

VOLUME 9

ISSUE 1

2023

ISSN 2454 – 3055



**INTERNATIONAL
JOURNAL OF
ZOOLOGICAL
INVESTIGATIONS**

*Forum for Biological and
Environmental Sciences*

Published by Saran Publications, India



In Vitro* α -Amylase and α -Glucosidase Inhibiting Activities of the Alcoholic Leaf Extracts of *Trigonella foenum-graecum

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Received: 27th December, 2022; **Accepted:** 1st February, 2023; **Published online:** 19th February, 2023

<https://doi.org/10.33745/ijzi.2023.v09i01.037>

Abstract: *Trigonella foenum-graecum* is a medicinally valuable plant commonly used to treat many disorder traditionally. In this study presence of phyto-compounds were evaluated using preliminary phytochemical analysis and GCMS observations, and the antidiabetic efficacy was confirmed by the inhibitory activity against the α -amylase and α -glucosidase enzymes. The presence of various bioactive compounds such as phenol, saponin, alkaloid, flavonoid, triterpenoids were reported in the alcoholic extracts of the plant leaves. The GC-MS analysis revealed the presence of 30 and 40 various major and minor compounds in the ethanol and methanol leaf extracts, respectively. The ethanol and methanol extracts possess to have strong inhibitory activity against the α -glucosidase with 66.6% and 75% of inhibition in the activity, respectively and an inhibition of 55.5% and 62.5% were recorded with α -amylase activity, respectively. The result suggested that the methanolic extract showed potential antidiabetic activity than the ethanolic solvent extract of the plant. It is required to further evaluate the plant for the isolation of bioactive compound which is responsible for the anti-hyperglycemic activity.

Keywords: Diabetes Mellitus, α -Amylase, α -Glucosidase, *Trigonella foenum-graecum*, GC-MS, Phytochemicals

Citation: Kavitha V. and Karthikeyan J.: *In Vitro* α -amylase and α -glucosidase inhibiting activities of the alcoholic leaf extracts of *Trigonella foenum-graecum*. Intern. J. Zool. Invest. 9(1): 321-331, 2023.

<https://doi.org/10.33745/ijzi.2023.v09i01.037>



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Introduction

Diabetes mellitus is characterized by the hyperglycemic condition due to the insufficient secretion of insulin or its action. Around 451 million people with different age groups are living with diabetes worldwide (Kifle *et al.*, 2022). Diabetes results in the increased oxidative stress and dyslipidemia (AD Association). Oxidative stress may cause cellular injury, organ dysfunction

and tissue damages (Mahdi *et al.*, 2003). Acute complications such as ketoacidosis and hyper osmolarity are also evident with diabetes mellitus patients (Kitabchi *et al.*, 2009). Diabetes can be managed by the alternative sources such as medicinal plants (Patel *et al.*, 2012). People with type 2 diabetes are prone to major risk of micro- and macro-vascular complications (Aryangat and

Gerich, 2010).

Two enzymes namely α -amylase and α -glucosidase released by the intestinal lumen were responsible for the production of glucose from many oligosaccharides (Shang *et al.*, 2012). The inhibition of the α -amylase activity may reduce the conversion of glucose from their original source and reduces the available glucose for the absorption. The inhibition of α -amylase enzyme activity plays a major role in the control of diabetes mellitus especially at the post-prandial level of glucose (Bhandari *et al.*, 2008). The synthetic hypoglycemic reagents such as acarbose will inhibit the α -glucosidase and α -amylase activity. However, the synthetic anti-diabetic drugs will increase risk of failure of organs in the diabetic patients (Rupasinghe *et al.*, 2016).

More than 25% of drugs available were derived from medicinal plants. Only parts of medicinal plants were evaluated scientifically for their clinical efficacy. Conventional therapies and strategies were used to treat type II diabetes. The traditional healthcare system is a potential resource for the bioactive compounds which are very useful in the development of novel drugs to treat diabetes (Trojan *et al.*, 2011).

There is growing interest in herbal remedies because of their effectiveness, minimal side effects in clinical experience, and relatively low cost. The world health organization approves the use of plant drugs for different diseases including diabetes mellitus (Patil *et al.*, 2012). Among the various medicinal plants documented as hyperglycemic agent, fenugreek is important dietary and medicinal plant (Nathiya *et al.*, 2014).

