic control in diabetic subjects.

METHOD: A cross-sectional study included 200 confirmed diabetic and healthy subjects. Fasting blood sugar was determined by enzymatic method glucose oxidase and glucose hexokinase. Glycemic control was also determined for diabetic subjects based on the last 2-month diabetic clinic visits and current measurement.

RESULT: (Median ± IQR [interquartile range]) fasting blood sugar difference among Khat chewer and non khat chewer were 159 ± 83 mg/dl and 202 ± 79 mg/dl respectively in diabetic subjects when tested by glucose oxidase. Similarly, in healthy non khat chewer and khat chewer, khat chewers has lower (Median ± IQR) fasting blood glucose level 82 ± 18 mg/dl than non khat chewers 94 ± 13 mg/dl when tested by glucose oxidase. Regarding risk factors associated with poor glycemic control in diabetic subjects, positive parental diabetes history, insulin medication, being overweight, obese were significantly associated with poor glycemic control.

CONCLUSION: There was significant effect of khat on median FBS among khat chewers in diabetic and healthy individuals. And the proportion of glycemic control was high among diabetic subjects.

RECOMMENDATION: Health care professional and patients should manage the risk factors to delay disease progression and restrain the damage. More studies should be conducted in randomized control trial manner to further elucidate khat effect on blood sugar level so that the actual effect of khat can be identified unlike in cross sectional where there may not be strong causal relationship.

KEYWORDS: Khat, Fasting blood sugar, Diabetes mellitus, Risk factors

RECEIVED: April 23, 2021. **ACCEPTED:** July 8, 2021.

TYPE: Original Research

FUNDING: The author(s) disclosed receipt of the following financial support for the research, authorship, and/or publication of this article: The total budget for this study is covered by Addis Ababa University.

DECLARATION OF CONFLICTING INTERESTS: The author(s) declared no potential conflicts of interest with respect to the research, authorship, and/or publication of this article.

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Introduction

Khat refers to the leaves and young shoots of the plant *Catha edulis Forsk*, which belongs to the plant family Celastraceae.[1] The most active and the principal constituent in khat is "*cathinone*," which is responsible for major pharmacological effects.[2,3] It accounts (77.7-342 mg/100 gm) of khat.[4] Cathinone released from Khat chewing has an important effect on carbohydrate metabolism via increased cortisol level leading to a reduced insulin secretion and insulin resistance through up regulation of resistin expression Adipose tissue secretory factor (ADSF) in adipose tissue.[5] Study showed that in both diabetic and healthy khat chewers serum level of resistin and cortisol level was higher compared to non-khat chewers.[6]

Due to its adrenergic effect cathinone raises plasma catecholamines level and it counteract insulin action and thus resulting in glucagon secretion, activation of glycogenolysis in liver, (β-2 adrenoreceptor mediated response) adreno corticotropic hormone (ACTH) secretion, suppress insulin release from pancreatic Beta cells (α 2 adrenoreceptor mediated response) which generally leads to increased blood sugar level.[7]

Moreover, in randomized experimental study conducted in rat fed with khat, cathinone decrease the activity of free radical metabolizing enzymes there by heightening oxidative stress,[8] which has vital role in development of diabetes and diabetes complications.[9] Though the essence of khat in diabetic patients is unclear, study showed that the overall effect is harmful because

the user probably may not follow dietary advice, and intake of sweetened beverages along with khat worsen the underlying hyperglycemia.[10] More importantly it could be the risk for the development of diabetes .In analytical cross-sectional study in Saudi Arabia showed that there was significant association between khat chewing and development of type-2 diabetes with an Odds ratio of 3.5 among khat chewers.[11] Additionally diabetic khat chewers will demonstrates a marked glycemic responsiveness towards catecholamines (Adrenaline Noradrenaline) due to the underline reduced insulin secretion and insulin sensitivity.[12]

The scientific report in literatures has contradictory report on khat's effect on blood glucose level ranging from no effect on plasma glucose level of diabetic individual while it increased blood glucose level in diabetic patients,[13] significant reduction of blood glucose level in diabetic khat chewers[14] and significantly increased blood glucose levels in diabetic patients[15] has been reported. These conflicting reports make it difficult to come to conclusion and calls for further investigations.

