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Impact of khat leaves on glycosylated haemoglobin and lipid profile in healthy individuals in Dire Dawa, Ethiopia

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Abstract

Objective: The objective of this study is to determine the effect of Catha edulis leaves on glycosylated haemoglobin and lipid profiles in healthy individuals in Dire Dawa, Ethiopia.

Method: A cross-sectional study was conducted to evaluate the effect of khat leaves on the glycated haemoglobin and lipid profile in the Dire Dawa population. For the study, 100 male subjects (aged ⩾20–⩽40 years) were recruited and divided into two groups, each consisting of 50 subjects: the first group was khat chewing people while the other group was non-khat chewing individuals. Blood samples were collected and tested to evaluate the glycated haemoglobin and lipid profiles.

Results: The mean glycated haemoglobin value of khat chewers was 5.33% and for non-chewers, it was 5.48%, respectively. Since *p* value is less than the significance value, the *t*-test supports the reduction in glycated haemoglobin values in khat chewers. The mean values of total cholesterol, and triglycerides in khat chewers are 175.2 and 172.92, and for non-chewers they are 168.7 and 164.56, respectively.

Conclusion: From this study, we concluded that Catha edulis leaves have a significant effect on glycosylated haemoglobin levels. Mean glycated haemoglobin values of long-term healthy khat chewers are comparatively less than healthy non-chewers. Long-term khat chewing increases total cholesterol levels and triglycerides levels but there is no significant effect on the high-density lipoprotein and low-density lipoprotein levels.

Keywords

Catha edulis, khat, glucose, glycated haemoglobin, total cholesterol, triglycerides, high-density lipoprotein, low-density lipoprotein

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Background

Catha edulis (khat) is a plant grown commonly in the horn of Africa. The leaves of the khat are chewed by individuals for their stimulant activity.[1] Its young buds and tender leaves are chewed to accomplish a state of happiness and incitement. Khat is an evergreen bush, which is grown as a bush or a small tree. The extracts have a fragrant smell. The taste is astringent and somewhat sweet. The plant is seedless and tough, developing in an assortment of climates and soils. Khat contains more than 40 alkaloids, glycosides, tannins, terpenoids, flavonoids, sterols, vitamins, and minerals. Phenylalkylamines and cathedulins are the major alkaloids. Recently, 62 different cathedulins from fresh khat leaves were characterized.[2]

The khat phenylalkylamines contain cathinone, cathine, and norephedrine. These compounds are related to amphetamine and noradrenaline. Cathinone is primarily found within the youthful take offs and shoots. During development, cathinone is metabolized to cathine and norephedrine.[3]

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It is believed that a few million individuals are routine khat clients, living in topographical regions near to where khat develops, especially Yemen, Somalia, Ethiopia, Djibouti, and Kenya.[4] Individuals chew khat extracts essentially for its pleasurable and invigorating impacts. The stimulant impact of this plant is due to the nearness of a monoamine alkaloid cathinone. There have been various debates and wrangles about khat-chewing and about its positive as well as negative effect on society. There is a broadly held view among khat chewers in the Middle East locale that khat juice makes a difference by lowering their blood glucose levels and maintains it at stable levels.[5]

Diabetes may be a major cause of visual deficiency, kidney issues, heart attacks, stroke, and lower appendage removal. Diabetes is the eighth driving cause of early mortality in the world. At the time of writing, no satisfactorily successful remedy for diabetes mellitus has been found. Currently available therapeutic options, including dietary modification, oral hypoglycaemic, and insulin, have their limitations.[6]

Different studies have identified an effect of khat on the health and behaviours of individuals; for instance, a study conducted in the Gurage zone has identified that khat chewing increases the risk of blood pressure.[7] A review study conducted in 2010 revealed that khat chewing increases the risks of cardiovascular disease.[8,9] A further study conducted in Yemen has revealed that khat (Catha edulis) leaves have toxic effects on the blood constituents, induce alterations in biomarkers of oxidative stress and biochemicals, and could be an indicator for liver and kidney toxicity.[10] In addition, khat chewing was significantly associated with risky sexual behaviours, which in turn increases the risk of developing sexually transmitted diseases.[11]

Numerous common herbs and flavours are claimed to have properties that bring down blood sugar levels and make them valuable for individuals with or at risk of type 2 diabetes. Without a doubt, a few of these items may have hurtful impacts on the body. Therefore, we ought to explore these plant items to find their genuine impacts. Khat is one of those plants that have been claimed for their antidiabetic properties, broadly utilized all through the world. From the existing scientific literary works, no past investigation has been done to evaluate the impact of khat extracts on the glycosylated haemoglobin (HbA1c) and lipid levels in the people of Dire Dawa town. Therefore, this study is designed to test the hypothesis that there is no difference in the HbA1c and lipid profiles among healthy individuals of khat chewers and non-khat chewers in Dire Dawa, Ethiopia.