Fenugreek (*Trigonella foenum-graecum*) is a leguminous herb cultivated in India and North African countries. It belongs to the family *Fabaceae* and is variously called in different languages, viz., Fenugrec (French), Methi (Hindi), Bockshorkelee (German), Fieno greco (Italian), Pazhitnik (Russian), Alholva (Spanish), Koroha (Japanese), Hulba (Arabian), Halba (Malaya), and K'u-Tou (China) (Srinivasan, 2006). Fresh or dried

fenugreek leaves and tender stems are edible. These leaves provide a good amount of various minerals and vitamins. They are specially rich in choline (Chadha, 1985). It is useful for internal and external swelling and burns and also used to prevent the hair falling off (Kritikar and Basu, 1991). Fenugreek is rich in Alkaloids, carbohydrates, steroidal saponins, amino acids and minerals, therefore it can be used for nutritional, nutraceutical, medicinal and therapeutic purposes (Aasim *et al.*, 2018). Fresh fenugreek leaves are beneficial for indigestion, flatulence and in sluggish liver treatment. Fenugreek has a broad range of pharmacological profile, but also it has anti-diabetic, anti-plasmodic, hypolipidemic, immunological, antibacterial, anti-helminthic, anti-inflammatory, analgesic and anti-oxidant activity (Yadav *et al.*, 2011).

Materials and Methods

Plant Material:

Freshly Collected plant materials of *Trigonella foenum-graecum* from the medicinal plant garden was authenticated with the Post-Graduate Department of Plant Biology and Biotechnology, Presidency College, Chennai, India. The leaves were chopped into small pieces and allowed to air dried until the moisture content of the leaves were removed. The dried leaves were subjected to mixer blender to make them coarse powder and stored in the air tight containers until further use.

The powdered leaves were soaked in methanol and ethanol for a period of 48 h at room temperature, and the filtrate was collected using Whatman's filter paper and the solvents were removed using rotary evaporator and the resulting extracts were allowed to dry and used for further analysis.

Phytochemical Analysis:

Solvent mediated leaf extracts of *Trigonella foenum-graecum* were subjected to qualitative phytochemical analysis for the presence of various secondary metabolite compounds following the methods of Harborne (1973).

Test for Alkaloids:

100 mg of the alcoholic extract was dissolved in 5 ml of 1% Hydrochloric acid and filtered, 2 to 3 drops of Dragendorff's reagent was added with the filtrate and the formation of orange-red colour precipitate confirmed the presence of Alkaloids.

Test for Flavonoids:

The plant extracts were dissolved in methanol by mild heating, to each of the extract small pieces of magnesium ribbon was added, followed by the addition of a few drops of concentrated hydrochloric acid the colour changed from orange, pink, red colour to purple colour indicated the presence of flavonoids.

Test for Tannins:

200 mg of each plant extract was dissolved in about 10 ml of distilled water and then filtered. 2 ml of filtered extract was taken in a separate test tube. 1% alcoholic ferric chloride solution was added to the test tubes and the formation of blue green precipitate indicated the presence of tannins.

Test for steroids:

100 mg leaf extract was dissolved in equal volume of acetic acid and chloroform. The sample was cooled at 0°C for few minutes and few drops of concentrated sulfuric acid was added to the sample and the formation of reddish brown or violet-brown ring indicated the presence of a steroid.

Test for Diterpenoids:

1 ml of leaf extract was treated with a few drops of 1% copper acetate solution, formation of emerald green color indicated the presence of diterpenoids.

Test for Terpenoids:

500 mg of extract was dissolved in ethanol. 1 ml of the extract and 1 ml of acetic anhydride were taken in a clean test tube. Few drops of concentrated sulfuric acid was added to the tubes. The colour changed from pink to violet which indicated the presence terpenoids.

Test for Saponins:

1 g of each extract was shaken vigorously with 3 to 5 ml of distilled water, persistent foam for 10 min confirmed the presence of saponins.

Cardiac glycosides (Keller-Killani test):

3 ml of each plant extract was treated with 2 ml of glacial acetic acid and few drops of 1% ferric chloride solution followed by this 1 ml of concentrated sulfuric acid was added. Formation of brown ring at the interface showed the presence of cardiac glycosides.

Carbohydrate Test:

2 ml of leaf extract was treated with few drops of Molisch reagent and 1 ml concentrated sulfuric acid. Formation of red coloured ring at the interface indicated the presence of carbohydrates.

Test for Protein:

2 ml of each extract was treated with few drops of 1% Ninhydrin solution. Formation of blue colour on mild heating in the water bath confirmed the presence of protein.

GC-MS analysis:

GC-MS analysis of these extracts was carried out by following the method of Hema *et al.* (2010). Chromatograph interfaced to a mass spectrometer (GC-MS) equipped with an Elite-1, fused silica capillary column (30 m, 0.25 mm ID, 1 m df, composed of 100% Dimethyl poly siloxane). For GC/MS detection, an electron ionization system with ionizing energy of 70 eV was used. Helium gas (99.999%) was used as the carrier gas at constant flow rate 1 ml/min and an injection volume of 2 ml was employed (Split ratio of 10:1), injector temperature 250°C; ion- source temperature 280°C. The oven temperature was programmed from 110°C (isothermal for 2 min) with an increase of 10°C/min to 200°C, then 5°C/min to 280°C, ending with a 9 min isothermal at 280°C. Mass spectra were taken at 70eV; a scan interval of 0.5 sec and fragments from 45 to 450 Da. Total GC running time was 36 min. The relative % amount of each component was calculated by

