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Characterization of ethyl acetate and methanol extracts of *Commiphora myrrha* and evaluating *in vitro* anti-diabetic and anti-obesity activities

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ABSTRACT

Diabetes mellitus is a clinical disease categorized by hyperglycemia. Reduction of gastrointestinal glucose absorption through the inhibition of carbohydrate digesting enzymes is one of *in vitro* anti-diabetic therapeutic approach. This investigation aimed to estimate the *in vitro* anti-diabetic and anti-obesity activities for ethyl acetate and methanol extracts of *Commiphora myrrha* oleo-gum as well as the identification of the bioactive compounds. *Commiphora myrrha* was extracted with methanol and ethyl acetate. The two extracts were used to evaluate their α-glucosidase, α-amylase, and pancreatic lipase inhibitory activities. Identification of the bioactive compounds of ethyl acetate was analyzed by GC-MS (gas chromatography-mass spectrometry). The results showed that the ethyl acetate extract had a stronger inhibition activity on α-amylase (IC_{50} = 54.60 µg/ml) and α-glucosidase (IC_{50} = 58.7 µg/ml) than methanol extract on α-amylase (IC_{50} = 124.01 µg/ml) and α-glucosidase (IC_{50} = 191.2 µg/ml). Also, ethyl acetate extract had a promising inhibitory effect on pancreatic lipase (IC_{50} = 107.8 µg/ml) than methanol extract (IC_{50} = 498.1 µg/ml). GC-MS analysis of ethyl acetate extract identified 31 compounds. Among them nobiletin (50.26%), metaproterenol (orciprenaline) (14.99%), morantel (8.86%), and tricetin (3.38%) were the main compounds. These findings proved that *C. myrrha* has anti-diabetic and anti-obesity inhibition activity may be due to the bioactive compounds with interesting medicinal properties.

INTRODUCTION

Diabetes mellitus is a chronic health disorder that has been increased in the previous years and appreciated to be 439 million people by 2030. Diabetic patients demonstrated the risk in the incidence of several chronic health complications include obesity (Ahmad and Crandall, 2010). In this case, diabetes and obesity is a global health syndrome referred as diabesity (Tschop and DiMarchi, 2012).

α-glucosidase, α-amylase, and pancreatic lipase are enzymes secreted by lumen of small intestine, pancreas, and salivary glands (Tadera *et al*., 2006). They play an important role in digestion of carbohydrates (degradation of starch and oligosaccharides to monosaccharaides) and glucose absorption, so in turn, inhibition of these enzymes causes reduction of post-prandial blood glucose by decreasing the rate of glucose absorption and release in the small intestine (Hanhineva *et al*., 2010; Keskes *et al*., 2014; Narkhede *et al*., 2011). Also, a diet rich in fats and sedentary lifeway contributes the occurrence of type 2 diabetes, obesity, hyperlipidemia, and cardiovascular diseases (Cani *et al*., 2008; Etoundi *et al*., 2010; Liu *et al*., 2013).

However, one of anti-diabetic drugs strategy is to search for plants as α-glucosidase and α-amylase inhibitors as well as anti-obesity drugs (plants as pancreatic lipase inhibitors) (Hasani-Ranjbar *et al*., 2008; 2009).

Actually, many artificial drugs (acarbose and orlistat) are used broadly as inhibitors for mentioned enzymes but unfortunately they cause many side effects. Hence, many studies have been condensed to decrease their harmful effects by replacing those synthetic drugs with natural and safer inhibitors, which have fewer

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side effects and are desired more over than the synthetic drugs (Keskes *et al*., 2014; Mahalingam, 2017). So, large number of plants used as natural inhibitors owing to their active compounds as phenols and flavonoids which have been reported as effective inhibitors for these enzymes as garlic (*Allium sativum*), artichoke (*Cynara scolymus*), *Rosmarinus officinalis*, *Apium graveolens*, and *Lavandula angustifolia* (Allouche *et al*., 2004; Kasabri *et al*., 2017; Pereira *et al*., 2011).

