International Science and Technology Journal
المجلة الدولية للعلوم والتقنية
Volume 39 العدد
Part 2 المجلد
المجلة الدولية للعلوم والتقنية
International Science and Technology Journal
ISTJ

Extraction of Biochemical Compounds in Tree Type of Dates and Identification by LC-TOF-MS
http://www.doi.org/10.62341/istj-vol39-2-sm45

Received	**2026/11/01**	**تم استلام الورقة العلمية في**
Accepted	**2026/11/26**	**تم قبول الورقة العلمية في**
Published	**2026/11/27**	**تم نشر الورقة العلمية في**

Extraction of Biochemical Compounds in Tree Type of Dates and Identification by LC-TOF-MS

Sumayyah Sulayman Khalleefah Miftah
Faculty of Science - Department of Chemistry - University of Derna - Al-Qubba Branch - Libya
a0921907350@gmail.com

Abstract
In this study used methanol and chloroform solvents and tree type of dates at the ripening stage use of Liquid Chromatography–Time-of-Flight Mass (LC-TOF-MS) showed that the extraction using methanol and chloroform (50 % methanol: 50 % chloroform) in Khalas was able to extract 26 compounds followed by Rutab with 10 compounds while in Tamar only 17 compounds were extracted. The study the relationship in compounds extracted with polarity of solvents mixture from the scores and loadings plots. This study aims to discover high-molecular-weight compounds by using LC-TOF – MS and solvent-mixing apparatus.
Keywords: Dates, LC-TOF-MS, and solvents.

International Science and Technology Journal
المجلة الدولية للعلوم والتقنية
Volume 39 العدد
Part 2 المجلد
المجلة الدولية للعلوم والتقنية
International Science and Technology Journal
ISTJ

Extraction of Biochemical Compounds in Tree Type of Dates and Identification by LC-TOF-MS
http://www.doi.org/10.62341/istj-vol39-2-sm45

استخلاص المركبات البيوكيميائية في نوع شجرة النخيل وتشخيصها بواسطة LC–TOF–MS

سمية سليمان خليفة مفتاح
كلية العلوم – قسم الكيمياء – جامعة درنة – فرع القبة
a0921907350@gmail.com

الملخص

في هذه الدراسة، استُخدمت ثلاثة أنواع من التمور. وأظهرت تقنية "LC–TOF–MS" أن استخدام خليط من الميثانول والكلوروفورم (بنسبة 50% : 50%) مكّن من استخلاص 26 مركباً من تمور "الخلاص"، تليها تمور "الرطب" بـ17 مركباً، بينما تم استخلاص 10 مركباً فقط من تمور "التمر" تهدف هذه الدراسة الى اكتشاف مركبات ذات اوزان جزيئية عالية عن طريق استخدام جهاز LC–TOF–MS ، خلط المذيبات

الكلمات المفتاحية: التمور، تقنية "LC–TOF–MS"، تحليل المكونات الرئيسية.

1. Introduction

About 4000 years ago, date has been cultivated commercially in that it has been identified as the South of Iraq. In the ancient world were the East and African region large quantities of dates have been grown. The botanical name of the palms tree, Fenix dactyliferous. TMCS acts as a catalyst, increasing the power of the donor silyl (BSTFA) and assuring greater competence for the reaction. However, few reports have been found in the literature regarding the derivatization of GLY and AMPA using this combination of reagents (Farag et al, 2014). The study on the used of *N*,*O*-bis (trimethylsilyl)trifluoroacetamide (BSTFA) and N-(tert-butyldimethylsilyl)-*N* methyltrifluo-roacetamide (MTBSTFA) to derivatives the natural hormone estrone (E1) and the synthetic estrogen 17_ethinylestradiol (EE2). In the study of Ferrier and Thurman (2003), they focus on the importance of unequivocally detecting emerging contaminants, as well as establishing their presence in the environment by accurate mass spectrometric

