Volatile Constituents of *Beta Vulgaris* pulp-wastes as a Source of Bioactive Natural Products

Mohamed E. Mostafa[1], Hani Mohamed[2], Adel M. Kamal El-Dean[2], Remon M. Zaki[2], Mamdouh Abdel-Mogib[3]

[1]Plant Protection Research Institute, Agriculture Research Center, 12618, Egypt.
[2]Chemistry Department, Faculty of Science, Assiut University, 71516, Assiut, Egypt.
[3]Chemistry Dept., Faculty of Science, Mansoura University, Mansoura, 35516,

Abstract

The recycling of agro-industrial bio-wastes of most vegetable residues into value-added products has been highly encouraged. High-value naturally occurring compounds can be found in sugar beet pulps. Comprehensive GC/MS analysis of the volatile compounds of petroleum ether (60-80^{o}C) and methylene chloride fractions of sugar beet pulps has led to the identification of thirty eight volatile secondary metabolites of biological interests belonging to different classes such as acetogenins (Fat derivatives), sesquiterpenes, sterols and shikimate derivatives (phenolic constituents). Twenty-two compounds were identified from petroleum ether (60-80^{o}C) extract, the most predominant constituents were n-hexadecanoic acid (42.79 %), (Z,Z)-9,12-octadecadienoic acid (21.94%), hexadecanoic acid, methyl ester (6.67%), **(**E)-8-octadecenoic acid methyl ester (5.40%), (*Z, Z*)- 9,12-octadecadienoic acid methyl ester (5.02%) and (3β, 5α)-stigmasta-7,16-dien-3-ol (1.53%). Methylene chloride fraction afforded twenty three compounds and the more predominant constituents were 2-hydroxy-1-(hydroxymethyl) hexadecanoic acid ethyl ester (11.20 %), (Z) 9- octadecenal (7.08%), hexadecanoic acid, methyl ester (5.17%), 4-((1E)-3-hydroxy-1-propenyl)-2-methoxyphenol (4.37%), n-hexadecanoic acid (3.23 %), (Z,Z)-9,12-octadecadienoic acid methyl ester (3.04 %), **(**Z)-9-octadecenoic acid methyl ester (2.95%) and (3β, 24S) stigmast-5-en-3-ol (2.00 %).

Keywords: Volatile phytochemical constituents, Beta vulgaris, Sugar beet pulps, GC/MS techniques.

Introduction

Agricultural processing inevitably goes along with the production of large amounts of agro-residues, which may represent a major waste disposal problem. The new technologies applying environmentally clean processes have been playing a central role within this context.

Sugar beet is one of the main sugar crops in the world which has outsized importance to fulfill the requirement of market for sugar supply scarcity [1, 2].

The sugar-beet plant is mostly biennial *Beta vulgaris* belong to Chenopodiaceae goosefoot family, beet pulp is considered as a byproduct from the processing of sugar beet in sugar beet industries which is mainly used as fodder for livestock. Beet pulp is the fibrous material left after the sugar is extracted from sugar beets. It is supplied either as dried flakes or as compressed pellets [3].

The phytochemical screening revealed that sugar beet contains many different secondary metabolites belonging to different natural products classes such as, phenolic acids derivatives, flavonoids [4,5], triterpenes saponins [6,7,8], acetogenins [4], terpenes and sterols [9], also betacyanins and phenolic compounds have been reported in sugar beet [8,10].

Herein, our main goal is to increase the added value of the beet pulp through the extraction of volatile phyto-constituents for possible applications as flavor or aromatic ingredients in food, cosmetic and pharmaceuticals products and identification their main naturally occurring products using GC/MS technique.

Experimental

General

GC/MS analysis of the volatile fractions were performed on a Varian GC interfaced to Finnegan SSQ 7000 Mass selective Detector (SMD) with ICIS V2.0 data system for MS identification of the GC components. The column used was DB-5 (J&W Scientific, Folosm, CA) cross-linked fused silica capillary column (30 m long, 0.25 mm internal diameter) coated with poly dimethyl-siloxane (0.5µm film thickness). The oven temperature was programmed from 50°C for 3 min. at isothermal, then heating by 7°C /min to 250°C and isothermally for 10 min., at 250°C. Injector temperature was 200°C and the volume injected was 0.5 μl. Transition-line and ion source temperature were 250°C and 150°C, respectively. The mass spectrometer had a delay of 3 min. to avoid the solvent plead and then scanned from m/z 50 - 300. Ionization energy was set at 70 eV. (Agriculture Research Center (NRC), Dokki, Cairo).

Solvents and chemicals

Petroleum ether (60-80°C), methylene chloride, methanol and anhydrous sodium sulphate were purchased from ADWIC Company.

Sugar beet pulps material

Sugar beet pulp of Beta vulgaris subspecies vulgaris varieties altissima (sugar beet) were provided by Bilqass sugar factory of Daqahlya Company for Sugar & Refining in Daqahlya, Egypt in April 2017.

Extraction process

The air-dried and powdered sugar beet pulps (250 g) was soaked in methanol (4 x 0.5 L) then filtrated and evaporated using rotary evaporator to its 1/3 volume. Exhaustive liquid–liquid extraction using petroleum ether (60-80°C) and methylene chloride was performed to yield petroleum ether (3.31 g), methylene chloride (0.29 g) fractions. The petroleum ether fraction was defatted using cold methanol, and then both fractions were subjected to GC/MS analyses.

Results and Discussion

Because less polar compounds tend to be volatile, petroleum ether and methylene chloride fractions were prepared for the GC/MS analysis to separate, identify and quantify their volatile phytochemicals profile. GC/MS analyses of pet. ether and methylene chloride (Table 1 and 2) revealed the presence of various secondary metabolites belonging to different classes, acetogenins (fat derivatives), sesquiterpene, sterols and shikimates derivatives (phenolic constituents).

Each constituent peak in the GC chromatogram was integrated and compared with the EI-MS database spectra of known components stored in the NIST library. Twenty-two compounds were effectively matched and identified in petroleum ether (60-80oC) extract and the most predominant constituents were n-hexadecanoic acid (42.79 %), (Z,Z)-9,12-octadecadienoic acid (21.94%), hexadecanoic acid, methyl ester (6.67%), (E)-8-octadecenoic acid methyl ester (5.40%), (Z,Z)- 9,12-octadecadienoic acid methyl ester (5.02%) and (3β, 5α)-stigmasta-7,16-dien-3-ol (1.53%), while methylene chloride fraction afforded twenty five phytochemicals and the more predominant constituents were 2-hydroxy-1-(hydroxymethyl) hexadecanoic acid ethyl ester (11.20 %), (Z) 9- octadecenal (7.08%), hexadecanoic acid, methyl ester (5.17%), 4-((1E)-3-hydroxy-1-propenyl)-2-methoxyphenol (4.37%), n-hexadecanoic acid (3.23 %), (Z,Z)-9,12-octadecadienoic acid methyl ester (3.04 %), (Z)-9-octadecenoic acid methyl ester (2.95%) and (3β, 24S) stigmast-5-en-3-ol (2.00 %).