In the eastern part of Ethiopia, Hararghe where khat is consumed on daily bases by the population and it is the major source of income for majority of population and it accounts majority of trade in the Eastern Ethiopia. On searching the local literature in our study area, Harar town there was no published literature on human study regarding the effect of khat on blood glucose level among diabetics and healthy individuals. As it has been indicated in many published articles including animal studies, khat has a significant effect on blood glucose level ranging from hyperglycemic to hypoglycemic effects. Therefore, this study provides information on effect of khat chewing on blood glucose level in the study site and to see if it has any benefit for diabetes control. Moreover it can be used to provide objective nutritional advice for diabetic patients. This may contribute scientific justification for use of khat in traditional medicine for treatment of diabetes. Additionally, the present study assessed factors related with poor glycemic control in diabetic patients. Health care profesionals can use this study finding to extend the efforts of limiting and restraining diabetic complications in diabetic patients.

Materials and Methods

Institution based comparative cross-sectional study was conducted in Harar town Hiwot Fana specialized university hospital from January to March 2020. Convenient sampling method was applied to collect data from study participants. Sample size were determined by the rule of thumb as recommended by Van Voorhis and Morgan[16] and the total sample size for this study was 200 individuals of both sex aged 18 to 65. Subjects were categorized in 4 groups (diabetic khat chewers n = 50, diabetic non khat chewer n = 50, healthy khat chewer n = 50, and healthy non khat chewer n = 50). Both type 1 and type 2 diabetic patients coming to diabetic clinic at Hiwot Fana Specialized university hospital and normoglycemic individuals from Haramaya University academic staffs and Hiwot Fana specialized university hospital health workers who fulfilled the inclusion criteria were included in the study. Subjects were included in our study based on the following inclusion criteria; adults (aged 18-65) of both sexes, diabetic khat chewers and non-khat chewers who is on follow-up at least for 6 months and healthy khat chewers and non-khat chewers without previous history of systemic disease and with normal body mass index (BMI) and blood glucose at the time of data collection. Pregnant women, previous khat chewers, both diabetic and healthy individual who is not in fasting state in the morning were excluded from our study. As a data collection tool we use structured interview questiner to collect data form volenteer study participants.

Operational Definitions

1. Diabetic khat chewer: Confirmed diabetic patients (type 1 and 2) were considered as khat chewer if they had been chewing khat before diagnosis of diabetes mellitus (DM) and chew khat continuously at least for a year on daily bases. 2. Healthy khat chewer: Individual who chew khat at least for a year on daily bases. 3. Non-khat chewer: Individuals (diabetic or healthy) who never chewed khat, chew khat previously, or chew khat occasionally. 4. Sleeping: assessed as Nocturnal: sleeping mostly at night and Diurnal: sleeping mostly during day time. 5. Smoking: assed as smoker and non-smoker.

Data Collection and FBS Determination

Subjects were informed about the objective of the study and written consent were obtained. Data on sociodemographic and behavioral characteristics, was collected using structured interview questionaire from volunteers. Detailed medical history of diabetic patients regarding Blood pressure, history of hypertension, type of anti-diabetic drug and last 2-months FBS result was reviewed and recorded. Anthropometric measurements (height, weight, waist circumference) were measured using standard height and weight measurement scale. BMI was calculated as weight divided by height squared and expressed as kg/m^2. Waist circumference of subjects wearing tiny close were measured using meter put between lower ribs and hips and reported in cm and converted to inches. All anthropometric measurements were reported to the nearest 0.5 cm.

About 5 ml of blood specimen after overnight fasting (8-12 hour) and before morning insulin injection or oral antidiabetic therapies (for diabetic subjects) were collected from median cubital vein cleaned with 70% alcohol. Fasting specimen from diabetic patients were collected before they took morning antidiabetic drug or insulin. Serum was separated by centrifuging the specimen at 2500 RPM for 5 minutes and fasting sugar were determined using Biosystem A-25 and COBAS 6000 c501 clinical chemistry analyzer for glucose oxidase and glucose hexokinase methods respectively. In this study subjects with no known history of chronic illness, having normal BMI and blood glucose level at the time of

data collection were considered as normoglycemic or healthy individuals with cut-off value of 70 to 100 mg/dl. Similarly, for diabetic patient's hyperglycemic cut-off value for fasting blood glucose level was ⩾125 mg/dl.