Commiphora genus belongs to family Burseraceae include other than 200 species. It grows in tropical dry places as Africa, Arabia, and India (Gadir and Ahmed, 2014; Su *et al*., 2009). It produces many commercial resins; myrrh oleo-gum resin is one of them (Baser *et al*., 2003). These resins are yellow to red in color and always are covered with a dusty powder has a lighter color. However, true myrrh is produced by wounding *Commiphora myrrha* (Hosseinkhani *et al*., 2017). Myrrh has many effective medicinal uses and has been used to cure tumors, fever, disorders of gall bladder, dysmenorrhea, and skin infections (El Ashry *et al*., 2003; Massoud *et al*., 2001). Many previous investigations have been demonstrated the presence of many phytochemicals possess the mentioned biological activities as flavonoids, terpenoids, carbohydrates, lignans, steroids, and others (Shen *et al*., 2007).

Our study was designed to determine the α-glucosidase and α-amylase and pancreatic lipase inhibitory activity of *C. myrrha* methanol and ethyl acetate extracts as well as identification of the bioactive phytochemicals in the most active extract by GC-MS analysis.

MATERIALS AND METHODS

Chemicals and reagents

α-Amylase, α-glucosidase (*Saccharomyces cerevisiae*), starch, and 3,5,di-Nitro salicylic acid (DNS) were purchased from Sigma-Aldrich, Bangalore. Sodium carbonate (Na_2CO_3), P-Nitro-phenyl- α-glucopyranoside (p-NPG), di-sodium hydrogen phosphate, and sodium dihydrogen phosphate were purchased from Hi-Media.

Plant materials

Commiphora myrrha oleo gum-resin was purchased from a local herbalist (Harraz Medicinal Plant Co., Ciaro, Egypt) and recognized by Dr. Rim Samir Hamdy, Prof. of Plant Taxonomy, Faculty of Science, Cairo University. Then, it was grounded into fine powder and kept in dark bottles until used at Medicinal Chemistry Dept., Theodor Bilharz Research Institute.

Extraction of plant

Nearly, 400 g of dried powder of *C. myrrha* was divided into two equal quantities (200 g) and extracted with two different solvent; 85% methyl alcohol and ethyl acetate for 7 days, then filtered and concentrated with Rotatory Evaporator Buchi to obtain a crude methanol extract and the ethyl acetate extract.

In-vitro anti-diabetic assays

α-Amylase inhibitory assay

α-Amylase inhibition method was carried out with minor modification (Gayathri and Gayathri, 2014). The enzyme solution was equipped by melting α-amylase in 20-mM phosphate buffer (6.9 pH) at concentration 0.5 mg/ml. Nearly, 1 ml of each extract at various concentrations ranged from 7.81 to 1,000 µg/ml was added to 1 ml of enzyme solution mixed together and kept warm at 25°C for 10 minutes. After that, 1-ml starch (0.5%) was added to the solution and kept warm again at 25°C for 10 minutes. The reaction stopped when 2-ml di-Nitro salicylic acid was added (DNS color reagent), then heating the reaction mixture for 5 minutes in a water bath. Then cooled and the absorbance at 565 nm was measured using spectrophotometer. Acarbose was used with the same concentrations as a control. The experiment was carried out in triplets.

The inhibition % was calculated by the equation:

$$[(Ac - As)/Ac] \times 100$$

where, *Ac* is the absorbance of control and *As* is the absorbance of tested extract.

α-Glucosidase inhibitory assay

α-Glucosidase inhibition method was carried out with minor modification (Shai *et al*., 2011). In this method, the enzyme was equipped by melting α-Glucosidase in 50 µl of phosphate buffer (100 mM, 6.9 pH). Nearly, 20 µl of each extract at various concentrations ranged from 7.8 to 1,000 µg/ml was added to 10 µl of enzyme solution and incubated for 15 minutes at 37°C. Then, 20 µl of 5-mM P-NPG was added as a substrate and incubated again at 37°C for 20 minutes. The reaction was stopped by adding 50 µl of Na_2CO_3 (0.1 M). The absorbance of the released p-nitrophenol was measured at 405 nm using multi-plate Reader. Acarbose was used with the same concentrations as a control. The experiment was carried out in triplets.