Table 1. Identified volatile constituents of petroleum ether (60-80^{o}C) extract of sugar beet pulp using GC/MS technique.

Component No	R.T	Pet. ether %	M.F	*m/z* (ret. int. %)
Acetogenins (Fat Derivatives)				
Unsaturated Fats				
2-Nonadecene (1)	27.88	0.66	$C_{19}H_{38}$	139 (5) $[C_{10}H_{19}]^+$, 125 (17) $[C_9H_{17}]^+$, 111 (40) $[C_8H_{15}]^+$, 97 (85) $[C_7H_{13}]^+$, 83 (92) $[C_6H_{11}]^+$, 69 (81) $[C_5H_9]^+$, 55 (100) $[C_4H_7]^+$, 57 (90) $[C_4H_9]^+$, 71 (43) $[C_5H_{11}]^+$, 85 (27) $[C_6H_{13}]^+$, 99 (7) $[C_7H_{15}]^+$.
Fatty Acids				
Pentadecanoic acid (2)	29.44	0.65	$C_{15}H_{30}O_2$	242 (7)$[M]^+$, 199 (20)$[C_{12}H_{23}O_2]^+$, 185 (17) $[C_{11}H_{21}O_2]^+$, 171 (10)$[C_{10}H_{19}O_2]^+$, 157 (10)$[C_9H_{17}O_2]^+$, 143 (17) $[C_8H_{15}O_2]^+$, 129 (43) $[C_7H_{13}O_2]^+$, 115 (17) $[C_6H_{11}O_2]^+$, 101(10) $[C_5H_9O_2]^+$, 87(23) $[C_4H_7O_2]^+$, 73 (100) $[C_3H_5O_2]^+$.
n-Hexadecanoic acid (3)	31.97	42.79	$C_{16}H_{32}O_2$	256 (10) $[M^+]$, 227 (7) $[M\text{-}CH_3CH_2]^+$, 213 (20) $[C_{14}H_{27}O_2]^+$, 199 (7) $[C_{12}H_{23}O_2]^+$, 185 (13) $[C_{11}H_{21}O_2]^+$, 171 (13) $[C_{10}H_{19}O_2]^+$, 157 (17) $[C_9H_{17}O_2]^+$, 143 (7) $[C_8H_{15}O_2]^+$, 129 (42) $[C_7H_{13}O_2]^+$, 115 (17) $[C_6H_{11}O_2]^+$, 101 (10) $[C_5H_9O_2]^+$, 87 (20) $[C_4H_7O_2]^+$, 73 (100) $[C_3H_5O_2]^+$.
(Z,Z)-(9,12-Octadecadienoic acid (4)	35.09	21.94	$C_{18}H_{32}O_2$	280 (3) $[M^+]$, 57 (27) $[C_4H_9]^+$, 71 (17) $[C_5H_{11}]^+$, 84 (20) $[C_6H_{12}]^+$, 97 (33) $[C_7H_{13}]^+$, 111 (13) $[C_8H_{15}]^+$, 124 (10) $[C_9H_{16}]^+$, 137 (7) $[C_{10}H_{17}]^+$, 151 (5) $[C_{11}H_{19}]^+$.
Fatty Aldehydes				
(2E) Decenal (5)	15.07	0.47	$C_{10}H_{18}O$	111 (20) $[M\text{-}C_3H_7]^+$, 97 (23) $[C_6H_9O]^+$, 83 (60)$[C_5H_7O]^+$, 69 (47) $[C_4H_5O]^+$, 55 (100) $[C_3H_3O]^+$
(E,E)-2,4-Decadienal (6)	16.57	0.19	$C_{10}H_{16}O$	152 (3) $[M^+]$, 95 (10) $[C_6H_7O]^+$, 68 (5) $[C_4H_4O]^+$, 81 (100) $[C_5H_5O]^+$, 55 (13) $[C_3H_3O]^+$