Because of unavailability and un affordability of HgbA1c measurement, for determination of glycemic control, last consecutive 2 months diabetic clinic visits (before the study begins) FBS result and current measurement was used and subjects were categorized by average (average of the 3 months) FBS as poor glycemic control (FBS > 152 mg/dl) and good glycemic control (FBS < 152 mg/dl) according to American Diabetes Association (ADA) recommendation which is equivalent to 7% HgbA1C when HgbA1c measurement is not available.[17]

Quality Control

During data collection for each study participants questionaier was designated with unique serial number that match with specimen collection container. For reliability and representativeness of the study only complete and consistent data were incorporated.

In order to maintain the quality of laboratory result every laboratory procedure following SOP and IQC were performed to check the performance of chemistry analyzer by running quality control materials (both normal and pathological) daily before analysis of the samples and analysis of specimen has been carried out and control result were governed by Westgard rule. Quality of anthropometric measurements were also maintained as follows. Weight by standard weight measuring instrument put to zero prior to measurement and subjects wear least tiny close. Heights were also measured using standard height measuring meter standing upright position. Waist circumference of subjects wearing tiny close were measured using meter put between lower ribs and hips.

Statistical Analysis

Data were cleared, coded, and entered to SPSS version 21 software (IBM corporation USA) and analyzed. Kormogorov-smorvo test and histogram was used to examine data distribution. Non-parametric tests Mann-Whitney test (2-independent sample test) and Kruskal-Wals test (K-independents sample test) were used to compare fasting blood glucose among khat chewer and non-khat chewer with in the groups and between groups respectively. Association between poor glycemic control and risk factors was determined using bivariate logistic regression analysis (crude odds ratio [COR]). Factors with $P < .25$ were included in multivariable logistic regression analysis (adjusted odds ratio [AOR]) with corresponding 95% CI to identify predictors of poor glycemic control in the studied population and P-value of less than .05 was considered as statistically significant.

Results

In the study a total of 100 diabetic patients who had visited diabetic clinic during the study period and 100 healthy normoglycemic individuals were included. Of all the respondents 83 (41.5%) and 117 (58.5%) were male and female respectively. The Mean ± SD age of diabetic patients and healthy individuals were 44.2 ± 8 and 42 ± 7.4 years respectively (Table 1).

Duration of diabetes was greater than 7 years in 51% of diabetic subjects. The mean diabetes duration was 7.8 ± 3.1 years. (Mean ± SD, kg/m^2) body mass index was 26.1 ± 3.6 and 23 ± 1.5 in diabetics and healthy individuals respectively. Majority (42%) of diabetic patients were on insulin medication followed by metformin (33%) and combination of insulin and metformin (22%) (Table 2).

On the other hand, 26 of diabetic subjects has positive parental history of diabetes and almost all have normal body-mass index and blood pressure at the time of data collection as indicated in Table 3.

Khat Effect on Fasting Blood Glucose Level

In our study we found that khat chewing has hypoglycemic effect on serum glucose level in both diabetics and healthy subject of khat chewers compared to respective control groups, non-khat chewer using Mann-Whitney test. Diabetic khat chewers had significantly lower (Median ± IQR) blood glucose level (159.5 ± 83) mg/dl than non-khat chewers with diabetes (202 ± 79) mg/dl when tested by GOD ($P = .002$). Similarly, when we compare between healthy non-khat chewers and khat chewers, khat chewers have lower (Median ± IQR) fasting blood glucose level (82 ± 18) mg/dl than that of the non-khat chewers (94 ± 13) mg/dl when tested by GOD ($P < .01$) (Table 4).