The inhibition % was calculated by the equation:

$$[(Ac - As)/Ac] \times 100$$

where, *Ac* is the absorbance of control and *As* is the absorbance of tested extract.

In vitro anti-obesity using pancreatic lipase inhibitory assay

The lipase inhibition activity of plant extract was measured by the method proposed by Kim *et al*. (2010). In this assay, the porcine pancreatic lipase activity was measured using p-nitrophenyl butyrate (NPB) as a substrate. Lipase solution (100 µg/ml) was prepared in a 0.1-mM potassium phosphate buffer (pH 6.0). In this assay, extracts with different concentrations ranged from 7.81 to 1,000 µg/ml were pre-incubated with 100 µg/ml of lipase for 10 minutes at 37°C. The reaction was then started by adding 0.1-ml NPB substrate. The amount of p-nitrophenol released in the reaction was measured using Multi-plate Reader after incubation at 37°C for 15 minutes. Orlistat was used with the same concentrations as a control. Each experiment was performed in triplets. The data were expressed as percentage inhibition, which was calculated using the formula, Inhibitory activity (%) = $(1 - As/Ac) \times 100$ where, *As* is the absorbance in the presence of the test substance and *Ac* is the absorbance of control.

Inhibitory concentration 50% (IC50) value calculation

The concentration of the extract or drug which inhibits 50% of enzyme activity is termed as the IC_{50}. Acarbose and orlistat were used as controls. A standard dose response curve was plotted

at all the different concentrations. From the plotted curves, the IC_{50} value for each of the extract was calculated.

Data analysis

The data were combined and identified as mean ± standard deviation (SD). IC_{50} values were calculated by SPSS software.

GC-MS analysis

The crude ethyl acetate extract of *C. myrrha* was injected to GC-MS technique. It was carried out using a GC (Agilent Technologies 7890A) interfaced with a mass-selective detector (MSD, Agilent 7000) equipped with a polar Agilent HP-5ms (5%-phenyl methyl poly siloxane) capillary column (30 m × 0.25 mm i.d. and 0.25 Elm film thickness). The carrier gas was helium with the linear velocity of 1 ml/minute. The injector and detector temperatures were 200°C and 250°C, respectively. Injection mode, split; split ratio 1:10, volume injected 1 µl of the sample. The MS operating parameters were as follows: ionization potential 70 eV, interface temperature 250°C, and acquisition mass range 50–600. The identification of components was based on a comparison of their mass spectra and retention time (RT) with those of the authentic compounds and by computer matching with NIST and WILEY libraries as well as by comparison of the fragmentation pattern of the mass spectral data with those reported in the literature.

RESULTS AND DISCUSSION

In vitro anti-diabetic assays

The inhibitory activity of methanol and ethyl acetate extracts of *C. myrrha* on α-amylase and α-glucosidase enzymes was shown in Tables 1 and 2). The results demonstrated that the plant showed α-amylase inhibition activity in a concentration dependent-manner. The ethyl acetate extract showed higher inhibitory activity than the methanol extract as its inhibition % ranged from 22.75% ± 1.20% to 76.35% ± 1.20% from the lowest to the highest concentration (7.81–1,000 µg/ml), while methanol extract ranged from 15.32% ± 0.58% to 71.32% ± 1.2% from lowest to highest concentration. The maximum inhibition% is for Acarbose was found to be 37.81% ± 1.2% to 86.32% ± 0.63% from lowest to highest concentration. Regarding to α-glucosidase, also, the ethyl acetate extract has higher inhibition activity than methanol extract as ranged from 21.84% ± 2.10% to 69.38% ± 1.50% from lowest to highest concentration, while methanol extract ranged from 14.63% ± 0.72% to 58.34% ± 1.5% from lowest to highest concentration. Also, Acarbose had the maximum inhibition % ranged from 32.15% ± 0.58% to 90.10% in the same manner of concentrations. This activity may be returned to the

Table 1. Inhibition assay of α-amylase activity of *C. myrrha* extracts at different concentrations.