Table 1: Preliminary phytochemical screening of ethanol and methanol leaf extracts of *Trigonella foenum-graecum*

Test	Ethanol	Methanol
Steroid	++	+++
Tanins	++	+
Saponin	++	++
Cumarin	+	+
Phenol	+++	-
Alkaloid	+++	+++
Flavonoid	+++	+++
Diterpinoids	++	+++
Cardio glycosides	-	+
Carbohydrates	++	+++
Protein	+++	++
Terpenoids	++	++
Anthocyanin	-	-
Enodin	-	-

comparing its average peak area to the total areas, software adopted to handle mass spectra and chromatograms was a Turbo mass.

Alpha Amylase Inhibition Assay:

Inhibition of porcine α -amylase activity was determined using dinitrosalicylic acid followed by the method of Kwon *et al.* (2006). Stock solutions of plant extracts and positive control Acarbose were prepared in water. *Trigonella foenum-graecum* leaf extract or Acarbose (100 μ l of 10 to 100 mg/ml) was added to 100 μ l of α -amylase (1 U/ml) and 200 μ l of sodium phosphate buffer (20 mM, pH 6.9). The test tubes were pre-incubated for a period of 10 min at 25 °C, to this about 200 μ l of 1 % starch solution was added. The reaction mixtures were further incubated at 25 °C for 10 min. The reactions were stopped by adding 1 ml of dinitrosalicylic acid and kept in boiling water bath to arrest the reaction. The reaction mixture was allowed to cool to RT, and diluted to 1:5 ratio with water, and absorbance was measured in a spectrophotometer at 540 nm. Percentage of inhibition of enzyme activity was calculated as--

$$\text{Percentage of } \alpha \text{ amylase inhibition} = \frac{\text{OD of Control} - \text{OD of Sample}}{\text{OD of Sample}} \times 100$$

α -Glucosidase Inhibition Assay:

Inhibition of α -glucosidase activity was determined using yeast α -glucosidase and

p-nitrophenyl- α -D-glucopyranoside (pNPG) followed by the method of Kim *et al.* (2004). *Trigonella foenum-graecum* leaf extract or Acarbose (100 μ l of 20 to 100 μ g/ml) was added to 50 μ l of α -glucosidase, prepared in 0.1 M phosphate buffer (pH 6.9), and 250 μ l of 0.1 M phosphate buffer. The test tubes were pre-incubated for 20 min at 37°C. After pre-incubation, 10 μ l of 10 mM pNPG prepared in 0.1 M phosphate buffer was added to the sample and further incubated for 30min at 37 °C. The reactions were stopped by adding 650 μ l of 1 M sodium carbonate to the test tubes and the absorption was measured at 405 nm by using UV-Visible spectrophotometer.

$$\text{Percentage of } \alpha \text{ Glucosidase inhibition} = \frac{\text{OD of Control} - \text{OD of Sample}}{\text{OD of Sample}} \times 100$$

Results

The preliminary phytochemical investigations of ethanol and methanol mediated leaf extracts of *Trigonella foenum-graecum* were tested for the presence of major bioactive compounds and the observations are presented in Table 1. The results revealed the maximum presence of phenols, flavonoids, alkaloids, proteins followed by moderate presence of steroids, tannins, saponins, diterpenoids, carbohydrates and terpenoids in the extracts tested in the present study.

To know the various bioactive compound present in the extracts, Gas-Chromatography-Mass

Spectroscopic analysis was performed and the presence of various major and minor bioactive compounds were identified (Tables 2, 3; Figs. 1, 2).

The ethanol mediated solvent extract of leaves of *Trigonella foenum-graecum* subjected to GC-MS analysis revealed the presence of 30 various compounds with peak percentage area. Propane, 1,1,3-triethoxy-, D-Fructose, 3-O-methyl-, Benzofurane-2-carboxylic acid, 3... Morpholine, 4,4'-(phenylmethylen..., along with many other major and minor compounds possess to have antimicrobial, anti-inflammatory, antioxidant and anti-proliferative activities.

The methanolic leaf extract of *Trigonella foenum-graecum* showed the presence of 40 major and minor compounds with the presence of 2,5-Dihydro-5-methoxy-2-furanone, 2-Methylpyrrolidine, Aziridine, 1-(1,1-dimethylethyl)..., 2-Butenoic acid, 4-hydroxy-, met..., 9,12,15-Octadecatrienoic acid, e... and 3-Tetradecen-5-yne, (E)- with specific biological activity.