Glycemic Control and Factors Affecting Glycemic Control

The proportion of poor glycemic control among type-2 diabetic patients were (22) 22%. In bivariable logistic regression analysis use of hormonal contraceptive, occupation, address, family history of diabetes, type of antidiabetic drug, staple food, BMI, waist circumference was found to be significantly associated with poor glycemic control. When entered to multivariable logistic regression analysis type of anti-diabetic drug, BMI, family history, staple food were predictors of poor glycemic control among type-2 diabetic patients as depicted in (Table 5). Respondents who had family history of diabetes are 4.8 times more likely to have poor glycemic control when compared to those who do not have parental history (AOR = 4.8, 95% CI = 1.12-21.37). Those Diabetic subjects who were on insulin therapy alone were 14 time more likely to have poorly controlled blood glucose than who were on combination therapy (AOR = 14.634 95% CI = 2.4-86.66). Participants who had BMI ⩾ 30/obese were found to be 14.4 times more likely to have poor glycemic control compared to subjects with normal BMI (AOR = 14.4 95% CI = 1.406-148.551). Study subjects who consume vegetable foods regularly are 0.1 times less likely to have poor blood glucose control compared to those who consume mostly cereal sources regularly (AOR = 0.118 95% CI = 0.025-0.562).

Table 1. Socio-demographic and behavioral characteristics (N = 200).

VARIABLE	STUDY GROUPS				TOTAL	%
	DIABETICS		HEALTHY			
	KHAT CHEWER (N = 50)	NON-KHAT CHEWER (N = 50)	KHAT CHEWER (N = 50)	NON-KHAT CHEWER (N = 50)		
Age						
25-34	9 (18%)	4 (8%)	9 (18%)	7 (14%)	29	14
35-44	14 (28%)	21 (42%)	21 (42%)	23 (46%)	79	39
45-54	22 (44%)	16 (32%)	16 (32%)	17 (34%)	71	35
⩾55	5 (10%)	9 (18%)	4 (8%)	3 (6%)	21	10
Sex						
Male	21 (42%)	18 (36%)	26 (52%)	18 (36%)	83	41
Female	29 (58%)	32 (64%)	24 (48%)	32 (64%)	117	58.5
Marital status						
Single	2 (4%)	4 (8%)	9 (18%)	12 (24%)	27	13
Married	34 (68%)	34 (68%)	26 (52%)	25 (50%)	119	60
Divorced	3 (6%)	5 (10%)	8 (16%)	10 (20%)	26	13
Widowed	11 (%)	7 (14%)	7 (14%)	3 (6%)	28	14
Contraceptive use						
Yes	7 (14%)	16 (32%)	14 (28%)	14 (28%)	51	56
No	10 (20%)	4 (8%)	8 (16%)	17 (34%)	39	44
Alcohol consumption						
Yes	13 (26%)	27 (54%)	31 (62%)	28 (56%)	99	49.5
No	37 (74%)	23 (46%)	19 (38%)	22 (44%)	101	50.5
Cigarette smoking						
Yes	15 (30%)	4 (8%)	9 (18%)	3 (6%)	31	15.5
No	35 (70%)	46 (92%)	41 (82%)	47 (94%)	169	84.55
Regular enough sleep						
Yes	34 (68%)	35 (70%)	37 (74%)	36 (72%)	142	71
No	16 (32%)	15 (30%)	13 (26%)	14 (28%)	58	29

Discussion

The current study demonstrated that khat chewing significantly lower fasting plasma glucose level in khat chewer compared to non-khat chewers in both diabetics and healthy individuals. The hypoglycemic effect of khat in khat chewer groups showed by the present study might be due to the presence of detectable amount of Mg, Zn, Fe, Ch, Pb, Cu, in khat leaves in which their presence at desirable physiological concentration is very important for glucose hemostasis (Mg) and insulin synthesis, storage, and release (Zn).[18]

Another possible explanation for this could be the presence of ascorbic acid which present on khat leaves (150 mg/100 mg of khat)[10] has an anti-oxidant role and combats the destructive effects of free radicals in diabetic patients[19] and lower fasting blood glucose level in type-2 diabetics individuals.[20] Though in the present study we couldn't measure serum vitamin C level of study subjects.