Fatty Esters				
9-Oxo-nonanoic acid, methyl ester (7)	19.43	0.12	$C_{10}H_{18}O_3$	155 (20) $[M-OCH_3]^+$, 143 (30) $[C_8H_{15}O_2]^+$, 115 (10) $[C_6H_{11}O_2]^+$, 101 (10) $[C_5H_9O_2]^+$, 87 (77) $[C_4H_7O_2]^+$, 59 (33) $[C_2H_3O_2]^+$
Methyl 10-oxo-8-decenoate (8)	23.31	0.14	$C_{11}H_{18}O_3$	138 (33) $[M-C_2H_3O_2]^+$, 111 (13) $[C_7H_{11}O]^+$, 97 (33) $[C_6H_9O]^+$, 83 (54) $[C_5H_7O]^+$, 69 (72) $[C_4H_5O]^+$, 55 (100) $[C_3H_3O]^+$
Tetradecanoic acid, methyl ester (9)	26.34	0.20	$C_{15}H_{30}O_2$	213 (3) $[M-C_2H_5]^+$, 199 (13) $[C_{12}H_{23}O_2]^+$, 143 (17) $[C_8H_{15}O_2]^+$, 129 (10) $[C_7H_{13}O_2]^+$,101 (5)$[C_5H_9O_2]^+$, 87 (66) $[C_4H_7O_2]^+$, 59 (7) $[C_2H_3O_2]^+$,57 (17) $[C_4H_9]^+$,71 (7) $[C_5H_{11}]^+$, 155 (7) $[C_{11}H_{23}]^+$, 211 (3) $[C_{14}H_{27}O]^+$.
Pentadecanoic acid methyl ester (10)	28.46	0.33	$C_{16}H_{32}O_2$	256 (3) $[M]^+$, 225(3) $[M-OCH_3]^+$, 213 (10) $[C_{13}H_{25}O_2]^+$, 199 (5) $[C_{12}H_{23}O_2]^+$, 185 (3) $[C_{11}H_{21}O_2]^+$, 171 (3) $[C_{10}H_{19}O_2]^+$, 157 (5) $[C_9H_{17}O_2]^+$, 143 (17) $[C_8H_{15}O_2]^+$, 129 (7) $[C_7H_{13}O_2]^+$, 115 (3) $[C_6H_{11}O_2]^+$, 101 (7) $[C_5H_9O_2]^+$, 87 (68) $[C_4H_7O_2]^+$, 73 (3) $[C_3H_5O_2]^+$, 59 (8) $[C_2H_3O_2]^+$.
Hexadecanoic acid methyl ester (11)	30.54	6.67	$C_{17}H_{34}O_2$	270 (3) $[M]^+$, 227 (10) $[C_{14}H_{27}O_2]^+$, 241(3) $[M-C_2H_5]^+$, 239 (3) $[M-OCH_3]^+$, 227 (10) $[C_{14}H_{27}O_2]^+$, 213 (2) $[C_{13}H_{25}O_2]^+$, 199 (2) $[C_{12}H_{23}O_2]^+$, 185 (5) $[C_{11}H_{21}O_2]^+$, 171 (5) $[C_{10}H_{19}O_2]^+$, 157 (3) $[C_9H_{17}O_2]^+$, 143 (18) $[C_8H_{15}O_2]^+$, 129 (7) $[C_7H_{13}O_2]^+$, 115 (3) $[C_6H_{11}O_2]^+$, 101 (7) $[C_5H_9O_2]^+$, 87 (71) $[C_4H_7O_2]^+$.
(Z,Z)-9,12-Octadecadienoic acid methyl ester (12)	33.71	5.02	$C_{19}H_{34}O_2$	294 (3) $[M^+]$, 57 (10) $[C_4H_9]^+$, 71 (7) $[C_5H_{11}]^+$, 84 (7) $[C_6H_{12}]^+$, 97 (13) $[C_7H_{13}]^+$, 111 (7) $[C_8H_{15}]^+$, 124 (8) $[C_9H_{16}]^+$, 137 (7) $[C_{10}H_{17}]^+$, 151 (3) $[C_{11}H_{19}]^+$, 263 (3) $[C_{18}H_{31}O]^+$.
(E)-8-Octadecenoic acid methyl ester (13)	33.85	5.40	$C_{19}H_{36}O_2$	296 (2) $[M^+]$, 57 (37) $[C_4H_9]^+$,71 (13) $[C_5H_{11}]^+$, 85 (17) $[C_6H_{13}]^+$, 87 (43) $[C_4H_7O_2]^+$, 101 (10) $[C_5H_9O_2]^+$, 115 (7) $[C_6H_{11}O_2]^+$.
11-Octadecenoic acid methyl ester (14)	33.92	0.66	$C_{19}H_{36}O_2$	57 (40) $[C_4H_9]^+$, 71 (22) $[C_5H_{11}]^+$, 85 (17) $[C_6H_{13}]^+$, 98 (28)$[C_7H_{14}]^+$, 111 (18)$[C_8H_{15}]^+$, 125 (10) $[C_9H_{17}]^+$, 139 (5) $[C_{10}H_{19}]^+$.
16-Methyl-heptadecanoic acid, methyl ester (15)	34.28	0.84	$C_{19}H_{38}O_2$	298 (3) $[M^+]$,59 (7) $[C_2H_3O_2]^+$, 73 (10) $[C_3H_5O_2]^+$, 87 (70) $[C_4H_7O_2]^+$, 101 (7) $[C_5H_9O_2]^+$, 115 (3) $[C_6H_{11}O_2]^+$, 129 (10) $[C_7H_{13}O_2]^+$, 143 (20) $[C_8H_{15}O_2]^+$, 157 (3) $[C_9H_{17}O_2]^+$, 171 (3) $[C_{10}H_{19}O_2]^+$.
Docosanoic acid methyl ester (16)	40.90	0.48	$C_{23}H_{46}O_2$	354 (7) $[M^+]$, 59 (7) $[C_2H_3O_2]^+$, 73 (3) $[C_3H_5O_2]^+$, 87 (77) $[C_4H_7O_2]^+$, 101 (7) $[C_5H_9O_2]^+$, 115 (3) $[C_6H_{11}O_2]^+$, 129 (10) $[C_7H_{13}O_2]^+$, 143 (23) $[C_5H_{15}O_2]^+$, 199 (7) $[C_{12}H_{23}O_2]^+$, 255 (7) $[C_{16}H_{31}O_2]^+$, 311 (10) $[C_{20}H_{39}O_2]^+$.
Tricosanoic acid methyl ester (17)	42.39	0.49	$C_{24}H_{48}O_2$	368 (7) $[M^+]$, 325 (10) $[C_{21}H_{41}O_2]^+$, 269 (5) $[C_{17}H_{33}O_2]^+$, 199 (7) $[C_{12}H_{23}O_2]^+$, 143 (23) $[C_8H_{15}O_2]^+$, 115 (3) $[C_6H_{11}O_2]^+$.
Tetracosanoic acid, methyl ester (18)	43.83	0.56	$C_{25}H_{50}O_2$	382 (7) $[M^+]$, 339 (10) $[C_{22}H_{43}O_2]^+$, 283 (3) $[C_{18}H_{35}O_2]^+$, 241 (3) $[C_{15}H_{29}O_2]^+$, 199 (7) $[C_{12}H_{23}O_2]^+$, 171 (2) $[C_{10}H_{19}O_2]^+$, 143 (25) $[C_8H_{15}O_2]^+$.
Sesquiterpenes				
6,10,14-trimethyl-(2-Pentadecanone (19)	28.84	0.29	$C_{18}H_{36}O$	113 (10) $[C_8H_{17}]^+$, 85 (33) $[C_6H_{13}]^+$, 71 (62) $[C_5H_{11}]^+$, 57 (49) $[C_4H_9]^+$.
Sterols				
Stigmasterol (20)	52.95	0.64	$C_{29}H_{48}O$	412 (100) $[M^+]$, 394 (10) $[C_{29}H_{46}]^+$, 379 (13) $[C_{28}H_{43}]^+$, 351 (27) $[C_{26}H_{39}]^+$, 255 (57) $[C_{19}H_{27}]^+$, 213 (27) $[C_{16}H_{21}]^+$, 199 (10) $[C_{15}H_{19}]^+$, 159 (40) $[C_{12}H_{15}]^+$, 145 (40) $[C_{11}H_{13}]^+$, 55 (70) $[C_4H_7]^+$.

(3β, 5α)-Stigmasta-7, 16-dien-3-ol (21)	54.47	1.53	$C_{29}H_{48}O$	412 (10) $[M]^+$, 369 (7) $[C_{26}H_{41}O]^+$, 300 (10) $[C_{21}H_{32}O]^+$, 271 (100) $[C_{19}H_{27}O]^+$, 246 (17) $C_{17}H_{26}O]^+$.
β-Sitosterol (22)	54.63	1.37	$C_{29}H_{50}O$	414 (100) $[M^+]$, 396 (50) $[C_{29}H_{48}]^+$, 381 (37) $[C_{28}H_{45}]^+$, 329 (47) $[C_{23}H_{37}O]^+$, 303 (43) $[C_{21}H_{35}O]^+$, 273 (27) $[C_{19}H_{29}O]^+$, 255 (23) $[C_{19}H_{27}]^+$, 231 (17) $[C_{16}H_{23}O]^+$, 213 (35) $[C_{16}H_{21}]^+$.

Table 2. Identified volatile constituents of methylene chloride extract of sugar beet Pulp using GC/MS technique.