Anti-diabetic activity of the ethanol and methanol leaf extracts were performed to confirm the traditional use in diabetes mellitus. The present results suggested the strong antidiabetic potential against the diabetic enzymes mainly alpha-amylase (Fig. 3) and alpha-glucosidase (Fig. 4). The ethanol extract possessed alpha amylase inhibitory activity of 55.5% at a concentration of 100 µg/ml as shown in Figure 3 against the positive control acrobose with 69.5% and the methanol extract possessed potential inhibitory efficacy against the alpha amylase activity with 62.5% of inhibition in enzyme activity. The inhibitory activity of fenugreek leaves were much higher against alpha glucosidase enzyme than the alpha amylase activity. The positive control standard acrobose showed the inhibition of 83.30% while the negative controls ethanol and methanol mediated solvent extracts showed the inhibition of enzyme activity with 66.6% and 75%, respectively. The potential inhibitory activity of alcoholic extracts of *Trigonella foenum-graecum* may play the role of inhibiting the process of conversion of oligosaccharides into simple sugars

by the enzyme action and thereby it can reduce the chances of hyperglycemic condition in post-prandial period in diabetic patients.

Discussion

Phytochemical analysis revealed the presence of steroids, tannins, saponins, phenols, alkaloids, flavonoids, diterpenoids and terpenoids along with protein and carbohydrates in ethanol and methanol mediated leaf extract of *Trigonella foenum-graecum*. The present results are in agreement with the presence of high amount of flavonoids, alkaloids and saponins along with the phyto-compounds in the fenugreek leaves (Ahmad *et al.*, 2016). The major compounds such as falvonoids, alkaloids and saponins have antibacterial, antioxidant, anticancer and anti-diabetic activities (Ghalloo *et al.*, 2022). Bioactive compounds of the ethanol and methanol extracts of the *Trigonella foenum-graecum* leaves possess promising therapeutic applications.

The antidiabetic effect of *Trigonella foenum-graecum* leaf extracts caused the alpha amylase and alpha glucosidase enzyme inhibition with a concentration dependent activity (Ganeshpurkar *et al.*, 2013). The inhibition increases with the increasing concentrations of the tested extracts. The inhibition of α - amylase was ranging from 55.5% to 7.6% with ethanol extract and from 62.5% to 25% with methanol solvent leaf extract. While the α - glucosidase inhibition varies from 66.6% to 8.3% and about 75% of inhibition in the enzyme activity with ethanol and methanol solvent extracts, respectively. The control of blood sugar level by the enzyme inhibition is a novel approach by which the post prandial glucose level can be altered. α -amylase and α - glucosidase were responsible for the conversion of insoluble starch into simple monosaccharides such as glucose for the absorption through intestinal villi. Results of the present study confirmed the antidiabetic property of the leaf extracts of *Trigonella foenum-graecum*, which is potentially effective over the inhibition of both the enzymes studied in the present investigations. The results are in agreement with the studies of Ganeshpurkar