The present study is in agreement with surveillance study conducted Ethiopia[21] and experimental study in Yemen, in which a significant decrease in blood glucose among diabetic and healthy khat chewers were recorded. There was reduction of blood glucose by 61.2% in healthy khat chewers within 4 h of consumption.[22] Our study is in line with similar study conducted in Yemen in 2013 where significantly decreased plasma glucose level in diabetics and healthy khat chewers were observed.[23] It is also in agreement with the systematic review

Table 2. Clinical data and anthropometric measurement of diabetic participants (N = 100).

VARIABLE	STUDY GROUPS		TOTAL	%
	DIABETICS			
	KHAT CHEWER (N = 50)	NON-KHAT CHEWER (N = 50)		
Family history of DM				
Yes	11 (22%)	24 (48%)	35	35
No	39 (78%)	26 (52%)	65	65
History of hypertension				
Yes	15 (30%)	17 (34%)	32	32
No	35 (70%)	33 (66%)	68	68
Type of anti-diabetic drug				
Insulin	23 (46%)	21 (42%)	44	44
Metformin	15 (30%)	11 (22%)	26	26
Insulin+metformin	12 (24%)	18 (36%)	30	30
Diabetes duration				
⩽7 y	33 (%)	30 (60%)	63	63
>7 y	17 (34%)	20 (40%)	37	37
BMI (kg/m^2)				
Normal	23 (46%)	16 (32%)	39	39
Overweight	16 (32%)	26 (52%)	53	53
Obese	11 (22%)	8 (16%)	21	21
Waist circumference (inches)				
Low risk	24 (48%)	13 (26%)	37	37
Intermediate risk	17 (34%)	31 (62%)	48	48
High risk	9 (18%)	6 (12%)	17	17
Blood pressure (mm/Hg)				
Normotensive	35 (70%)	34 (68%)	69	69
Pre-hypertensive	7 (14%)	4 (8%)	11	11
Hypertensive	8 (16%)	12 (24%)	20	20

study where a insignificant reduction in blood glucose were observed.[24] This hypoglycemic effect of khat in both diabetics and healthy khat chewers could be explained by the presence minerals, tannins (7%-14% in dried material), vitamins (Vitamin c), flavonoids, saponin.[10,25]

Contrary to our study; hyperglycemic effect of khat in diabetic individuals while no effect on healthy individuals during the khat session have been reported.[26,13] This can be explained by khat's adrenergic action there by releasing nor-epinephrine which has one tenth of epinephrine potency on plasma glucose level in healthy non diabetic individuals.[27] Plasma glucose level rises following nor-epinephrine release but in healthy individuals this is compensated by good responsiveness of pancreatic beta cells there by releasing insulin to counter balance plasma glucose level and decrease hepatic glucose output. Rise in plasma glucose level by 10 to 15 mg/dl in healthy non diabetic individuals there is 60% to 100% increase in peripheral insulin level to counter balance blood glucose level with complete suppression of hepatic output.[28,29]

The present study contradict with another finding,[6,30] reported that khat significantly increase blood glucose level in diabetics and healthy khat chewers compared to non-khat

Table 3. Clinical data and anthropometric measurement of healthy individuals (N = 100).

VARIABLES	STUDY GROUPS		TOTAL	%
	HEALTHY KC (N = 50)	HEALTHY NKC (N = 50)		
Family history of diabetes				
Yes	16 (32%)	10 (20%)	26	26
No	34 (68%)	40 (80%)	74	74
BMI (Kg/m^2)				
Normal 18-24.9	50	50	100	100
Waist circumference				
Low risk	44 (88%)	47 (94%)	91	91
Intermediate risk	6 (12%)	3 (6%)	9	9
Blood pressure				
Normotensive	50 (100%)	50 (100%)	100	100

Table 4. Comparison of serum glucose level among khat chewer and no khat chewer diabetic patients and healthy individuals.