Materials and methods

Study area and period. The study was conducted in Dire Dawa town between October 2017 and May 2018. Dire Dawa is situated in the eastern part of Ethiopia, 515 km from Addis Ababa, the capital city of Ethiopia. The total area of the region is 128,802 ha and it shares common boundaries with the Ethiopian Somali Regional States in the west, north, and east and with the Oromia Regional State in the south.

Study design. A cross-sectional study was applied to determine the effect of Catha edulis on the HbA1c and lipid profiles in healthy individuals in Dire Dawa.

Source population. Male khat chewing and non-khat chewing peoples from Dire Dawa.

Study population

A total of 100 volunteers for the study were taken as study subjects and divided into two groups: khat chewers and non-chewers with 50 participants in each group.

Inclusion criteria

Individuals who have been using khat in the past year. People who are non-smokers, non-alcoholics, and who are not under medication for any disease conditions included in this study.

Exclusion criteria

Individuals who have donated blood recently, and diabetic people were excluded in from this study.

Sampling technique

A convenient sampling technique was used for the study. Blood samples were collected after getting the consent of the candidates.

Blood sample collection

Blood samples were collected from the study subjects by two lab technicians. A 2-day training was given for the blood sample collectors and data collectors. Blood samples were collected in a vacutainer by venepuncture from individuals. Blood samples were given to laboratory technologists for testing for HbA1C and lipid profiles. All samples were collected at 7:00 a.m. before the study participant had taken any meal or khat.

Study variables

Dependent variable: HbA1c, total cholesterol, triglycerides, high-density lipoprotein (HDL), and low-density lipoprotein (LDL).
Independent variable: khat chewing.

Operational definition

HbA1c is a form of haemoglobin that is measured primarily to identify the 3-months average plasma glucose concentration.

Table 1. Lipid profile test normal ranges.

Lipid profile	Normal range	Low	High
Total cholesterol	150–200 mg/dL	<150 mg/dL	>200 mg/dl
Triglycerides	40–140 mg/dL	<40 mg/dL	>140 mg/dl
HDL cholesterol direct	35–170 mg/dL	<35 mg/dL	>170 mg/dl
VLDL	5–35 mg/dL	<5 mg/dL	>35 mg/dl
LDL cholesterol direct	65–170 mg/dL	<65 mg/dL	>170 mg/dl
Total cholesterol/HDL ratio	0–4.5		>4.5
LDL/HDL cholesterol ratio	0–3.55		>3.55

HDL: high-density lipoprotein; VLDL: very low density lipoprotein; LDL: low-density lipoprotein.

Table 2. Descriptive summaries of study variables of Dire Dawa, 2019.

Variables	*N*	Khat chewers				Non-khat chewers				*p*-value
		Minimum	Maximum	Mean	SD	Min	Max	Mean	SD	*p*-value
HbA1c	100	4.8	6.3	5.34	0.32	4.6	6.2	5.48	0.32	0.026*
Total cholesterol	100	143	214	175.2	18.14	145	215	168.7	13.16	0.045*
Triglycerides	100	130	236	172.92	26.30	142	209	164.56	13.2	0.047*
HDL	100	39	59	48.36	5.94	40	57	48.6	4.47	0.805
LDL	100	52	114	90.72	13.09	59	125	88.66	14.34	0.45

HDL: high-density lipoprotein; LDL: low-density lipoprotein.
*Indicates that the variable is significant at 5%.

For people without diabetes, the normal range for the HbA1c level is between 4% and 5.6%. HbA1c levels between 5.7% and 6.4% mean a higher chance of getting diabetes. Levels of 6.5% or higher mean people are diabetic.

Lipid profile or lipid panel is a panel of blood tests that serves as an initial broad medical screening tool for abnormalities in lipids, such as cholesterol and triglycerides. The normal ranges of lipid profiles are listed in Table 1.