Component No	R.T	CH_2Cl_2 %	M.F	m/z (ret. int. %)
Acetogenins (Fat Derivatives)				
Unsaturated Fats				
2-Nonadecene (1)	35.50	2.41	$C_{19}H_{38}$	139 (5) $[C_{10}H_{19}]^+$, 125 (17) $[C_9H_{17}]^+$, 111 (40) $[C_8H_{15}]^+$, 97 (85) $[C_7H_{13}]^+$, 83 (92) $[C_6H_{11}]^+$, 69 (81) $[C_5H_9]^+$, 55 (100) $[C_4H_7]^+$, 57 (90) $[C_4H_9]^+$, 71 (43) $[C_5H_{11}]^+$, 85 (27) $[C_6H_{13}]^+$, 99 (7) $[C_7H_{15}]^+$.
1-Nonadecene (23)	31.86	1.56	$C_{19}H_{38}$	167 (7) $[C_{12}H_{23}]^+$, 153 (2) $[C_{11}H_{21}]^+$, 139 (7) $[C_{10}H_{19}]^+$, 125 (17) $[C_9H_{17}]^+$, 111 (37) $[C_8H_{15}]^+$, 97 (78) $[C_7H_{13}]^+$, 83 (80) $[C_6H_{11}]^+$, 69 (71) $[C_5H_9]^+$, 55 (96) $[C_4H_7]^+$.
Fatty Alcohols				
6-Undecanol (24)	23.19	0.64	$C_{11}H_{24}O$	101 (67) $[C_6H_{13}O]^+$, 100 (27) $[C_6H_{12}O]^+$, 84 (13) $[C_6H_{11}]^+$, 70 (3) $[C_5H_{10}]^+$, 57 (27) $[C_4H_9]^+$, 55 (91) $[C_4H_7]^+$.
1-Docosanol (25)	38.84	1.98	$C_{22}H_{46}O$	57 (100) $[C_4H_9]^+$, 71 (40) $[C_5H_{11}]^+$, 85 (37) $[C_6H_{13}]^+$, 99 (10) $[C_7H_{15}]^+$, 113 (7) $[C_8H_{17}]^+$, 127 (3) $[C_9H_{19}]^+$, 141 (2) $[C_{10}H_{21}]^+$.
1-Tetracosanol (26)	41.92	1.71	$C_{24}H_{50}O$	57 (100) $[C_4H_9]^+$, 71 (57) $[C_5H_{11}]^+$, 85 (37) $[C_6H_{13}]^+$, 99 (10) $[C_7H_{15}]^+$, 113 (7) $[C_8H_{17}]^+$, 127 (3) $[C_9H_{19}]^+$, 141 (3) $[C_{10}H_{21}]^+$, 155 (3) $[C_{11}H_{23}]^+$.
1-Heptacosanol (27)	47.57	0.65	$C_{27}H_{56}O$	99 (13) $[C_7H_{15}]^+$, 85 (37) $[C_6H_{13}]^+$, 71 (57) $[C_5H_{11}]^+$, 57 (100) $[C_4H_9]^+$.
Fatty Acids				
n-Hexadecanoic acid (3)	31.58	3.23	$C_{16}H_{32}O_2$	256 (10) $[M^+]$, 227 (7) $[M\text{-}CH_3CH_2]^+$, 213 (20) $[C_{14}H_{27}O_2]^+$, 199 (7) $[C_{12}H_{23}O_2]^+$, 185 (13) $[C_{11}H_{21}O_2]^+$, 171 (13) $[C_{10}H_{19}O_2]^+$, 157 (17) $[C_9H_{17}O_2]^+$, 143 (7) $[C_8H_{15}O_2]^+$, 129 (42) $[C_7H_{13}O_2]^+$, 115 (17) $[C_6H_{11}O_2]^+$, 101 (10) $[C_5H_9O_2]^+$, 87 (20) $[C_4H_7O_2]^+$, 73 (100) $[C_3H_5O_2]^+$.
Fatty Aldehydes				
(*Z*) 9- Octadecenal (28)	43.37	7.08	$C_{18}H_{34}O$	266 (3) $[M^+]$,167 (2) $[C_{12}H_{23}]^+$, 153 (3) $[C_{11}H_{21}]^+$, 139 (7) $[C_{10}H_{19}]^+$, 126 (7) $[C_9H_{18}]^+$, 113 (7) $[C_8H_{17}]^+$, 99 (10) $[C_7H_{15}]^+$, 85 (13) $[C_6H_{13}]^+$, 71 (17) $[C_5H_{11}]^+$, 57 (46) $[C_4H_9]^+$.
Fatty Esters				
5-Pentyl-2(5*H*)-furanone (29)	17.08	0.47	$C_9H_{14}O_2$	125 (41) $[M\text{-}C_2H_5]^+$, 111(7) $[M\text{-}C_3H_7]^+$, 97 (17) $[C_5H_5O_2]^+$, 83 (27) $[C_4H_3O_2]^+$, 57 (7) $[C_2HO_2]^+$.
Hexadecanoic acid methyl ester (11)	30.52	5.17	$C_{17}H_{34}O_2$	270 (3) $[M]^+$, 227 (10) $[C_{14}H_{27}O_2]^+$, 241(3) $[M\text{-}C_2H_5]^+$, 239 (3) $[M\text{-}OCH_3]^+$, 227 (10) $[C_{14}H_{27}O_2]^+$, 213 (2) $[C_{13}H_{25}O_2]^+$, 199 (2) $[C_{12}H_{23}O_2]^+$, 185 (5) $[C_{11}H_{21}O_2]^+$, 171 (5) $[C_{10}H_{19}O_2]^+$, 157 (3) $[C_9H_{17}O_2]^+$, 143 (18) $[C_8H_{15}O_2]^+$, 129 (7) $[C_7H_{13}O_2]^+$, 115 (3) $[C_6H_{11}O_2]^+$, 101 (7) $[C_5H_9O_2]^+$, 87 (71) $[C_4H_7O_2]^+$.
(*Z,Z*)-9,12-Octadecadienoic acid methyl ester (12)	33.66	3.04	$C_{19}H_{34}O_2$	294 (3) $[M^+]$, 57 (10) $[C_4H_9]^+$, 71 (7) $[C_5H_{11}]^+$, 84 (7) $[C_6H_{12}]^+$, 97 (13) $[C_7H_{13}]^+$, 111 (7) $[C_8H_{15}]^+$, 124 (8) $[C_9H_{16}]^+$, 137 (7) $[C_{10}H_{17}]^+$, 151 (3) $[C_{11}H_{19}]^+$, 263 (3) $[C_{18}H_{31}O]^+$.
(*Z*)-9-	33.78	2.95		265 (10) $[M\text{-}OCH_3]^+$, 183 (2) $[C_{11}H_{19}O_2]^+$, 157 (2)