FASTING BLOOD GLUCOSE	DIABETICS		HEALTHY INDIVIDUALS	
	KHAT CHEWER (N = 50)	NON-KHAT CHEWER (N = 50)	KHAT CHEWER (N = 50)	NON-KHAT CHEWER (N = 50)
GOD (Median ± IQR)	159 ± 83	202 ± 79	82 ± 18	94 ± 13
P value	$P = .002$		$P < .001$	
GHK (Median ± IQR)	141 ± 80	188 ± 79	71 ± 12	81 ± 10
P value	$P < .001$		$P < .001$	

GOD:- glucose oxidase, GHK:- glucose hexokinase, IQR:- interquartile range.

chewers. This may be attributed to that diabetic khat chewers will demonstrate increased glycemic responsiveness to catecholamines released as a result of cathinone in khat owing to the underlying defect in insulin action and secretion.[7] Another possible explanation for this could be elevation of ACTH level in both diabetic and healthy individuals induced by cathinone from khat leaves and this intern results in plasma elevation of cortisol and resistin. Resistin secreted by adipose tissues hinders insulin signaling and induce hepatic insulin resistance.[5] Enhanced glycemic responsiveness observed in diabetic patients might be due to consumption of sweetened beverage along with khat which worsens the pre-existing hyperglycemia.

In our study we tried to assess factors associated with glycemic control in diabetic patients at Hiwot Fana Specialized university hospital. Of the risk factors studied, Type of antidiabetic drug, BMI, family history of diabetes, staple food (type of food consumed regularly or consumed basically) were found to be significantly associated with glycemic poor control.

The mean FBS of diabetic individuals over the last 3 months were 182.8 ± 34.1 mg/dl. In this study FBS ⩾ 152 mg/dl was taken as poor glycemic control according to ADA recommendation.[17] This finding is higher than the study from Shene Gibe hospital, south east Ethiopia which was 130.3 ± 30.7 mg/dl[31] and higher than the ADA recommendation[17] and study conducted in Malaysia where mean FBS was 166 ± 86.4 mg/dl.[32] Evidently the current study result indicates glycemic control is poor. This might be due to difference in sociodemographic characteristics, life style. We found that 22% of study participants has poorly controlled blood glucose which is lower than findings in Addis Ababa[33] and Eritrea[34] ranging from 80% to 76.3% respectively. In our study glycemic control was assessed by measuring fasting plasma glucose where as in stated studies HgbA1C was measure. The larger sample size, use of HgbA1C as reliable glycemic index in the studies mentioned above could accounts for the observed difference.

Diabetic patients receiving only insulin medication were more likely to have poor glycemic control than those who are on combination therapy (insulin and metformin) and metformin alone and this finding is in line with finding in Jimma.[35] This can be justified by insulin is more prescribed for patients with longer diabetes duration and who have severed diabetes.

Table 5. Univariable and multivariable logistic regression analysis of factors associated with glycemic control of diabetic's patients at Hiwot Fana specialized university hospital.

FACTORS	NUMBER	GOOD N (%)	POOR N (%)	COR (95% CI)	AOR (95% CI)
Age					
25-34	13	2 (15.4)	11 (84.6)	1	
35-44	35	9 (25.7)	26 (74.2)	0.525 (0.097-2.83)	
45-54	38	9 (23.6)	29 (76.3)	0.586 (0.109-3.150)	
⩾55	14	2 (14.2)	12 (85.7)	1.091 (0.130-9.124)	
Sex					
Male	39	9 (23)	30 (76.9)	0.903 (0.344-2.369)	
Female	61	13 (21.3	48 (78.6)	1	
Contraceptive					
Yes	23	3 (13)	20 (86.9)	5. (0.999-25.021)*	
No	14	6 (42.8)	8 (57.1)	1	
Marital status					
Single	6	2 (33.3)	4 (66.6)	1	
Married	68	10 (14.7)	58 (85.2)	2.90 (0.467-17.992)	
Divorced	8	4 (50)	4 (50)	0.50 (0.056-4.473)	
Widowed	18	6 (33.3)	12 (66.6)	1.00 (.141-7.099)	
Occupation					
Government	21	6 (28.5)	15 (71.4)	1	
Private	16	3 (18.7)	13 (81.2)	1.733 (0.360-8.35)	
Farmer	8	1 (12.5)	7 (87.5)	2.80 (0.281-27.907)	
Marchant	22	2 (9)	20 (90.9)	4.0 (0.706-22.669)	
Others	33	10 (30.3)	23 (69.6)	0.920 (0.276-3.064)	
Address					
Urban	70	18 (25.7)	52 (74.2)	1	
Rural	30	4 (13.3)	26 (86.6)	2.250 (0.690-7.332)*	
Family history of DM					
Yes	35	5 (14.2)	30 (85.7)	2.125 (0.710-6.362)*	4.897 (1.122-21.37)*
No	65	17 (26.1)	48 (73.8)	1	Reference
Diagnosed with hypertension					
Yes	32	8 (25)	24 (75)	0.778 (0.288-2.099)	
No	68	14 (20.5)	54 (79.4)	1	
Type of anti-diabetic drug					
Insulin	44	3 (6.8)	41 (93.1)	10.451 (2.638-41.410)*	14.63 (2.47-86.66)*
Metformin	26	6 (23)	20 (76.9)	2.549 (0.796-8.160)*	2.013 (0.501-8.089)*
Insulin+metformin	30	13 (43.3)	17 (56.6)	1	Reference