http://www.doi.org/10.62341/istj-vol39-2-sm45

measurement techniques. A novel approach to studying the production of secondary metabolites by fungi using LC / TOFMS has been developed. Fungi grown on culture media are solvent-extracted and directly analyzed by LC / TOF-MS. Searching against a database of 465 secondary metabolites, mycotoxins and other compounds of interest can be readily identified. The methodology was validated by spiking culture media with 20 mycotoxin standards and identifying these toxins in the crude solvent extracts. Subsequently, using seven different fungi from culture collections, after culturing for 7 to 14 days in three different media, anticipated metabolites were readily identified. The review explained the unique features of these instruments and gives examples of their applications (Ferrer & Thurman, 2003). The use of liquid chromatography / mass spectrometry (LC-MS) methods for protein analysis is well acknowledged and has had a significant impact on understanding the complexities of biological systems. Less well publicized is the role that mass spectrometry has had in the characterization of expressed proteins in molecular biology laboratories .Al-farsi et al. (2011) conducted the extraction of phenolics and dietary fibre from date seeds and in their research, acetone 50 % and butanone were the most active solvents for extraction. The phenolic contents of seed concentrate to 18.10 % and 36.26 %, respectively. The total dietary fibre of seeds (57.87 g / 100 g) are larger after water and acetone extractions to 83.50 and 82.17 g / 100 g, respectively. Nine phenolic acids (free and liberated) were detected in seeds with *p*-hydroxybenzoic (9.89 mg / 100 g), protocatechuic (8.84 mg / 100 g), and *m*-coumaric (8.42 mg / 100 g) acids found to be among the highest, the total phenolic acid content improved considerably after extraction and purification from 48.64 to 193.83 mg / 100 g. The major phenolic acids found in the concentrates were protocatechuic, caffeic and ferulic acids.

2. Chemical Materials:

Methanol, chloroform were GC-grade solvents used and were purchased from Merck KGaA, 64271 Darmstadt, Germany while the reagents used include BSTFA (N,O-bis(trimethylsilyl)

http://www.doi.org/10.62341/istj-vol39-2-sm45

trifluoroacetamide) and 1% TMCS (trimethylchlorosilane) were produced from sigma-Aldrech.

3. Sampling

Three types of date fruits (Tamar, Rutab and Khalas) were purchased from supermarkets Al Qmae in Albatha

3.1.Sample Preparation

The samples were taken from three different types of date; Khalal, Rutab and Tamar tree type of dates at the ripening stage and the seed were removed then blended for homogenization, the number of samples is three.

3.2. Mixture Extraction

Methanol and chloroform were used for the extraction solvents of dates fruit. The usage of variety of solvents allows selecting the one with greatest ability to extract biochemical compounds in date fruits. The extraction was implemented by weighing 2 g of homogeneous sample and placed in beakers and each was drenched into 20 mL of solvent for 2 h at room temperature. The two mixture solvent design used for extraction is while the solvents used were prepared 50%methanol 50%chloroform. the solution was then filtered using Whatman filter paper No 1 before subjecting to rotary evaporator at 40 °C for concentration of the sample after which BSTFA was added for derivatization process befor sent LC-MS-TOF technique To improve the extraction yield and preserve compounds when placed in the device. After those the best mixture design solvents in extraction sample was taken separately from the different date types (Khalas, Rutab and Tamer) .

4. Results and Discussion

The compounds identification was performed by analyzing the LC, TOF and MS spectral pattern based on micro TOF-Q 86 source type ESI database library and comparison with literature data. Most of the possible compounds identified have intensity of about 23 - 283. The LC-TOF-MS results is shown in Appendices B from figure 17-19, and the corresponding compounds with their retention times, peak's area, molecular formula, molecular weights (MW), and Intensity in the tables

.

Extraction of Biochemical Compounds in Tree Type of Dates and Identification by LC-TOF-MS
http://www.doi.org/10.62341/istj-vol39-2-sm45

4.1. Methanol - Chloroform Extract Rutab (% 50 -% 50)

The extract of Methanol 50 % + Chloroform 50 % is presented in Table 1 and figure 1 with intense higher than 40. Eight of the intensity are prominent and include 4H – 6-methyl3,5-dihydroxy-2,3-dihydro – Pyran – 4-one (C6H8O4) with retention time of 2.13 min and intensity of 170; Tridecanoic acid (C13H26O2) with retention time of 2.13 min and intensity of 63; Stearic acid (C18H33O2) with retention time of 2.13 min and intensity of 193; 9,12-Octadecadienoic acid (Z,Z) (C18H32O2) with retention time of 3.08 min and intensity of 82; 5-o-caffeoylquinic acid (C16H17O9) with retention time of 12.86 min and intensity of 253; 3-o-caffeoylquinic acid (C16H17O9) with retention time of 13.53 min and intensity of 254; 4-o-caffeoylquinic acid (C16H17O9) with retention time of 22.38 min and intensity of 193; Sucrose (C12H20O11) with retention time of 22.95 min and intensity of 64 .