Khat chewers are regular (daily) khat chewers who have chewed khat for at least 1 year. Non-khat chewers are those who have never chewed khat in their lifetime.

Statistical analysis

To compare the mean differences between the test and control groups, independent *t*-tests were used. The significant level used for the analysis is 5% (0.05)

To ensure the quality of data to be gathered, a range of mechanisms were employed. A 2-day training (orientation) was given for data collectors on the objective of the study, pre-analytical, analytical, and post-analytical procedures by a haematologist and researcher with an MSc degree. Any errors found during pre-analytical, analytical, and post-analytical processes were corrected immediately. The investigators checked the process of all the procedures throughout the data collection periods on a daily basis.

Laboratory examination of blood: about 5 mL of fasting venous blood was collected using a serum separator tube (SST). The serum separated within 2 h of sample collection. A trained laboratory technologist analysed the samples to determine the lipid profile and blood glucose levels. A Hitachi 7600 analyser was used to detect all blood lipids (triglycerides (TG), total cholesterol (TC), high-density lipoprotein cholesterol (HDL-C), and low-density lipoprotein cholesterol (LDL-C)).

Ethical consideration

This study was conducted following the Declaration of Helsinki. Ethical clearance was obtained from Dire Dawa University, College of Medicine and Health Sciences. Institutional Health Research Ethics Review Committee (IHRERC) was secured by ethical clearance with the reference number DDU/IHRERC/0869/19. Before data and sample collection, written informed consent was obtained from each study participant. Confidentiality was maintained by omitting any personal identification from the questionnaire and, instead, a code was used. The collected data were used only for research purposes.

Result

A total of 100 volunteers participated in the study. Among them, 50 were khat chewers (test) and 50 were non-khat chewers (control). Blood samples were taken from each individual and their HbA1c and lipid panel tests were done. Descriptive summaries such as minimum, maximum, mean, and standard deviation values of the study variables are presented in Table 2.

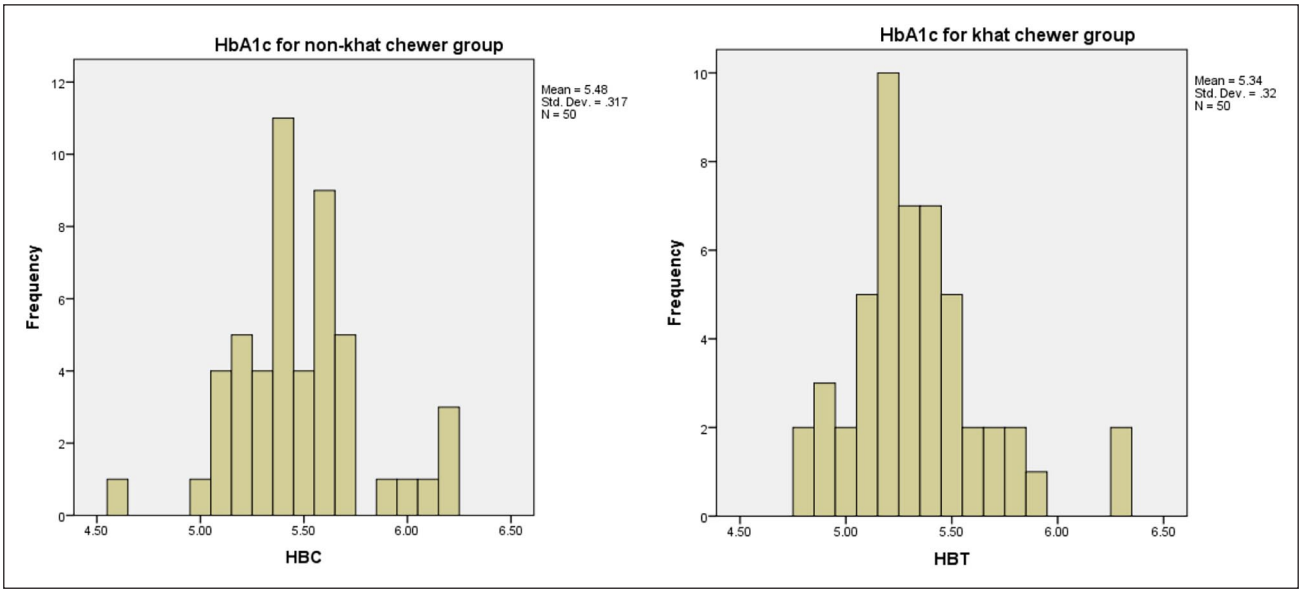

Figure 1. Histograms of HbA1c levels in khat chewers and non-chewers.