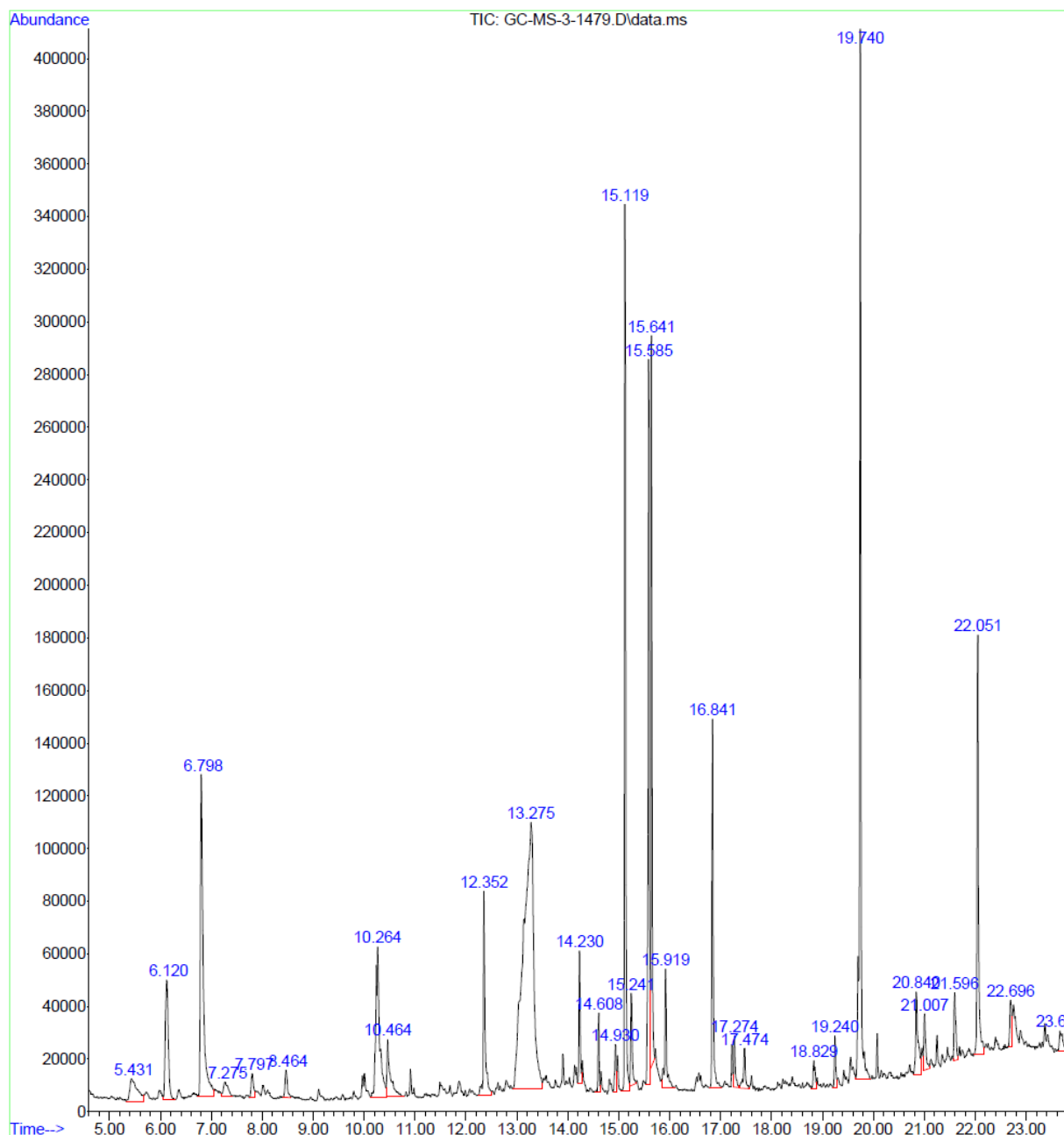


Fig. 1: GCMS Chromatogram of ethanol leaf extract of *Trigonella foenum-graecum*.

Table 2: Bioactive compounds found in ethanol leaf extract of *Trigonella foenum-graecum*

S. No.	R.T.	Peak Name	Molecular formula	Peak area %
1	5.431	Benzyl chloride	C ₆ H ₅ CH ₂ CL	1.35
2	6.120	Propane, 1,1,3-triethoxy-	C ₉ H ₂₀ O ₃	2.93
3	6.789	2-Methylpyrrolidine	C ₅ H ₁₁ N	7.37
4	7.275	(E)-1,3-Butadien-1-ol	C ₄ H ₆ O	0.51
5	7.797	4-Tetradecene, (Z)-	C ₁₄ H ₂₈	0.51
6	8.464	Cyclohexane, 1,1'-(1,3-butanedi...	C ₁₆ H ₃₀	0.51
7	10.264	2-Methylpyrrolidine	C ₅ H ₁₁ N	4.69
8	10.464	2-Methylpyrrolidine	C ₅ H ₁₁ N	1.50
9	12.352	5-Octadecene, (E)-	C ₁₈ H ₃₆	2.85
10	13.275	D-Fructose, 3-O-methyl-	C ₇ H ₁₄ O ₆	22.03

11	14.230	1-Heneicosyl format	C ₂₂ H ₄₄ O ₂	1.31
12	14.608	1-Hexacosene	C ₂₆ H ₅₂	0.74
13	14.930	4-Undecanone	C ₁₁ H ₂₂ O	0.66
14	15.119	Lidocaine	C ₁₄ H ₂₂ N ₂ O	8.45
15	15.241	2-Cyclohexen-1-one, 4,4-dimethyl-	C ₈ H ₁₂ O	1.18
16	15.585	Benzofurane-2-carboxylic acid, 3...	C ₉ H ₆ O ₃	8.11
17	15.641	Dibutyl phthalate	C ₁₆ H ₂₂ O ₄	5.93
18	15.919	1-Octadecene	C ₁₉ H ₃₈	1.76
19	16.841	Phytol	C ₂₀ H ₄₀ O	3.86
20	17.274	9,12,15-Octadecatrienoic acid, e...	C ₁₈ H ₃₀ O ₂	0.65
21	17.474	1-Docosene	C ₂₂ H ₄₄	0.71
22	18.829	Isophytol	C ₂₀ H ₄₀ O	0.44
23	19.240	Benzylephedrine	C ₁₇ H ₂₁ N	0.59
24	19.740	Morpholine, 4,4'-(phenylmethylen...	C ₁₅ H ₂₂ N ₂ O ₂	11.55
25	20.840	1-Docosene	C ₂₂ H ₄₄	1.62
26	21.007	Octadecanoic acid, 2,3-dihydroxy...	C ₂₁ H ₄₂ O ₄	0.91
27	21.596	N-Methyl-1-adamantaneacetamide	C ₁₃ H ₂₁ NO	0.97
28	22.051	Cyclotetracosane	C ₂₄ H ₄₈	5.06
29	22.696	Cyclotrisiloxane, hexamethyl-	C ₆ H ₁₈ O ₃ Si ₃	0.73
30	23.662	Cyclotrisiloxane, hexamethyl-	C ₆ H ₁₈ O ₃ Si ₃	0.53