Concentration (µg/ml)	Inhibition %		
	Standard drug Acarbose	Ethyl acetate	Methanol
7.81	37.81 ± 1.2	22.75 ± 1.2	15.32 ± 1.2
15.63	40.75 ± 1.5	31.25 ± 2.1	20.17 ± 2.1
31.25	48.84 ± 1.2	44.37 ± 0.58	31.58 ± 1.5
62.5	59.31 ± 1.5	51.91 ± 1.3	44.38 ± 1.3
125	60.17 ± 0.63	59.41 ± 0.58	50.09 ± 0.58
250	69.37 ± 1.2	66.73 ± 0.63	57.14 ± 1.5
500	80.14 ± 0.58	70.58 ± 2.1	66.32 ± 0.72
1,000	86.32 ± 0.63	76.35 ± 1.2	71.32 ± 0.58

Data was represented as mean ± SD.

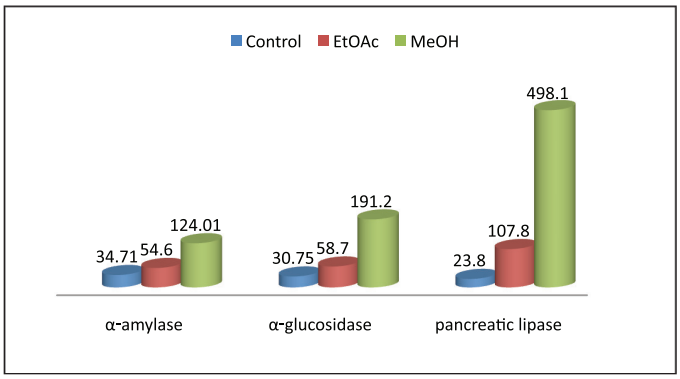

Figure 1. IC50 of *Commiphora myrrha* extracts in comparison with controls as anti-diabetic and anti-obesity inhibitors.

Table 2. Inhibition assay of α-glucosidase activity of *C. myrrha* extracts at different concentrations.

Concentration (µg/ml)	Inhibition %		
	Standard drug Acarbose	Ethyl acetate	Methanol
7.81	32.15 ± 0.58	21.84 ± 2.1	14.63 ± 0.72
15.63	43.28 ± 1.2	29.87 ± 1.5	21.97 ± 1.2
31.25	50.31 ± 1.5	39.92 ± 0.58	30.17 ± 1.5
62.5	60.14 ± 0.72	51.38 ± 0.72	38.95 ± 1.3
125	63.42 ± 2.1	55.89 ± 0.58	48.38 ± 0.63
250	71.34 ± 1.5	59.37 ± 1.3	51.44 ± 0.58
500	86.34 ± 1.2	62.71 ± 2.1	55.67 ± 2.1
1,000	90.10 ± 0.58	69.38 ± 1.5	58.34 ± 1.5

Data was represented as mean ± SD.

Table 3. Inhibition assay of pancreatic lipase activity of *C. myrrha* extracts at different concentrations.

Concentration (µg/ml)	Inhibition %		
	Standard drug Orlistat	Ethyl acetate	Methanol
7.81	29.31 ± 1.4	9.35 ± 1.2	----
15.63	45.25 ± 3.1	18.98 ± 0.63	-----
31.25	54.36 ± 2.6	29.35 ± 1.5	-----
62.5	60.35 ± 2.1	43.67 ± 0.72	6.37 ± 1.3
125	65.34 ± 1.5	52.41 ± 2.1	16.35 ± 0.73
250	80.12 ± 0.58	57.32 ± 1.5	32.16 ± 1.2
500	86.35 ± 2.1	61.32 ± 0.63	50.14 ± 0.92
1000	93.25 ± 1.5	67.35 ± 2.1	56.32 ± 1.5

Data was represented as mean ± SD.