(Continued)

Table 5. (Continued)

FACTORS	NUMBER	GOOD N (%)	POOR N (%)	COR (95% CI)	AOR (95% CI)
Diabetes duration					
<7	63	13 (20.6)	50 (79.3)	1	
⩾7	37	9 (24.3)	28 (75.6)	0.809 (0.307-2.129)	
Cigarate smoking					
Yes	19	5 (26.3)	14 (73.6)	0.744 (0.235-2.355)	
No	81	17 (20.9)	64 (79)	1	
Alcohol drink					
Yes	40	11 (27.5)	29 (72.5)	0.592 (0.228-1.536)	
No	60	11 (18.3)	49 (76.6)	1	
Regular and enough sleep					
Yes	69	13 (18.8)	56 (81.1)	1	
No	31	9 (29)	22 (70.9)	0.567 (0.212-1.516)	
Sleep pattern					
Nocturnal	71	15 (21)	56 (78.8)	1	
Diurnal	29	7 (24)	22 (75.8)	0.842 (0.302-2.343)	
Fasting habit					
Yes	47	12 (25.5)	35 (74.4)	1	
No	53	10 (18.8)	43 (81.1)	1.474 (0.570-3.814)	
Blood pressure					
Normotensive	69	13 (18.8)	56 (81.1)	1	
Prehypertensive	11	2 (18.1)	9 (81.1)	1.045 (0.201-5.422)	
Hypertensive	20	7 (35)	13 (65)	0.431 (0.144-1.294)	
BMI					
18-24.9	39	16 (41)	23 (58.9)	1	Reference
25-29.9	42	5 (11.9)	37 (88)	5.148 (1.661-15.952)*	5.565 (1.360-22.763)*
⩾30	19	1 (5.2)	18 (94.7)	12.522 (1.515-103.524)*	14.45 (1.40-148.551)*
Waist circumference					
Low risk	37	13 (35.1)	24 (64.8)	1	
Increased risk	48	8 (16.6)	40 (83.3)	2.708 (0.981-7.479)*	
High risk	15	1 (6.6)	14 (93.3)	7.583 (0.894-64.331)*	
Roots and tuber					
1	24	7 (29.1)	17 (70.8)	1	
2	61	12 (19.6)	49 (80.3)	1.68 (0.569-4.967)	
3	15	3 (20)	12 (80)	1.64 (0.353-7.69)	
Legume sources					
1	9	2 (22.2)	7 (77.7)	0.986 (0.19-5.123)	
2	91	20 (21.9)	71 (78)	1	

(Continued)

Table 5. (Continued)