Table 3: Bioactive compounds found in the Methanol Leaf extract of *Trigonella foenum-graecum*

S. No.	R.T.	Peak Name	Molecular formula	Peak area %
1	4.987	2-Hydroxyethyl butyl sulfide	C ₆ H ₁₄ O ₆	2.09
2	6.231	Propane, 1,1,3-triethoxy-	C ₉ H ₂₀ O ₃	0.57
3	6.753	2,5-Dihydro-5-methoxy-2-furanone	C ₅ H ₆ O ₃	5.92
4	6.953	2-Methylpyrrolidine	C ₅ H ₁₁ N	9.45
5	7.331	1-Methoxy-2,3-cis-dimethylazirid...	C ₅ H ₁₁ NO	1.18
6	8.453	3-Amino-4,5-dimethyl-2(5H)-furanone	C ₆ H ₉ NO	1.76
7	10.064	1-Ethyl-2-pyrrolidinone	C ₆ H ₁₁ NO	0.87
8	10.319	1-Methyl-2-pyrrolidone-4-carboxa...	C ₅ H ₉ NO	3.76
9	10.531	Aziridine, 1-(1,1-dimethylethyl)...	C ₉ H ₁₉ N ₂ O	0.94
10	10.742	2-Ethyl-4,4-dimethyl-2-oxazoline	C ₇ H ₁₃ NO	0.91
11	11.864	2(4H)-Benzofuranone, 5,6,7,7a-te...	C ₁₁ H ₁₆ O	0.51
12	12.352	2-Tetradecene, (E)-	C ₁₄ H ₂₈	1.00
13	13.308	N-Isobutyl-(2E,4Z)-octadienamide	C ₁₂ H ₂₁ NO	0.95
14	13.563	D-Fructose, 3-O-methyl-	C ₇ H ₁₄ O ₆	1.63

15	13.919	2-Butenoic acid, 4-hydroxy-, met...		4.48
16	14.141	Cyclohexanone, 3-(4-hydroxybutyl...	C ₁₁ H ₂₀ O ₂	0.55
17	14.297	4(1H)-Pyrimidinone, 2,6-dimethyl-	C ₆ H ₈ N ₂ O	1.08
18	14.608	Bicyclo[3.1.1]heptane, 2,6,6-tri...	C ₁₀ H ₁₈	0.86
19	14.841	Phthalic acid, decyl isobutyl ester	C ₂₂ H ₃₄ O ₄	0.79
20	15.130	2-Imidazolidinone	C ₃ H ₆ N ₂ O	3.09
21	15.252	2-Methoxy-5-methylbenzaldehyde	C ₉ H ₁₀ O ₂	1.06
22	15.352	Hexadecanoic acid, methyl ester	C ₁₇ H ₃₄ O ₂	0.55
23	15.497	9-Hexadecenoic acid	C ₁₆ H ₃₀ O ₂	0.81
24	15.641			15.00
25	15.919	Acetic acid, chloro-, octadecyl ...	C ₂₀ H ₃₉ ClO ₂	1.04
26	16.519	2-Methylcyclopropane-1-carboxyli...	C ₅ H ₉ NO	1.34
27	16.841	Phytol	C ₂₀ H ₄₀ O	3.30
28	17.096	9,12,15-Octadecatrienoic acid, e...	C ₁₈ H ₃₀ O ₂	15.14
29	17.241	Octadecanoic acid	C ₁₈ H ₃₆ O ₂	1.46
30	19.685	15-Hydroxypentadecanoic acid	C ₁₅ H ₃₀ O ₃	1.76
31	20.240	6H-Benzofuro[3,2-c][1]benzopyran...	C ₁₅ H ₁₀ O ₂	1.10
32	20.729	.beta.-Sitosterol	C ₂₉ H ₅₀ O	1.42
33	20.829	E,Z-1,3,12-Nonadecatriene	C ₁₉ H ₃₄	0.82
34	20.996	1-Nonadecene	C ₁₉ H ₃₈	1.13
35	21.340	Acridin-9-yl-(4-methoxy-phenyl)-...	C ₂₀ H ₁₆ N ₂ O	0.69
36	21.585	1-Naphthalenamine, N,N-dimethyl-	C ₁₂ H ₁₃ N	1.96
37	22.040	Cyclotetracosane	C ₂₄ H ₄₈	1.51
38	22.696	E,Z-1,3,12-Nonadecatriene	C ₁₉ H ₃₄	1.70
39	22.762	3-Tetradecen-5-yne, (E)-	C ₁₄ H ₂₄	5.49
40	23.662	Vitamin E	C ₂₉ H ₅₀ O ₂	0.62