Table 4. GC-mass ethyl acetate of *C. myrrha.*

Peak no.	Rt	Area %	MF	MW	Components	Compound Nature	Common biological activity	References
1	3.94	0.57	$C_{10}H_8O_2$	160	6-Methylchromone	Hydrocarbon	Antimicrobial activity	(Flores *et al*., 2014)
2	7.69	0.55	$C_8H_{13}NO$	139	Tropinon	Alkaloid	Treating II type *diabetes mellitus*	(Segre *et al*., 2015)
3	9.21	14.39	$C_{11}H_{17}NO_3$	211	Metaproterenol (orciprenaline)	Adenosine Sulfate salt	Orciprenaline drug Lung Problems	(Ullah *et al*., 2017)
4	9.51	50.26	$C_{21}H_{22}O_8$	402	Nobiletin	Flavonoid	Anti-inflammatory, Anti-cancer And Cholesterol lowering	(Huang *et al*., 2016)
5	10.37	0.64	$C_{15}H_{32}$	212	2,6,11-Trimethyldodecane	Sesquiterpene	Anti-oxidant, antinoceptive and anti-inflammatory activities	(Haloui *et al*., 2010)
6	10.42	0.58	$C_{14}H_{22}O$	206	3,5-di-tert-butylphenol	Alkylated phenol	Antioxidant activity against LDL-oxidation	(Kusch *et al*., 2011)
7	10.47	0.77	C19H18O6	342	3,7,8,4'-Tetramethoxyflavone	Flavonoid	Powerful antiallergic	(Sato and Tamura, 2015)
8	11.09	1.2	$C_9H_{12}N_4O_3$	224	Temorin (Theacrine)	Alkaloid	Anti-inflammatory and analgesic effects	(Wang *et al*., 2011)
9	11.16	0.68	$C_{13}H_{14}O_9$	314	Salicylic acid - β- D- O-glucuronide	Phenolic glucuronide	Anti-inflammatory	(Kuehl *et al*., 2004)
10	11.38	0.52	$C_{22}H_{30}O_2S$	358.5	Santonox	Epoxyanhydride resin	Antioxidant standard	(Ho *et al*., 2013)
11	11.7	0.63	$C_{23}H_{34}O_2$	342.5	Cannabidiol dimethyl ether	Cannabinoid derivative	Treatment of atherosclerosis.	(Takeda *et al*., 2011)
12	11.93	0.58	$C_{21}H_{22}O_{11}$	450	Astilbin	Flavonoid	Antibacterial activity	(Moulari *et al*., 2006)
13	12.57	1.54	$C_{10}H_{20}O$	156	β- Citronellol	Monoterpenoid	Neuroprotective activity	(de Sousa *et al*., 2006)
14	12.64	0.53	$C_{15}H_{24}O$	220	Spathulenol	Sesquiterpene	Antioxidant, anti-inflammatory, antiproliferative and antimycobacterial activities	(do Nascimento *et al*., 2018)
15	12.73	0.56	$C_{15}H_{24}$	204	Selinene	Sesquiterpene	Antimicrobial activity	(Wetwitayaklung *et al*., 2009)
16	12.78	0.63	$C_{20}H_{32}$	272	Cembrene	Diterpene	Anti-tumor and anti-inflammatory	(Hegazy *et al*., 2017)
17	12.91	0.71	$C_{15}H_{24}O$	220	Caryophyllene oxide	Sesquiterpene	Anticancer and analgesic activities	(Fidyt *et al*., 2016)
18	13.07	0.59	$C_{15}H_{26}O_2$	238	Geranyl isovalerate	Sesquiterpene	Antimicrobial activity	(Al-Qudah, 2013)
19	13.3	0.53	$C_{15}H_{24}$	204	Ledene oxide	Sesquiterpene	Anti-tumor, Analgesic Antibacterial, Anti-inflammatory	(Alagammal *et al*., 2012)
20	13.37	0.59	$C_{15}H_{24}O_2$	236	Corymbolone	Sesquiterpene	Antibacterial	(Zhang *et al*., 2017)
21	13.54	3.38	$C_{15}H_{10}O_7$	302	Tricetin	Flavonoid	Anticancer	(Chien *et al*., 2017)
22	13.86	0.74	$C_{12}H_{10}O_2S$	218	Thiobisphenol	Bisphenol	Antioxidant	(Yamamura *et al*., 1995)
23	13.92	1.36	$C_{16}H_{12}O_6$	300	Geraldol	Flavonoid	Anticancer and antiangiogenic	(Touil *et al*., 2011)
24	14.04	1.51	$C_{18}H_{22}O_2$	270	Estrone	Steroid	Natural hormone	(Schäfer *et al*., 2003)
25	14.11	0.6	C20H30O	286	Retinol	Vitamin A	Anti-microbial and treating skin-related diseases	(Feneran *et al*., 2011)
26	14.45	1.09	$C_{21}H_{20}O_{10}$	432	Vitexin	Flavone glycoside	Anti-inflammatory effect	(Nikfarjam *et al*., 2017)
27	15.17	2.35	$C_{21}H_{44}O$	312.5	Heneicosanol	Fatty alcohol	Anti-microbiological activity	(Balachandar *et al*., 2018)
28	16.74	0.73	$C_{15}H_{32}O$	228	Hexahydrofarnesol	Sesquiterpene alcohol	Anti-microbiological activity	(Liolios *et al*., 2007)
29	18.1	8.86	$C_{12}H_{16}N_2S$	220	Morantel	Heterocyclic	Anthelmintic drug removal of parasitic worms in livestock	(Enejoh and Suleiman, 2017)
30	21.09	0.57	C12H14O5	238	Methyl Sinapate	Phenolic acid	Antioxidant, antimicrobial, anti-inflammatory, and anticancer	(Nićiforović and Abramovič 2014)
31	21.94	1.77	C19H18O5	326	3-(3,4- dimethoxyphenyl)-7-methoxy-4-methylcoumarin	Coumarin	Antiinflammatory	(Ouf *et al*., 2015)
Total		100.1						