Octadecenoic acid methyl ester (30)			**$C_{19}H_{36}O_2$**	**$[C_9H_{17}O_2]^+$, 143 (7) $[C_8H_{15}O_2]^+$, 129 (7) $[C_7H_{13}O_2]^+$, 115 (7) $[C_6H_{11}O_2]^+$, 101 (7) $[C_5H_9O_2]^+$, 87 (40) $[C_4H_7O_2]^+$, 73 (10) $[C_3H_5O_2]^+$, 59 (17) $[C_2H_3O_2]^+$.**
16-Methyl-heptadecanoic acid, methyl ester (15)	**34.26**	**0.86**	**$C_{19}H_{38}O_2$**	**298 (3) $[M^+]$, 59 (7) $[C_2H_3O_2]^+$, 73 (10) $[C_3H_5O_2]^+$, 87 (70) $[C_4H_7O_2]^+$, 101 (7) $[C_5H_9O_2]^+$, 115 (3) $[C_6H_{11}O_2]^+$, 129 (10) $[C_7H_{13}O_2]^+$, 143 (20) $[C_8H_{15}O_2]^+$, 157 (3) $[C_9H_{17}O_2]^+$, 171 (3) $[C_{10}H_{19}O_2]^+$.**
2-Hydroxy-1-(hydroxymethyl) hexadecanoic acid ethyl ester (31)	**40.73**	**11.20**	**$C_{19}H_{38}O_4$**	**299 (7) $[M\text{- }OCH_3]^+$, 57 (83) $[C_4H_9]^+$, 71(40) $[C_5H_{11}]^+$, 85 (30) $[C_6H_{13}]^+$, 99 (13) $[C_7H_{15}]^+$, 113 (7) $[C_8H_{17}]^+$, 127 (2) $[C_9H_{19}]^+$, 239 (50) $[C_{16}H_{31}O]^+$, 255 (7) $[C_{16}H_{31}O_2]^+$.**
Hexadecanoic acid, 2,3-dihydroxypropyl ester (32)	**40.79**	**0.99**	**$C_{19}H_{38}O_4$**	**239 (50) $[C_{16}H_{31}O]^+$, 71 (50) $[C_5H_{11}]^+$, 85 (53) $[C_6H_{13}]^+$, 99 (13) $[C_7H_{15}]^+$, 113 (7) $[C_8H_{17}]^+$, 57 (100) $[C_4H_9]^+$**
Docosanoic acid, methyl ester (16)	**40.91**	**0.87**	**$C_{23}H_{46}O_2$**	**354 (5) $[M^+]$, 239 (3) $[C_{22}H_{43}O_2]^+$, 255 (7) $[C_{16}H_{31}O_2]^+$, 199 (8) $[C_{12}H_{23}O_2]^+$, 185 (5) $[C_{11}H_{21}O_2]^+$, 157 (3) $[C_9H_{17}O_2]^+$, 143 (23) $[C_8H_{15}O_2]^+$, 129 (13) $[C_7H_{13}O_2]^+$, 101 (10) $[C_5H_9O_2]^+$, 87 (74) $[C_4H_7O_2]^+$, 74 (100) $[C_3H_6O_2]^+$, 59 (10) $[C_2H_3O_2]^+$.**
Tricosanoic acid methyl ester (17)	**42.39**	**0.54**	**$C_{24}H_{48}O_2$**	**368 (7) $[M^+]$, 325 (10) $[C_{21}H_{41}O_2]^+$, 269 (5) $[C_{17}H_{33}O_2]^+$, 199 (7) $[C_{12}H_{23}O_2]^+$, 143 (23) $[C_8H_{15}O_2]^+$, 115 (3) $[C_6H_{11}O_2]^+$.**
Tetracosanoic acid, methyl ester (18)	**43.83**	**0.87**	**$C_{25}H_{50}O_2$**	**382 (7) $[M^+]$, 339 (10) $[C_{22}H_{43}O_2]^+$, 283 (3) $[C_{18}H_{35}O_2]^+$, 241 (3) $[C_{15}H_{29}O_2]^+$, 199 (7) $[C_{12}H_{23}O_2]^+$, 171 (2) $[C_{10}H_{19}O_2]^+$, 143 (25) $[C_8H_{15}O_2]^+$.**
Sterols				
Stigmasterol (20)	**52.95**	**0.62**	**$C_{29}H_{48}O$**	**412 (100) $[M^+]$, 394 (10) $[C_{29}H_{46}]^+$, 379 (13) $[C_{28}H_{43}]^+$, 351 (27) $[C_{26}H_{39}]^+$, 255 (57) $[C_{19}H_{27}]^+$, 213 (27) $[C_{16}H_{21}]^+$, 199 (10) $[C_{15}H_{19}]^+$, 159 (40) $[C_{12}H_{15}]^+$, 145 (40) $[C_{11}H_{13}]^+$, 55 (70) $[C_4H_7]^+$.**
β-Sitosterol (22)	**54.62**	**2.00**	**$C_{29}H_{50}O$**	**414 (37) $[M^+]$, 329 (40) $[C_{23}H_{37}]^+$, 397 (30) $[C_{29}H_{49}]^+$, 399 (20) $[C_{28}H_{47}O]^+$, 273 (27) $[C_{19}H_{29}O]^+$, 149 (30) $[C_{10}H_{13}O]^+$, 132 (17) $[C_{10}H_{12}]^+$.**
Shikimates Derivatives				
2-Methoxy-4-vinylphenol (33)	**16.46**	**0.92**	**$C_9H_{10}O_2$**	**150 (100) $[M^+]$, 135 (75)$[M\text{-}CH_3]^+$, 78 (7) $[M\text{-}C_3H_4O_2]^+$, 108 (3) $[C_6H_4O_2]^+$, 107 (34) $[C_7H_7O]^+$, 91 (3) $[C_6H_3O]^+$, 75 (2) $[C_6H_3]^+$, 65 (3) $[C_5H_5]^+$, 52 (7) $[C_4H_4]^+$, 89 (7) $[C_7H_5]^+$, 77 (33) $[C_6H_5]^+$, 63 (7) $[C_5H_3]^+$, 51 (10) $[C_4H_3]^+$.**
2,6-Dimethoxy-phenol (34)	**17.36**	**0.49**	**$C_8H_{10}O_3$**	**154 (100) $[M^+]$, 139 (44) $[C_7H_7O_3]^+$, 111 (25) $[C_6H_7O_2]^+$, 96 (27) $[C_5H_4O_2]^+$, 68 (10) $[C_4H_4O]^+$, 55 (10) $[C_3H_3O]^+$.**
4-Hydroxy-3-methoxy-benzaldehyde (35)	**18.63**	**1.00**	**$C_8H_8O_3$**	**152 (94) $[M^+]$, 151 (100) $[M\text{-}H]^+$, 137 (7) $[M\text{-}CH_3]$, 121 (3) $[C_7H_5O_2]^+$, 92 (3) $[C_6H_4O]^+$.**
4-Hydroxy-3,5-dimethoxy-benzaldehyde (36)	**24.83**	**0.49**	**$C_9H_{10}O_4$**	**182 (100) $[M^+]$, 167 (10) $[C_8H_7O_4]^+$, 139 (8) $[C_7H_7O_3]^+$, 97 (3) $[C_5H_5O_2]^+$, 82 (5) $[C_4H_2O_2]^+$, 65 (12) $[C_4HO]^+$, 108 (7) $[C_6H_4O_2]^+$, 95 (7) $[C_5H_3O_2]^+$, 55 (20) $[C_3H_2O]^+$.**
4-((1E)-3-Hydroxy-1-propenyl)-2-methoxyphenol (37)	**26.77**	**4.37**	**$C_{10}H_{12}O_3$**	**180 (64)$[M^+]$, 163(3)$[C_{10}H_{11}O_2]^+$, 149(3)$[C_9H_9O_2]^+$, 136 (3) $[C_8H_8O_2]^+$, 123(3)$[C_7H_7O_2]^+$, 124 (53)$[C_7H_8O_2]^+$, 137 (100) $[C_8H_9O_2]^+$, 147 (8) $[C_9H_7O_2]^+$, 124 (54) $[C_3H_6O]^+$, 91 (34) $[C_7H_7]^+$, 77 (18) $[C_6H_5]^+$, 65 (13) $[C_5H_5]^+$, 55 (15) $[C_3H_3]^+$.**