Table 1. Compounds detected in dates (Rutab) from Methanol - Chloroform Extract (50 % - 50%) using LC-TOF –MS.

N	Retention time min	Intense	Possible compounds	Type	Molecular formula	Molecular weight	Reference
1	2,14	50	6-methyl-3,5-dihydroxy-2,3-dihydro-4H-Pyran4-one	antioxidant activity	$C_7H_6O_3$	146	(Farag, M. A et al 2014)
2	2,14	187	Un	-	C15H20O10	360	(No ref)
3	2,14	63	O-Feruloylquinic acid	Fatty acid	C17H18O10	318	(Farag, M. A et al 2014)

Extraction of Biochemical Compounds in Tree Type of Dates and Identification by LC-TOF-MS

http://www.doi.org/10.62341/istj-vol39-2-sm45

N	Retention time min	Intense	Possible compounds	Type	Molecular formula	Molecular weight	Reference
4	2,14	330	Un	-	C30H38O20	702	(no ref)
5	2,14	100	Un	-	C30H42H20	723	(Farag, M. A et al 2014)
6	14,99	93	Narinerin methyl ether	Fatty acid	C16H13O15	286	(Farag, M. A et al 2014)
7	14,99	15	Catechin / epicatechin	Antioxidant	C15H13O16	7	g, M. A 2013)
8	14,99	50	O-dicaffeoylshikimic acid	Phenolic acid	C22H25O13	497	(Farag, M. A et al 2014)
9	14.99	30	Luteolinrhamnosylhexoside	Flavanoids	C27H29O13	593	(Farag, M. A et al 2014)
10	22,35	64	4-o-caffeoylquinic acid	Phenol acid	C16H1	353	(Farag, M. A

Extraction of Biochemical Compounds in Tree Type of Dates and Identification by LC-TOF-MS
http://www.doi.org/10.62341/istj-vol39-2-sm45

N	Retention time min	Intense	Possible compounds	Type	Molecular formula	Molecular weight	Reference
					7 O9		et al 2013)

4.2. Methanol - Chloroform Extract Tamar (50 %- 50 %)

The extract of Methanol 50 % + Chloroform 50 % is shown in Table 2 and figure 2 and consist of intense higher than30. Five of the intensity are prominent of which are 4H-6-methyl3,5-dihydroxy-2,3-dihydro-Pyran-4-one ($C_6H_8O_4$) with retention time of 2.14 min and intensity of 50; Narinerin methyl ether ($C_{16}H_{13}O_{15}$) with retention time of 14.99 min and intensity of 93; O-dicaffeoylshikimic acid ($C_{22}H_{25}O_{13}$) with retention time of 14.99 min and intensity of 50; Luteolinrhamnosylhexoside ($C_{27}H_{29}O_{13}$) with retention time of 14.99 min and intensity of 30; 4-o-caffeoylquinic acid ($C_{16}H_{17}O_9$) with retention time of 22.35 min and intensity of 64.

Table 2. Compounds detected in dates (Rutab) from Methanol-Chloroform Extract (50 % - 50%) using LC-TOF -MS

number	Retention time	Intense	Possible compounds	Type	Molecular formula	Molecular weight	Reference
1	2,13	170	6-methyl-3,5-dihydroxy2,3-dihydro-4H-Pyran-4one	antioxidant activity	$C_6H_8O_4$	146 g/mol	(Farag, M. A et al 2014)
2	2,13	63	Tridecanoic acid	Fatty acid	C 13 H 26 O 2	214	(Farag, M. A et al 2014)
3	2,13	193	Stearic acid	Fatty acid	C 18 H 33 O 2	219	(Farag, M. A et al 2013)
4	2,13	104	Un	-	C 15 H 21 O 2	233	(no ref)