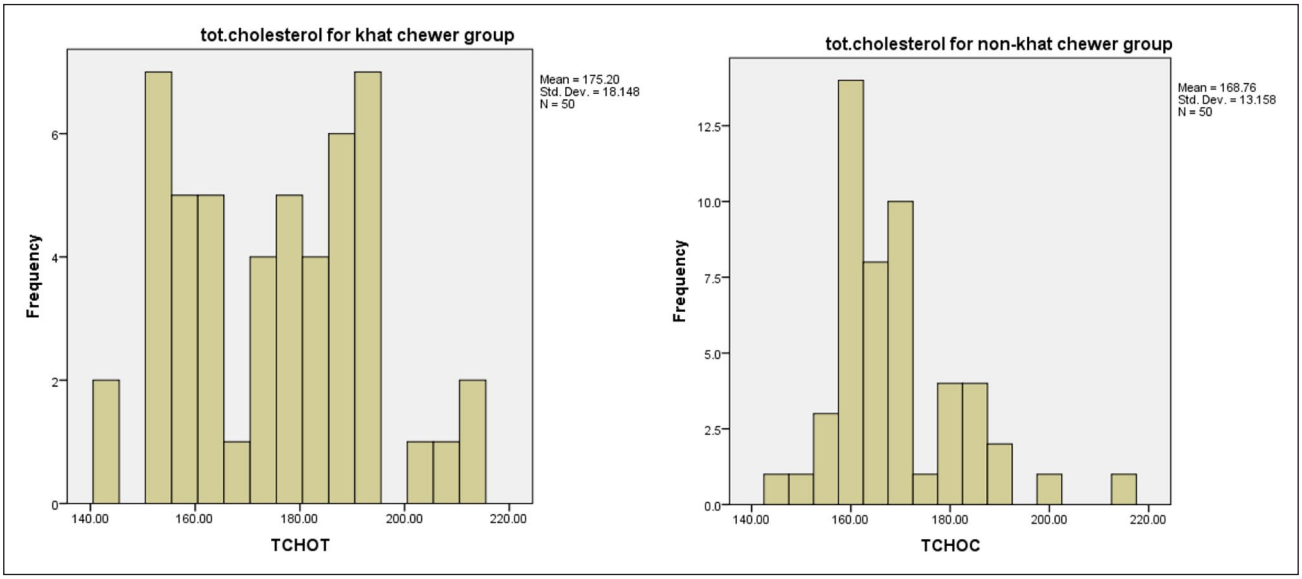

Figure 2. Histograms of total cholesterol levels in khat chewers and non-chewers.

The minimum and the maximum values of HbA1c of khat chewers are 4.8% and 6.3%, respectively. Whereas the minimum and the maximum values of HbA1c of non-khat chewers are 4.6% and 6.2%, respectively (Table 2). When we compare the sample statistic of the khat chewers and non-khat chewers the minimum and the maximum HbA1c values of the khat chewers are slightly higher than those of non-khat chewers. However, the mean HbA1c values of the treatment group is less than the mean HbA1c values of the control group (Figure 1).

The minimum and maximum values of total cholesterol in khat chewers are 143 mg/dL and 214 mg/dL respectively; whereas the minimum and the maximum values of total cholesterol in non-khat chewers are 145 mg/dL and 215 mg/dL, respectively. The mean and standard deviation of the total cholesterol in test groups are 175.2 and 18.14, respectively. The standard deviation indicates that the test group's total cholesterol values are on average apart from the mean by 18.14 units. The mean and standard deviation of the total cholesterol in the control group is 168.7 mg/dL and 13.158, respectively. The standard deviation indicates that the control group's total cholesterol values are on average apart from the mean by 13.158 units (Figure 2).

When we compare the sample statistic of the test and control groups, the minimum triglyceride values of the khat chewers are slightly less than those of the non-khat chewers.