FACTORS	NUMBER	GOOD N (%)	POOR N (%)	COR (95% CI)	AOR (95% CI)
Cereal sources					
2	27	12 (44.4	15 (55.5)	1	
3	73	10 (13.6)	63 (86.3)	0.198 (0.072-0.545)*	
Vegetables					
1&2	72	10 (13.8)	62 (86.1)	3.22 (1.18-8.806)*	
3	28	12 (42.8)	16 (57.1)	1	
Fruits					
1	7	2 (28.5)	5 (71.4)	0.685 (0.124-3.798)	
2&3	92	20 (21.7)	73 (79.3)	1	
Meat					
1	51	10 (19.6)	41 (80.3)	1	
2	45	11 (24.4)	34 (75.5)	0.754 (0.28-1.988)	
3	4	1 (25)	3 (75)	0.732 (0.069-7.799)	
Milk and milk					
1	30	8 (26.6)	22 (73.3)	0.68 (0.253-1.867)	
2&3	70	14 (20)	56 (80)	1	
Egg					
1	27	6 (22.2)	21 (77.7)	0.982 (0.33-2.845)	
2&3	73	16 (21.9)	57 (78)	1	
Staple foods					
Cereals	74	11 (14.8)	63 (85)	1	Reference
Vegetables	23	10 (43.4)	13 (56.5)	0.227 (0.080-0.645)*	0.118 (0.02-0.562)*
Mostly meat	3	1 (33.3)	2 (66.6)	0.349 (0.029-4.188)*	0.058 (0.00-1.565)

*Predictors of poor glycemic control with $P < .05$ in AOR analysis was considered statistically significant. 1: occasionally, 2: once or twice per week, 3: regularly per week.

The cell function decline as duration of disease increases so that there is high demand of insulin supply.[36]

Contradicts with another study in Jimma[37] and in Tanzania[38] where subjects on insulin and oral medication (combination therapy) are more likely to have poor glycemic control compared to those who are only on oral medications.

In the current study subjects with positive parental history of diabetes was more likely to have poor glycemic control similar with the study finding in Malaysia[39] and Saudi Arabia.[40] This might be due to the fact that the disease has genetic risk factor which can affect rigorousness of the disease.

Poor glycemic control was also associated with BMI, being obese is more likely to have poor glycemic control than normal or overweight individuals. This finding was in parallel with study in Nigeria[41] Turkey.[42] This can be explained by the fact that obesity is associated with increased insulin resistance and hyperglycemia in obese people.

Those diabetic patients who consume vegetable foods on regular bases are less likely to have poor glycemic control compared to those who consume cereals on regular or daily bases. Cereal foods are rich in carbohydrate. Raw vegetables both green and non-green leafy are essential to maintain blood glucose level near to normal both in diabetics and healthy individuals. Balanced diet containing more than 1 form of vegetable is good enough for healthy nutrition and will ensure adequate intake of fibers, phytochemicals, and minerals. Phytochemicals are rich in anti-oxidants and are believed to reduce the risk of some chronic ailments.[43] Study showed that,[44] Vegetables control level of blood glucose when consumed before carbohydrate meal and decrease post prandial hyperglycemia.

Conclusion

From the current study we conclude that Khat have significant hypoglycemic effect on fasting blood sugar level of diabetic and healthy khat chewers. Further investigation or phytochemical

analysis is needed to identify khat ingredient which caused the hypoglycemic effect so that in combination with modern medicine more potent antidiabetic drug can made.

Recommendation

More studies should be conducted in randomized control trial manner to further elucidate khat effect on blood sugar level so that the actual effect of khat can be identified unlike in cross sectional where there may not be strong causal relationship. Health care professional and patients should manage the risk factors to delay disease progression and restrain the damage.

Acknowledgements

We would like to thank our study participants for their willingness to participate and we would like to extend our appreciation to the Department of Medical Laboratory Sciences, College of Health Sciences, Haramaya University.

Author Contributions

Yordanos Mengistu, Gobena Dedefo, Samuel Kinde, Zerihun Ataro participated in the conception and design of the study as well as in the preparation and reviewing of the manuscript. Abay Atnafu, Gutema Jebesa, Mesay Arkew, Gebeyehu Asefa was directly involved in coordinating and performing the laboratory work as well as data analysis and also question of data. All the authors read and approved the final manuscript.

Ethical Approval

The study was commenced after obtaining ethical clearance from Addis Ababa University College of health science department of medical laboratory science research and Ethics review committee. Data was collected after written consent was obtained from study subjects. Confidentiality was kept by using codes which are not known by unauthorized person.

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