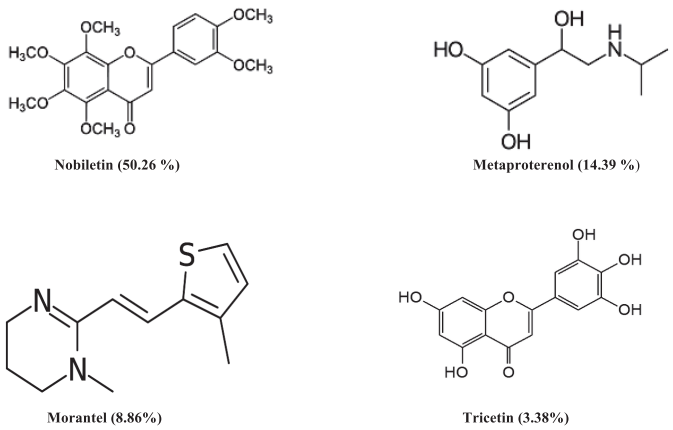

Figure 2. The structure of main constituents of ethyl acetate *C. myrrha* extract.

presence of phytochemicals, which are strong enzyme inhibitors. The IC_{50} values for both extracts are comparable with that of Acarbose (Fig. 1).

The inhibitory activity of *C. myrrha* is in a full agreement with other studies reported the inhibition activity of medicinal plants as black and green teas on enzymes (Zhang and Kashket, 1998), *Allium* species (Nickavar and Yousefian, 2010) and also, white and red ginger on both enzymes (Oboh *et al*., 2010). As well as, previous studies recommended using of eggplant phenolics as a diet to manage type-II diabetes (Oboh *et al*., 2010). So, our finding revealed that *C. myrrha* can be used as a natural inhibitor to reduce post-prandial hyperglycemia. This anti-diabetic inhibitory activity of ethyl acetate extract may be connected to the major compounds that identified in the extract as reported by previous studies on medicinal plants (Al-Hallaq *et al*., 2013; Habtemariam, 2012).