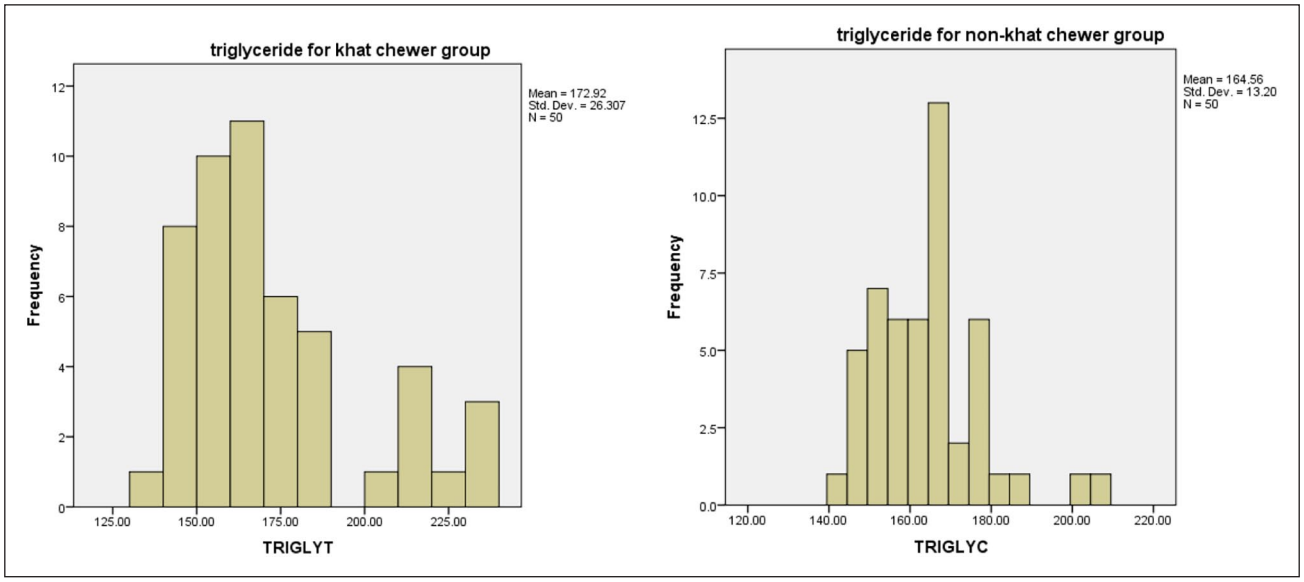

Figure 3. Histograms of triglycerides levels in khat chewers and non-chewers.