Extraction of Biochemical Compounds in Tree Type of Dates and Identification by LC-TOF-MS

http://www.doi.org/10.62341/istj-vol39-2-sm45

number	Retention time	Intense	Possible compounds	Type	Molecular formula	Molecular weight	Reference
5	2,13	237	Un	-	C 16 H 24 O 2	248	(no ref)
6	2,13	40	Compesterol	Natural steroids	C $_{28}$ H $_{48}$ O	400	(Farag, M. A et al 2014)
7	3,08	82	9,12-Octadecadienoic acid (Z,Z)-	Fatty acid	C 18 H 32 O 2	280	(Rajeswari. B & Srinivasan. M., 2015)
8	3,08	40	Hydroxyoctedecadienoic acid	Fatty acid	C $_{18}$ H $_{31}$ O $_{3}$	294	(Mathavi. P et al., 2013)
9	3,08	40	(E)-9-Octade-cenoic acid ethyl ester	Fatty acid	C 20 H 38 O 2	310	(Rajeswari. B & Srinivasan. M., 2015)
10	12,86	253	5-o-caffeoylquinic acid	Phenolic acid	C 16 H 17 O 9	353	(Farag, M. A et al 2014)
11	13,53	254	3-o-caffeoylquinic acid	Phenolic acid	C 16 H17 O 9	353	(Farag, M. A et al 2014)
12	17,86	283	Un	-	C 17 H 18 O 10	318	(Farag, M. A et al 2014)
13	18,97	110	Un	-	C 20 H 24 O 11	441	(no ref)
14	20,90	195	Un	-	C 13 H 15 O 10	331	(Farag, M. A et al 2013)
15	22,38	193	4-o-caffeoylquinic acid	Phenolic acid	C 16 H 17 O 9	353	(Farag, M. A et al 2013)
16	22,95	64	Sucuroso	Sugar	C 12 H 20 O 11	340	(Farag, M. A et al 2014)

Extraction of Biochemical Compounds in Tree Type of Dates and Identification by LC-TOF-MS

http://www.doi.org/10.62341/istj-vol39-2-sm45

number	Retention time	Intense	Possible compounds	Type	Molecular formula	Molecular weight	Reference
17	22, 95	11 6	Un	-	C16H27 O10	37 9	(Farag, M. A et al 2014)

4.3. Methanol - Chloroform Extract Khalas (50 %- 50 %)

The extract of Methanol 50 % + Chloroform 50 % is shown in Table 3 and figure 3 consist of intensity higher than 50. 11 of the peak are prominent which are 4H-6-methyl-3,5dihydroxy-2,3-dihydro-Pyran-4-one ($C_6H_8O_4$) with retention time of 2.21 min and intensity of 354; Stearic acid ($C_{18}H_{34}O_2$) with retention time of 2.21 min and intensity of 105; Apigenin ($C_{15}H_{10}O_5$) with retention time of 2.21 min and intensity of 65; Tridecanoic acid ($C_{13}H_{26}O$) with retention time of 3.20 min and intensity of 50; phingolipid conjugate with retention time of 12.68 of min and intensity of 146; 5-ocaffeoylquinic acid ($C_{16}H_{17}O_9$) with retention time of 12.93 min and intensity of 72; 3o-caffeoylquinic acid ($C_{16}H_{17}O_9$) with retention time 13.45 min and intensity of 87;
Luteolinrhamnosylhexoside ($C_{27}H_{29}O_{15}$) with retention time of 16.52 min and intensity of 80; Isoqurcetrin ($C_{21}H_{20}O_{12}$) with retention time of 18.21 min and intensity of 157; 4-o-caffeoylquinic acid ($C_{16}H_{17}O_9$) with retention time of 22.65 min and intensity of 157; Sucrose (**$C_{12}H_{21}O_{11}$**) with retention timeof 23.13 min and intensity of 93; Luteolinrhamonsyldihexoside ($C_{33}H_{39}O_{20}$) with retention time of 23.13 min and intensity of 66.