The more predominant constituents investigated from petroleum ether (60-80^{o}C) extract and methylene chloride of sugar beet pulp found to possess different biological activities as shown below in **Table (3)**. The wide range activities derived from these various volatile constituents provided value-added to these bio-wastes with potentially useful valuable applications.

Table 3. Reported biological activities of petroleum ether (60-80°C) and methylene chloride extract predominant phyto-constituents.

Predominant component	Biological activity
Acetogenins (Fat Derivatives)	
Fatty Alcohols	
2-Hydroxy-1-(hydroxymethyl) hexadecanoic acid ethyl ester (31)	- Hemolytic, pesticide, flavour, antioxidant. [11,12]
Fatty Acids	
n-Hexadecanoic acid (3)	- Antioxidant, Hypocholesterolemic, Nematicide, Hemolytic, Pesticide, Lubricant, 5-Alpha reductase inhibitor and antipsychotic [11,13,14,15]. - larvicidal activity against mosquitoes [16,17]. - Antifungal, flavor, potent antimicrobial agent, antimalarial pesticide and antipsychotic [18-25]. - cytotoxicity against human colorectal carcinoma cells (HCT-116) [26] - Antifouling property [27] - Control of human pathogens, pests, termites and maggots [28]. - Increasing proliferation of MSCs [29]. - Considered as larvicide [30]. - The leaf ethanolic extract of *Centella asiatica* showed significant inhibitory activity against *Mycobacterium tuberculosis.*due to presence of major bioactive n-Hexadecanoic [31]. - Repellent against Anopheles species and thus useful for malaria control [21,32]. - Antiandrogenic [12,33,34]. - Echo enhancement in sonographic doppler B-mode imaging [35].
(*Z,Z*)-9,12-Octadecadienoic acid (4)	- Hypocholesterolemic, antieczemic, antihistaminic, antiarthritic, nematicide, hepatoprotective, anti-inflammatory, cancer preventive, antiacne, 5-alpha reductase inhibitor, anti-eczemic, anticoronary, antiplasmodial activities [11,36]. - Insectifuge, antiandrogenic [18,19]. - Antifouling [27] - Antifungal activity [37].
Fatty Esters	
Hexadecanoic acid methyl ester (11)	- Antioxidant, Hypocholesterolemic, Nematicide, Pesticide, Antiandrogenic flavor, Hemolytic, 5-Alpha reductase inhibitor [38]. - Antimicrobial activity [22,23]. - Antifungal activity [39-41]. - Antibacterial, antitumor, immunostimulant, chemopreventive and lipoxygenase inhibitor [34,42].
(*Z,Z*)-9,12-Octadecadienoic acid methyl ester (12)	- Mosquito vector control [17] - Anticancer [12,41]
(*E*)-8-Octadecenoic acid methyl ester (13)	- Antioxidant, Antimicrobial [20,39,47].
(*Z*)-9-Octadecenoic acid methyl ester (30)	- Antifungal,Antioxidant, anticancer hypocholesterolemic nematicide, pesticide, antiandrogenic flavour, haemolytic, 5-Alpha reductase inhibitor, potent antimicrobial activity [18,21,23,40,43]. - Rodenticide [22,44].
Shikimates Derivatives	
4-((1*E*)-3-Hydroxy-1-propenyl)-2-methoxyphenol (37)	- Antimicrobial, Antioxidant, Antiinflammatory, Analgesic [14,24,45,46].

Conclusion

Sugar beet pulps is well-known rich with high contents of the desired volatile naturally occurring compounds. These high-value phytochemicals exert various biological activities that improve overall health and prevent diseases. Twenty-two volatile compounds were effectively matched and identified in petroleum ether (60-80^{o}C) extract using GC/MS technique while methylene chloride fraction afforded twenty three phytochemicals. The identified volatile compounds belonging to different classes, acetogenins (fat derivatives), sesquiterpene, sterols and shikimates derivatives (phenolic constituents).

Acknowledgment

Authors like to thank all the stuff members of Natural Products Laboratory, Chemistry Department, Faculty of Science, Mansoura University, for their support and kind cooperation.

References

1. **El-Shamy, S. S. M. (2018):** A Pharmacognostical Study of Certain Cultivars of *Beta vulgaris L*. Growing in Egypt: CU Theses, Cairo University. P: 2-18.
2. **Iqbal, M. A. and Saleem A. M. (2015):** Sugar beet potential to beat sugarcane as a sugar crop in Pakistan. *American-Eurasian J Agric Environ Sci.* **15** (1): 36-44.
3. **Michel, F.; Thibault, J. F.; Barry, J. L. and de Baynast, R. (1988):** Preparation and characterisation of dietary fibre from sugar beet pulp. *Journal of the Science of Food and Agriculture.* **42** (1): 77-85.
4. **El-Hawary, S.; Hammouda, F.; Tawfik, W.; Kassem, H.; Abdelshafeek, K. and El-Shamy, S. (2017):** Investigation of some chemical constituents, cytotoxicity and antioxidant activities of *beta vulgaris* var. Altissima cultivated in Egypt. **10**: 1391-1401.
5. **Takahashi, H.; Sasaki, T. and Ito M. (1987):** New flavonoids isolated from infected sugarbeet roots. *Bulletin of the Chemical Society of Japan.* **60** (6): 2261-2262.
6. **Yoshikawa, M.; Murakami, T.; Kadoya, M.; Yamahara, J. and Matsuda, H. (1988):** Medicial Foodstuffs. XV. Sugar Beet.(2): Structures of Betavulgarosides V, VI, VII, VIII, IX and X from the Roots and Leaves of Sugar Beet (*Beta vulgaris* L., Chenopodiaceae). *Chemical and pharmaceutical bulletin.* **46** (11): 1758-1763.