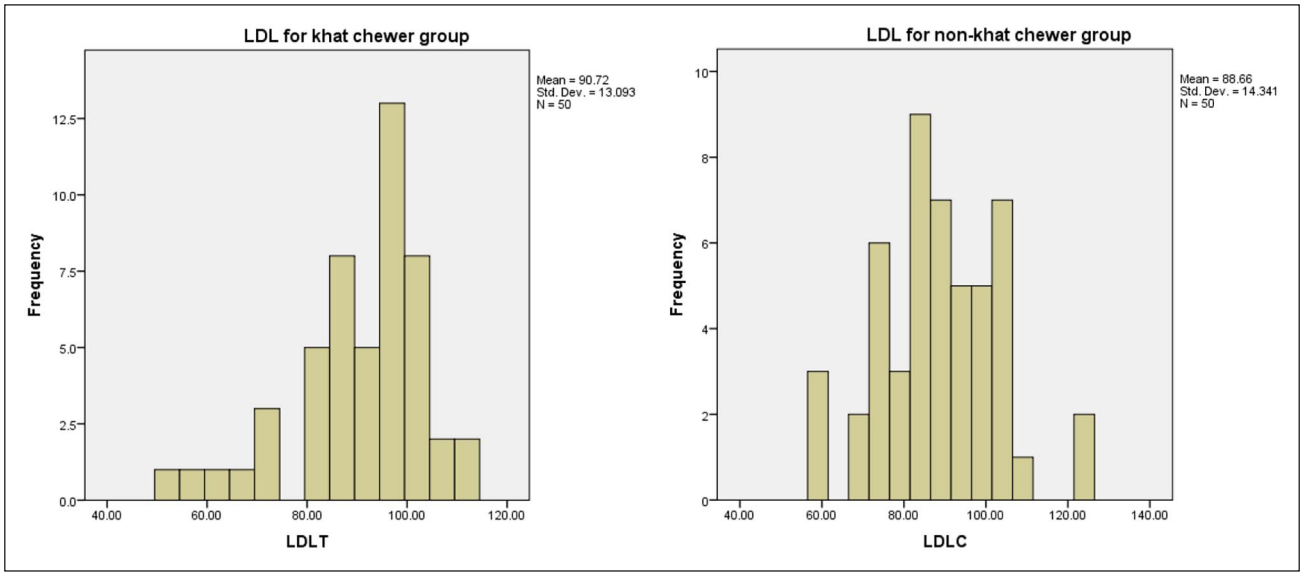

Figure 4. Histograms of LDL levels in khat chewers and non-chewers.

The maximum triglyceride values of the control group are slightly higher than that of the test group. However, the mean triglyceride values of the control group are less than the mean triglycerides values of the test group (Figure 3).

When we compare the sample statistic of the test and control groups, the minimum LDL values of the khat chewers is less than those of non-khat chewers. The maximum LDL values of the control group are higher than those of the control group. However, the mean LDL values of the control and test groups do not have significant differences (Figure 4).

The histograms provide a clear idea about the number of individuals distributed in different ranges of HbA1c, total cholesterol, triglycerides, and LDL values.

The HbA1c values of both khat chewers and non-chewers are maximally distributed in the range of 5%–5.5% (Figure 1). The total cholesterol values of the majority of khat chewers are distributed in the range of 170–195 mg/dL. Total cholesterol values of non-chewers are distributed in the range of 155–170 mg/dL (Figure 2). The histogram of triglycerides levels shows that the triglyceride values of khat chewers are maximally distributed between 140 and 175 mg/dL and in non-chewers 150 and 170 mg/dL. Elevated triglycerides values are more in khat chewers than non-chewers (Figure 3).

The age groups 20–25, 25–30, 30–35, and 35–40 of both khat chewers and non-chewers are distributed almost equally in each age group (Table 3).

Table 3. Age distribution of khat chewers and non-chewer of Dire Dawa, 2019.

Age group	20–25	25–30	30–35	35–40
Khat chewers	15	20	5	10
Non-khat chewers	14	24	4	8

The hypothesis about the HbA1c test was whether the mean HbA1c value of Khat chewers (μ_1) is less than the mean HbA1c level of the non-khat chewers (μ_2). The hypothesis is given as

$$H_0 : \mu_1 = \mu_2 \text{ vs } H_a : \mu_1 < \mu_2$$

Rejection of the null hypothesis H_0 is based on the *p*-value. As can be seen from Table 2, the *p*-value 0.026 is less than the significance value $\alpha = 0.05$, which indicates that we can reject the null hypothesis that there is no difference in the mean HbA1c levels between khat chewers and non-khat chewers and it can be claimed that the alternative hypothesis H_a is true. Thus, we conclude that the mean HB level of Khat chewers is less than the mean HB level of non-khat chewers.

The hypothesis that we test about the total cholesterol was whether the mean total cholesterol value of khat chewers (μ_1) is greater than the mean total cholesterol level of the non-khat chewers (μ_2). The hypothesis is given as

$$H_0 : \mu_1 = \mu_2 \text{ versus } H_a : \mu_1 > \mu_2$$

Table 2 shows that the *p*-value (0.045) is less than the significance value at $= 0.05$. So, we can reject the null hypothesis that there is no difference in the mean total cholesterol levels between khat chewers and non-khat chewers. We can claim the alternative hypothesis that H_a is true. Thus, we conclude that the mean total cholesterol level of khat chewers is greater than the mean total cholesterol level of the non-khat chewers.

The hypothesis about triglycerides was whether the mean triglyceride value of Khat chewers (μ_1) is greater than the mean triglyceride level of the non-khat chewers (μ_1). The hypothesis is given as

$$H_0 : \mu_1 = \mu_2 \text{ versus } H_a : \mu_1 > \mu_2$$

From Figure 4, the *p*-value (0.047) is found to be less than the significance value $\alpha = 0.05$. This indicates that we can reject the null hypothesis that there is no difference in the mean triglycerides levels between khat chewers and non-khat chewers. So the alternative hypothesis H_a is true. Thus, we conclude that the mean triglycerides level of khat chewers is greater than the mean triglycerides level of the non-khat chewers.