Extraction of Biochemical Compounds in Tree Type of Dates and Identification by LC-TOF-MS

http://www.doi.org/10.62341/istj-vol39-2-sm45

Table 3: Compounds detected in dates (Khalas) from Methanol - Chloroform Extract (50 % -50%) using LC-TOF -MS

N	Retention time min	Intense	Possible compounds	Type	Molecular formula	Molecular weight	Reference
1	2,21	354	6-methyl-3,5-dihydroxy2,3-dihydro-4H-Pyran-4one	antioxidant activity	$C_6H_8O_4$	146	(Farag, M. A et al
2	2,21	105	Stearic acid	Fatty acid	C18 H34 O2	219	(Farag, M. A et al
3	2,21	72	Un	-	C14 H14 O3	230	(Farag, M. A et al
4	2,21	65	Apigenin	flavanoid	C15 H10 O5	266	(Farag, M. A et al
5	3,20	100	Un	-	C14H11O5	262	(Farag, M. A et al
6	3,20	109	Linolenic acid	-	C18H29O2	277	(Farag, M. A et al
7	3,20	50	Tridecanoic acid	Fatty acid	C13 H26 O2	214	(Farag, M. A et al

Extraction of Biochemical Compounds in Tree Type of Dates and Identification by LC-TOF-MS

http://www.doi.org/10.62341/istj-vol39-2-sm45

N	Retention time min	Intense	Possible compounds	Type	Molecular formula	Molecular weight	Reference
8	3,20	32	9,12-Octadecadienoic acid (Z,Z)-	Fatty acid	C 18 H 32 O 2	280	(Rajeswari. B &
9	3,20	61	Un	-	C10 H27 O11	294	(Farag, M. A et al
10	3,20	23	Corchoriftty acid	Fatty acid	C18 H25 O4	304	(Farag, M. A et al
11	3,20	44	Hydroxy octadecadienoic acid	Fatty acid	C18 H31 O3	312	(Mathavi. P
12	12,68	146	Sphingolipid conjugate	Fatty acid	C23H47 NO7P	480	(Farag, M. A et al
13	12,68	51	Chiysoeriolhexosyl	Phenolic acid	C28H31 O5	607	(Farag, M. A et al
14	12,93	72	5-o-caffeoylquinic acid	Phenol acid	C16 H17 O9	353	(Farag, M. A et al
14	13,45	87	3-o-caffeoylquinic acid	Phenol acid	C16 H17 O9	353	(Farag, M. A et al

Extraction of Biochemical Compounds in Tree Type of Dates and Identification by LC-TOF-MS

http://www.doi.org/10.62341/istj-vol39-2-sm45

N	Retention time min	Intense	Possible compounds	Type	Molecular formula	Molecular weight	Reference
15	13,45	50	Un	-	C17 H29 O5	427	(Farag, M. A et al
16	16,52	71	Un	-	C17H26O15	421	(no ref)
17	1652	80	Luteolinrhamnosylhexoside	Flavanoids	C27 H29 O15	593	(Farag, M. A et al
18	18,21	157	Isoqurcetrin	Antioxidant	C21H20O12	465	Mathavi. P et al., 2013)
19	18,95	114	Un	-	C20H24O11	441	(no ref)
20	20,89	77	Un	-	C17H21O10	385	(no ref)
21	22,65	157	4-o-caffeoylquinic acid	Phenolic acid	C16 H17 O9	353	(Farag, M. A et al
22	22,65	60	Un	-	C27H22O13	554	(no ref)

Extraction of Biochemical Compounds in Tree Type of Dates and Identification by LC-TOF-MS

http://www.doi.org/10.62341/istj-vol39-2-sm45

N	Retention time min	Intense	Possible compounds	Type	Molecular formula	Molecular weight	Reference
23	23,13	93	Sucrose	sugar	C12H21O11	340	(Mathavi. P et al., 2013).
24	23,13	198	Un	-	C15H23O11	379	(no ref)
25	23,13	57	Un	-	C15H24O11	380	(no ref)
26	23,13	66	Luteolinrhamonsyldihexoside	Flavanoids	C33H39O20	757	(Farag, M. A et al