7. **Ridout, C. L.; Price, K. R.; Parkin, G.; Dijoux, M. G. and Lavaud, C. (1994):** Saponins from sugar beet and the floc problem. *Journal of agricultural and food chemistry.* **42** (2): 279-282.
8. **Yoshikawa, M.; Murakami, T.; Kadoya, M.; Matsuda, H.; Muraoka, O.; Yamahara, J. and Murakami, N. (1996)**: Medicinal Foodstuffs. III. Sugar Beet.(1): Hypoglycemic Oleanolic Acid Oligoglycosides, Betavulgarosides, I, II, III, and IV, from the Root of *Beta vulgaris* L.(Chenopodiaceae). *Chemical and pharmaceutical bulletin.* **44** (6): 1212-1217.
9. **Schmidt, J.; Kuhnt, C.; and Adam, G. (1994):** Brassinosteroids and sterols from seeds of *Beta vulgaris*. *Phytochemistry.* **36** (1): 175-177.
10. **Bokern, M.; H, euer, S.; Wray, V.; Witte, L.; Macek, T.; Vanek, T. and Strack, D. (1991):** Ferulic acid conjugates and betacyanins from cell cultures of *Beta vulgaris*. *Phytochemistry.* **30** (10): 3261-3265.
11. **Tyagi, T. and Agarwal, M. (2017):** Phytochemical screening and GC-MS analysis of bioactive constituents in the ethanolic extract of *Pistia stratiotes* L. and *Eichhornia crassipes* (Mart.) solms. *Journal of Pharmacognosy and phytochemistry.* **6** (1): 195-206.
12. **Krishnan, G. S.; Sebastian, D.; Savarimuthu, I.; Poovathumkal, J. A. and Fleming A.T. (2017):** In vitro and in silico anticancer effect of combined crude acetone extracts of *Plumbago zeylanica* L., *Limonia acidissima* L. and *Artocarpus heterophyllus* Lam. *Synergy.* **5**: 15-23.
13. **Gobalakrishnan, R.; Manikandan, P. and Bhuvaneswari, R. (2014):** Antimicrobial potential and bioactive constituents from aerial parts of *Vitis setosa* wall. *J. Med. Plant Res.* **8** (11): 454-460.
14. **Bhaskar, A. and Upgade, A. (2013):** Characterization and medicinal importance of phytoconstituents of *Carica papaya* from down south Indian region using gas chromatography and mass spectroscopy. *Asian journal of pharmaceutical and clinical research.* **6**: 101-106.
15. **Vijisaral, E.D. and Arumugam, S. (2014):** GC-MS analysis of bioactive constituents of *Indigofera suffruticosa* leaves. *Journal of Chemical and Pharmaceutical Research.* **6** (8): 294-300.
16. **Rahuman, A. A.; Gopalakrishnan, G.; Ghouse, B. S.; Arumugam, S. and Himalayan, B. (2000):** Effect of *Feronia limonia* on mosquito larvae. *Fitoterapia.* **71** (5): 553-555.

17. **Jeyasankar, A. and Chinnamani, T. (2018):** Larvicidal and pupicidal activities of *Solonum pseudocapsicum* fruits compunds against *Aedes aegypti, Anopheles stephensi* and *Culex quinquefasciatus* (Diptera: Culicidae). *J. Infectious Disease Med. Microbiol.* **2** (2): 11-16.

18. **Hema, R.; Kumaravel, S. and Alagusundaram, K. (2011):** GC/MS determination of bioactive components of *Murraya koenigii*. *Journal of American Science.* **7** (1): 80-83.

19. **Zito, P.; Sajeva, M.; Bruno, M.; Maggio, A.; Rosselli, S.; Formisano, C.; and Senatore, F. (2010):** Essential oil composition of stems and fruits of *Caralluma europaea* NE Br.(Apocynaceae). *Molecules.* **15** (2): 627-638.

20. **Aarabi, A.; Mizani, M. and Honarvar, M. (2017):** The use of sugar beet pulp lignin for the production of vanillin. *International journal of biological macromolecules.* **94**: 345-354.

21. **Mathivanan, D.; Gandhi, P. R.; Mary, R. R. and Suseem, S. (2018):** Larvicidal and acaricidal efficacy of different solvent extracts of *Andrographis echioides* against blood-sucking parasites. *Physiological and Molecular Plant Pathology.* **101**: 187-196.

22. **Sandanasamy, J.; Nour, A. H.; Tajuddin, S. N.; and Nour, A. H. (2014):** Chemical characterization and biological study of *Azadirachta indica* extracts. *Eur. J. Acad. Essays.* **1** (10): 9-16.

23. **Akpuaka, A.; Ekwenchi, M.; Dashak, D. and Dildar, A. (2013):** Biological activities of characterized isolates of n-hexane extract of *Azadirachta indica* A. Juss (Neem) leaves. *Nature and Science.* **11** (5): 141-147.

24. **Dandekar, R.; Fegade, B. and Bhaskar, V. (2015):** GC-MS analysis of phytoconstituents in alcohol extract of *Epiphyllum oxypetalum* leaves. *Journal of Pharmacognosy and Phytochemistry.* **4** (1): 149-154.

25. **Sermakkani, M. and Thangapandian V. (2012):** GC-MS analysis of *Cassia italica* leaf methanol extract. *Asian. J. Pharm. Clin. Res.* **5** (2): 90-94.

26. **Ravi, L. and Krishnan, K. (2017):** Cytotoxic potential of N-hexadecanoic acid extracted from Kigelia pinnata leaves. *Asian J. Cell. Biol.* **12** (1): 20-27.

27. **Manilal, A.; Sujith, S.; Sabarathnam, B.; Kiran, G.; Selvin, J.; Shakir, C.; and Lipton A. (2010):** Antifouling potentials of

seaweeds collected from the southwest coast of India. *World J. Agric. Sci.* **6** (3): 243-248.

28. **Manilal, A.; Sujith, S.; Sabarathnam, B.; Kiran, G.; Selvin, J.; Shakir, C. and Lipton A. (2011):** Biological activity of the red alga *Laurencia brandenii*. *Acta Botanica Croatica.* **70** (1): 81-90.
29. **Chen, D. F.; Li, X.; Xu, Z.; Liu, X.; Du, S. H.; Li, H.; Zhou, J. H.; Zeng, H. P. and Hua, Z. C. (2010):** Hexadecanoic acid from *Buzhong yiqi* decoction induced proliferation of bone marrow mesenchymal stem cells. *Journal of medicinal food.* **13** (4): 967-975.
30. **Naik, B. R.; Gowreeswari, G. S.; Singh, Y.; Satyavathi, R.; Daravath, S. and Reddy P. R. (2014):** Bio-synthesis of silver nanoparticles from leaf extract of *Pongamia pinnata* as an effective larvicide on dengue vector *Aedes albopictus* (Skuse)(Diptera: Culicidae). *Advances in Entomology.* **2** (2): 93-101.
31. **Suresh M., Rath, P. K.; Panneerselvam, A.; Dhanasekaran, D. and Thajuddin, N. (2010):** Anti-mycobacterial effect of leaf extract of *Centella asiatica* (Mackinlayaceae). *Research Journal of Pharmacy and Technology.* **3** (3): 872-876.
32. **Ogunlesi, M.; Okiei, W.; Ofor, E. and Osibote, A. E. (2009):** Analysis of the essential oil from the dried leaves of *Euphorbia hirta* Linn (Euphorbiaceae), a potential medication for asthma. *African Journal of Biotechnology.* **8** (24): 7042-7050.
33. **Kumar, S.; Samydurai, P.; Ramakrishnan, R. and Nagarajan, N. (2014):** Gas chromatography and mass spectrometry analysis of bioactive constituents of *Adiantum capillus-veneris* L. *International Journal of Pharmacy and Pharmaceutical Sciences.* 2014;6:60-63.
34. **Rahbar, N.; Shafaghat, A. and Salimi, F. (2012):** Antimicrobial activity and constituents of the hexane extracts from leaf and stem of *Origanum vulgare* L. ssp. Viride (Boiss.) Hayek. growing wild in Northwest Iran. *Journal of Medicinal Plants Research.* **6** (13): 2681-2685.
35. **Kushwaha, P.; Yadav, S. S.; Singh, V. and Dwivedi L. (2019):** Phytochemical screening and GC-MS studies of the methanolic extract of *Tridax procumbens. International Journal of Pharmaceutical Sciences and Research*. **10** (5): 2492-2496.
36. **Jargalsaikhan, U.; Javzan, S.; Selenge, D.; Nedelcheva, D.; Philipov, S. and Nadmid, J. (2013):** Fatty acids and their esters from *Cicuta virosa* L. *Mongolian Journal of Chemistry.* **14**: 71-74.