The hypothesis about HDL was whether there are significant differences between khat chewers and non-khat chewers on the mean HDL values. The hypothesis is given as

$$H_0 : \mu_1 = \mu_2 \text{ versus } H_a : \mu_1 \neq \mu_2$$

As can be seen from Table 2, the *p*-value of 0.805 is greater than the significance value $\alpha = 0.05$, which indicates that there is no adequate evidence to reject the null hypothesis There is no difference in the mean HDL levels between khat chewers and non-khat chewers. Thus, we conclude that there are no significant differences in the mean values of HDL between khat chewers and non-khat chewers.

The hypothesis about LDL was whether there are significant differences between khat chewers and non-khat chewers on the mean LDL values. The hypothesis is given as

$$H_0 : \mu_1 = \mu_2 \text{ versus } H_a : \mu_1 \neq \mu_2$$

From Table 2, the *p*-value of 0.455 is found to be greater than the significance value $\alpha = 0.05$, which indicates that there is not enough evidence to reject the null hypothesis. There is no difference in the mean LDL levels between khat chewers and non-khat chewers. Thus, we conclude that there are no significant differences in the mean values of LDL between khat chewers and non-chewers (Table 2).

Discussion

This study revealed that the HbA1c level of khat chewers is less than the mean HbA1c level of non-khat chewers. This finding contradicts the study conducted in Yemen, which had identified that chronic khat chewing is a risk factor in the development of non-insulin-dependent diabetes mellitus.[12] Similarly, another study conducted in Saudi Arabia revealed that khat chewing was identified as a risk factor for type 2 diabetes mellitus.[13] The difference can be explained by the variation of sample size of our study, which included only 100 individuals.

Our findings identified that the mean triglyceride levels of khat chewers is greater than the mean triglyceride levels of non-khat chewers. The finding was supported by a study conducted in Jima, which revealed that the serum triglyceride was shown to be higher among khat chewers.[14] This may be because khat chewers are usually physical inactive, which is in turn associated with an increased level of lipid profile.

The mean total cholesterol level of khat chewers is greater than the mean total cholesterol level of non-khat chewers. The current finding is supported by a study conducted in Yemen, which identified that the total cholesterol level was increased among khat chewers when compared with non-khat chewers.[10] This is probably due to the inhibition of critical antioxidant enzymes and scavenger proteins. In addition,

for optimal enzyme and protein functions, the pH value is an important factor; however, a significant decrease in pH has been reported among khat chewers.[15,16]

On the whole, this study revealed that although the HbA1c, total cholesterol level, and triglyceride levels were affected by long-term khat chewing, the values of LDL and HDL were not significantly affected.

Limitations of the study

Despite this finding, the current study was affected by the following limitations: first, we have included a small sample size due to resource limitations, second the sample size/power analysis was not performed for this study, third individuals were not tested for common morbidities that cause a change in lipid profile, fourth the individuals were not identified by the type of khat they chewed, bundles of khat, and the duration of khat chewing was not separately reported, and fifth, only male participants were involved in this study.

Conclusion

From this study, we conclude that khat leaves have a significant effect on HBA1c levels. Mean HbA1c values of long-term healthy khat chewers are comparatively less than that of healthy non-chewers. Long-term khat chewing increases total cholesterol levels and triglyceride levels but there is no significant effect on the HDL and LDL levels.

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Author contributors

D.A. and Y.T. made substantial contributions to the conception and design, acquisition of data, analysis, and interpretation of data. They wrote the draft manuscript and provided final approval of the version to be published. Y.T., D.A., A.S., and S.H. made substantial contributions to the design, acquisition of data, analysis, and interpretation of data. All the authors read and approved the final manuscript.

Data availability statement

Data are available upon reasonable request. All data relevant to the study are included in the article or uploaded as supplemental information. Data will be available upon request from the corresponding authors.

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.

Ethical approval

This study was conducted following the Declaration of Helsinki. Ethical clearance was obtained from Dire Dawa University, college of medicine and health sciences Institutional Health Research Ethics Review Committee (IHRERC) was secured by ethical clearance with a reference number DDU/IHRERC/0869/19.

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Informed consent

Before data and sample collection, written informed consent was obtained from each study participant.

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Supplemental material

Supplemental material for this article is available online.

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