The process of identifying in LC-TOF-MS; the extracted compounds have high molecular weight (MW) between 146-757 g/m such as Narinerin methyl ether Fatty acid (Farag et al., 2013); Catechin / epicatechi antioxidant (Farag et al., 2013); O-dicaffeoylshikimic acid Phenolic acid (Farag et al., 2014); Luteolinrhamnosylhexoside and 4-o-caffeoylquinic acid which were found in Tamar (Farag et al., 2013). Stearic acid biological activities include, 5-α reductase inhibitor, hypo cholesterolemic, suppository, cosmetic, lubricant, surfactant and softening agent, perfumery, propecic, flavor (Mathavi et al., 2013). Tridecanoic acid biological activities include; antioxidant, lubricant, Hypercholesterolemic, Cancer preventive, Cosmetic (Rajeswari & Srinivasan, 2015). 9, 12-Octadecadienoic acid (Z, Z)-. 5- Alpha reductase inhibitor (Rajeswari & Srinivasan, 2015) was found only in Rutab using LC-TOF-MS.

The Khalas the date was the best type of date in this study because it has many compounds which give several benefits to human health

Extraction of Biochemical Compounds in Tree Type of Dates and Identification by LC-TOF-MS

http://www.doi.org/10.62341/istj-vol39-2-sm45

such as Apigenin, Corchori fatty acid, Hydroxyoctadecadienoic acid, Sphingolipid conjugate, Chiysoeriolhexosyl, 5-o-caffeoylquinic acid, 3-o-caffeoylquinic acid, 4-o-caffeoylquinic acid, and Luteolinrhamonsyldihexoside.

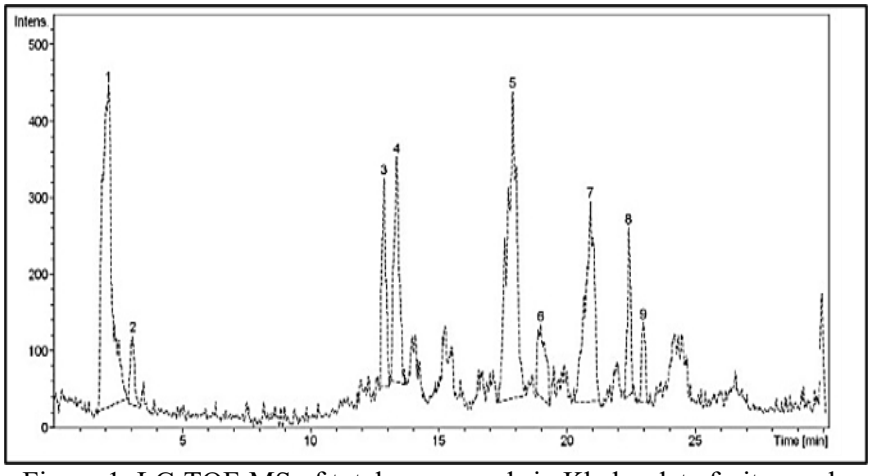


Figure 1: LC-TOF-MS of total compounds in Khalas date fruit sample extracted with Methanol - Chloroform (50 %- 50 %)

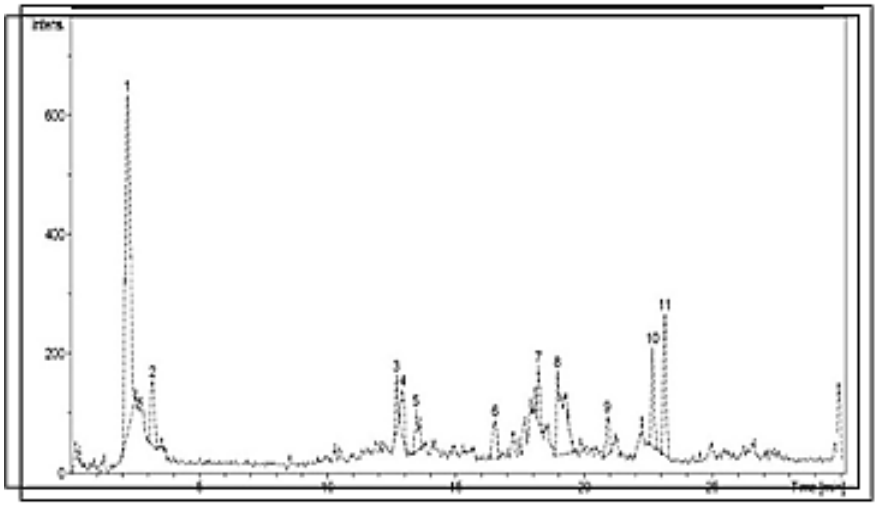


Figure 2: LC-TOF-MS of total compounds in Rutab date fruit sample extracted with Methanol - Chloroform (50 %- 50 %)