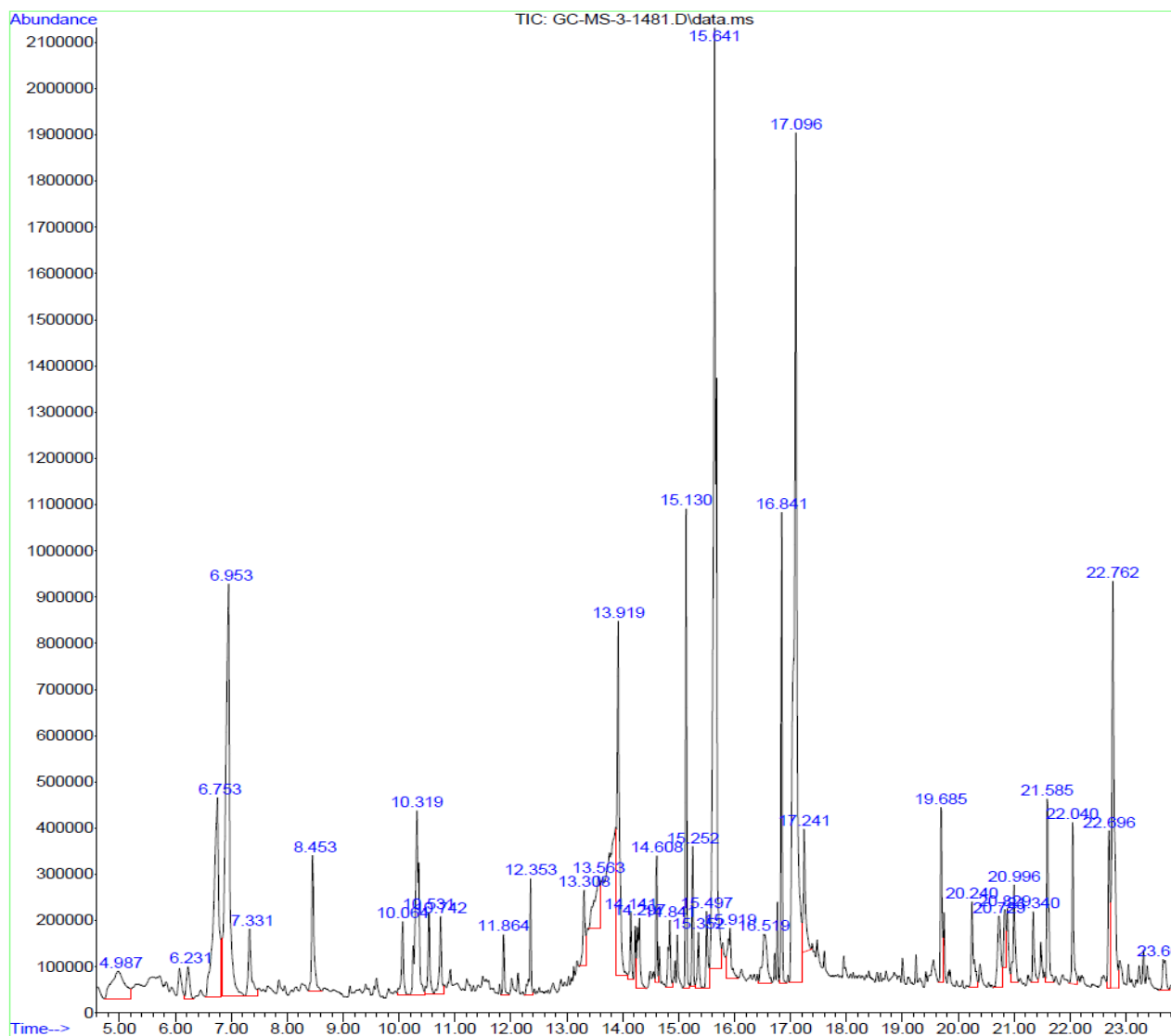


Fig. 2: GCMS Chromatogram of Methanol leaf extract of *Trigonella foenum-graecum*.