In vitro anti-obesity assay

The inhibitory activity of methanol and ethyl acetate extracts of *C. myrrha* on pancreatic lipase enzyme was shown in Table 3. The results revealed that the ethyl acetate extract showed higher inhibitory activity than the methanol extract as its inhibition % ranged from 9.35% ± 1.2% to 67.35% ± 2.10% from the lowest to the highest concentration (7.81–1,000 µg/ml), while methanol extract neglected at the small concentrations while ranged from 6.37% ± 1.3% to 56.32% ± 1.5% from lowest to highest concentration. The maximum inhibition% is for orlistat was found to be 29.31% ± 1.4% to 93.25% ± 1.5% from lowest to highest concentration. The IC_{50} values for both extracts are comparable with that of orlistat (Fig. 1). This activity may be due to the identified compounds from ethyl acetate extract as it has been reported that polyphenol compounds in the plants responsible for the anti-obesity and anti-diabetic inhibition activity (Lei *et al*., 2007; Yajima *et al*., 2005). However, our results agreed with other previous reports showed the inhibition activity of many medicinal plants on pancreatic lipase (Birari and Bhutani, 2007; Sharma *et al*., 2005).

GC-MS analysis

Our results proved that the ethyl acetate extract has the highest inhibitory activity and can be used as anti-diabetic and anti-obesity drugs. Therefore, we analyzed it by GC-MS to identify the phytochemicals may be responsible for its activity. Results of GC-MS show the different flavonoid compounds in the ethyl acetate of *C. myrrha*, such as alkaloid, coumarin, vitamin A_1, analogue pyrantel, phenolic acid, steroid, monoterpene, sesquiterpene, and diterpene which have therapeutic aspects. GC-MS analysis of *C. myrrha* showed 31 compounds as shown in Table 4 and Figure 2. The characterization of the components of the extract was fulfilled by their RT, molecular weight (MW), molecular formula (MF), concentration (%) also, common biological activity and the nature and of each compound. These compounds are listed according to their RTs.

The results demonstrated that the extract is rich with flavonoid compounds (57.44%) which have been known as an effective inhibitor for diabetes and obesity enzymes (Jung *et al*., 2014; Testa *et al*., 2016). The main compound of flavonoids is Nobiletin (50.26%); a polymethoxylated flavone; which has anti-inflammatory, anti-cancer, and cholesterol lowering. Also, other previous studies have been shown that it improves adiposity, dyslipidemia, hyperglycemia, and insulin resistance (Huang *et al*., 2016; Lee *et al*., 2013).

There is another dietary flavonoid is Tricetin (3.38%) which has anti-microbial effect, anti-oxidant activity, cytostatic properties, and anti-metastatic activity in various solid tumors including breast, liver, lung, bone, and brain tumors (Chien *et al*., 2017). Furthermore, the previous studies have been displayed the strongest α-glucosidase inhibition effect of this compound with comparison to the anti-diabetic acarbose drug (Wu and Tian, 2018).

Metaproterenol (14.39%) has been known as orciprenaline in other countries. It has been used as drug to treat lung problems (such as: asthma, bronchitis, and emphysema). Also, it is a bronchodilator works by orally inhaling devices to open the breathing passage (Ullah *et al*., 2017). This compound has not been separated previously from plant extract but it has already manufactured as drug named (Alupent). Furthermore, Morantel (8.86%) known as Anthelmintic drug used against larval stages and adult gut worms that dwell in the lumen of intestine and/or its mucosal surface (Dyary, 2016; Enejoh and Suleiman, 2017).

There are different sesquiterpene compounds (4.88%) which have anti-oxidant, anti-inflammation, anti-proliferative, and anti-mycobacterial activities (do Nascimento *et al*., 2018). However, these compounds may be meaningful to anti-diabetic and anti-obesity inhibitory activity of *C. myrrha* ethyl acetate extract.

CONCLUSION

This study demonstrated that the ethyl acetate extract of *C. myrrha* has anti-diabetic and anti-obesity inhibition activity and was rich in compounds that play an important role in therapy of hyperglycemia and obesity. Therefore, encourage to use this plant due to its effect is recommended to diabesity patients.

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