37. **Zhang, W.; Abdel-Rahman, F. H. and Saleh, M. A. (2011):** Natural resistance of rose petals to microbial attack. *Journal of Environmental Science and Health Part B.* **46** (5): 381-393.

38. **Sudha, T.; Chidambarampillai, S. and Mohan, V. (2013):** GC-MS analysis of bioactive components of aerial parts of Fluggea leucopyrus Willd.(Euphorbiaceae). *Journal of Applied Pharmaceutical Science.* **3** (5): 126.

39. **Chandrasekaran, M.; Senthilkumar, A. and Venkatesalu V. (2011):** Antibacterial and antifungal efficacy of fatty acid methyl esters from the leaves of Sesuvium portulacastrum L. *European review for medical and pharmacological sciences.* **15** (7): 775-780.

40. **Sharma, D.; Rani, R.; Chaturvedi, M. and Yadav, J. P. (2018):** Anibacterial efficacy and gas chromatography-mass spectrometery analysis of bioactive compounds present in different extracts of *Allium sativum*. *Asian J. Pharm. Clin. Res.* **11** (4): 280-286.

41. **Banaras, S.; Javaid, A.; Shoaib, A. and Ahmed, E. (2017):** Antifungal activity of Cirsium arvense extracts against phytopathogenic fungus *Macrophomina phaseolina*. *Planta Daninha.* **35**, 1-10.

42. **Begum, I. F.; Mohankumar, R.; Jeevan, M. and Ramani K. (2016):** GC–MS analysis of bio-active molecules derived from *Paracoccus pantotrophus* FMR19 and the antimicrobial activity against bacterial pathogens and MDROs. *Indian journal of microbiology.* **56** (4): 426-432.

43. **Seidel, V. and Taylor, P. W. (2004):** In vitro activity of extracts and constituents of Pelagonium against rapidly growing mycobacteria. *International journal of antimicrobial agents.* **23** (6): 613-619.

44. **Moorthy, V. and Boominathan M. (2011):** The antimicrobial activities of crude extracts and fraction of *Psidium guajava* and *Azadirachta indica* against *Staphylococcus aureus* in chronic disease affected patients. *International Journal of universal pharmacy and life sciences.* **1** (2): 2249-6793.

45. **Vadivel, E. and Gopalakrishnan, S. (2011):** GC-MS analysis of some bioactive constituents of *Mussaenda frondosa* Linn. *Inter. J. Pharm. Bio. Sci.* **2**: 313-320.

46. **Shareef, H. K.; Muhammed, H. J.; Hussein, H. M. and Hameed, I. H. (2016):** Antibacterial effect of ginger (*Zingiber officinale*) roscoe and bioactive chemical analysis using gas chromatography mass spectrum. *Oriental Journal of Chemistry.* **32** (2): 20-40.

الملخص العربي

المكونات المتطايرة لمخلفات لب البيتا فولجارس كمصدر للمنتجات الحيوية الطبيعية

محمد الحسينى صالح[] و هانى محمد عبد الوهاب[] و عادل محمد كمال الدين صابر[] و ريمون ميلاد زكى[] و ممدوح عبد المجيب محمد[]

[] *معهد بحوث وقاية النباتات –مركز البحوث الزراعية – الجيزة – مصر*

[] *قسم الكيمياء – كلية العلوم– جامعة اسيوط– اسيوط*

[] *قسم الكيمياء – كلية العلوم– جامعة المنصورة – المنصورة*

تحظى إعادة تدوير المخلفات الزراعية (بعض بقايا الخضروات) الناتجة من الصناعة إلى منتجات ذات قيمة مضافة ببالغ الأهتمام والتشجيع. حيث يمكن العثور على المركبات طبيعية النشأة ذات القيمة العالية فى خلاصات لب بنجر السكر. أدى تحليل الفصل الكروماتوجرافى/ طيف الكتلة للمواد الطيارة من خلاصتى الأثير البترولى (60-80 ^{o}م) وثنائى كلوريد الميثان للب بنجر السكر الى تعريف ثمانية وثلاثون مركباً عضوياً طياراً ذات أهمية بيولوجية عالية، تتبع هذه المركبات الطيارة فئات مختلفة من المنتجات الطبيعية مثل اسيتوجينينات (مشتقات دهنية) ، وتربينات نصف ثلاثيه ، واستيرودات، ومشتقات شيكيمات (مكونات فينولية). تم تعريف عدد اثنين وعشرون مركبا من خلاصة الإيثر البترولى حيث كانت المركبات السائدة هى n-Hexadecanoic acid (%42.79)، (Z,Z)-9,12-Octadecadienoic acid (%1.94)، Hexadecanoic acid methyl ester (%6.67)، (E)-8-Octadecenoic acid methyl ester (%5.40)، (Z,Z)- 9,12-Octadecadienoic acid methyl ester (%5.02) و (3β, 5α)-Stigmasta-7,16-dien-3-ol (%1.53). أثمرت خلاصة ثنائى كلوريد الميثان عن تعريف عدد ثلاثة وعشرون مركباً عضوياً. كانت المركبات السائدة من حيث التركيز هى 2-hydroxy-1-(hydroxymethyl) exadecanoic acid ethyl ester (%11.20)، (Z) 9-Octadecenal (%7.08)، Hexadecanoic acid methyl ester (%5.17)، 4-((1E)-3-Hydroxy-1-propenyl)-2-methoxyphenol (%4.37)، n-Hexadecanoic acid (%3.23)، (Z,Z)-9,12-Octadecadienoic acid methyl ester (%3.04)، (Z)-9-Octadecenoic acid methyl ester (%2.95) و (3ß, 24S) stigmast-5-en-3-ol (%2.00).