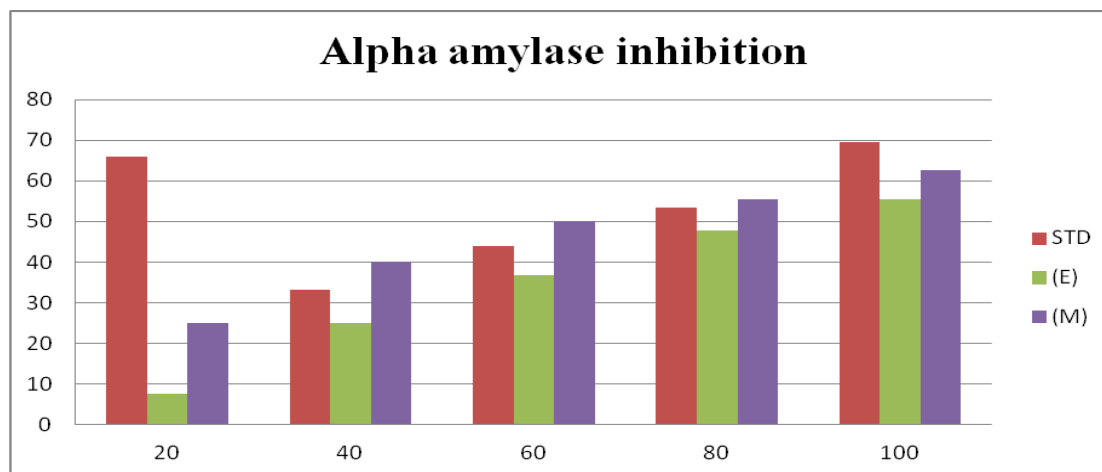


Fig. 3: α -Amylase inhibitory activity (percentage) of ethanol and methanol mediated leaf extracts of *Trigonella foenum-graecum*.

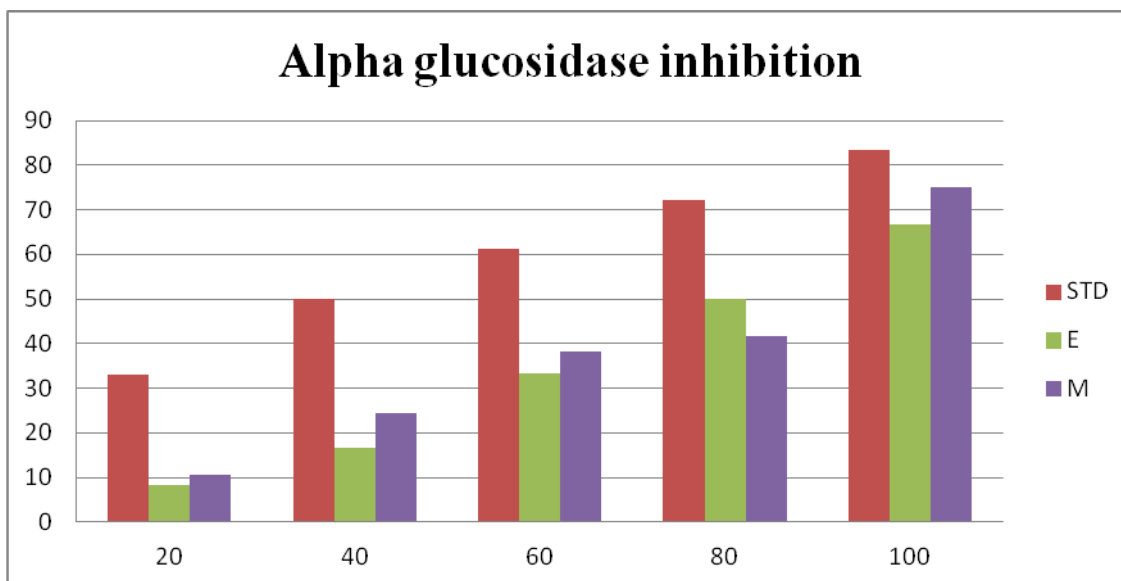


Fig. 4: α -Glucosidase inhibitory activity (percentage) of ethanol and methanol mediated leaf extracts of *Trigonella foenum-graecum*.

et al. (2013). The antidiabetic activity of the plant leaves can be attributed to the antioxidant activity of flavonoids and triterpenoids (Singh *et al.*, 2014). Fenugreek plant shows a potential antidiabetic activity against the Alloxan induced diabetes mellitus (Jung *et al.*, 2006). Further the medicinal plants were very effective in controlling the plasma glucose level with the presence of variety of chemical constituents which acts on different mechanism. It is evident that ethanol and methanol extracts showed the strong presence of flavonoids and terpenoids. α -glucosidase and α -amylase were responsible for reduced post prandial hyperlipidemia (Carrascosa *et al.*, 2001). The bioactive compound detected in the present study revealed the presence of major compounds in the extracts of *Trigonella foenum-graecum* such as propane 1,1,3 triethoxy which are responsible for the anti-hyperglycemic activity.

Conclusion

It is concluded that the ethanol and methanol leaf extracts of *Trigonella foenum-graecum* were very effective and significantly reduced the α -amylase and α -glucosidase enzymes. However, the methanol extract showed better inhibitory activity against both the enzymes studied. Further studies may clarify the identification of individual

compound which is responsible for the inhibition of the enzyme activity.

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