Extraction of Biochemical Compounds in Tree Type of Dates and Identification by LC-TOF-MS

http://www.doi.org/10.62341/istj-vol39-2-sm45

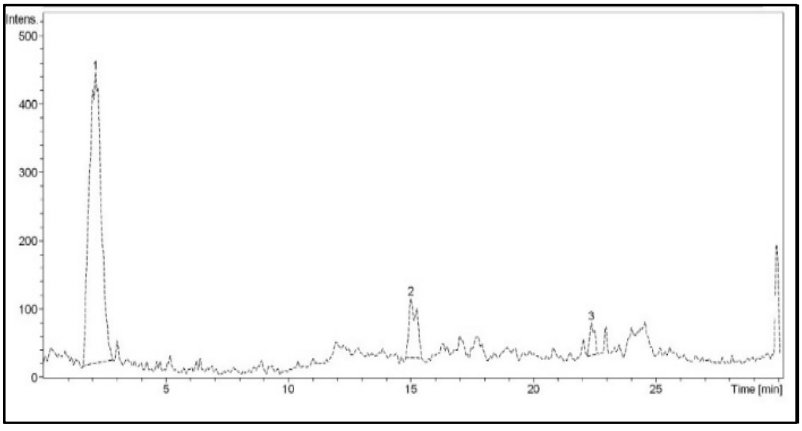


Figure 3: LC-TOF-MS of total compounds in Tamar date fruit sample extracted with Methanol - Chloroform (50 %- 50%)

5. Conclusion:

The results showed that by using LCTOF-MS with mixture design methanol and chloroform (50 % : 50 %), four major compounds high intense were 6-methyl-3,5-dihydroxy-2,3-dihydro-4H-Pyran-4-one; 5o-caffeoylquinic acid; 3-o-caffeoylquinic acid and linolenic acid, showed the relationship between compounds extracted with polarity of solvents mixture from the scores and loadings plots.

Recommendation: Thus, indicates that the three mixture design has potential to be used for extraction technique for dates recommendation for future studies mixing solvents in various proportions using new equipment to obtain new compounds.

References

[1] Abdel-Zaher, A., R. Abdel & F. Elwasei. 2010. “Blockade of Nitric Oxide Overproduction and Oxidative Stress by Nigella sativa Oil Attenuates MorphineInduced Tolerance and Dependence in Mice”. Neurochem Res. Vol. 35: p. 1557– 1565.

[2] Abdi, H. 2003. “Multivariate analysis” in Encyclopedia for Research Methods for the Social Sciences. M. Lewis-Beck, A. Bryman, T. Futing (ed.). Thousand Oaks, CA: Sage Publications. p. 669-702.

[3] Abdi, H. & L.J. Williams. 2010. "Principal component analysis". Wiley Interdisciplinary Reviews: Computational Statistics. Vol. 2. p. 433-459.

[4] Abdullah, S. E., M. T. Said & H. A. Mohammed. 2011. "Phenolic Contents and Antioxidant Activity of Various Date Palm (Phoenix dactylifera L.) Fruits from Saudi Arabia". Food and Nutrition Sciences. Vol. 2: p. 8.

[5] Adel, L. A. & N. B. Yassine. 2013. "Optimization of deglet-naur bate phenol extraction conditions". World Academy of Science, Engineering and Technology. Vol. 7: p. 691-694.

[6] Ahmed, I. A, A. W. K. Ahmed & Robinson. 1995. "Chemical composition of date varieties as influenced by the stage of ripening". Food Chemistry. Vol. 54: p. 305–309.

[7] Ahmed, J. A. Al-Musalla& S. N. Al-Hooti. 2013. "Isolation and characterization of insoluble date (Phoenix dactylifera L.) Fibers". Food Science. Vol. 50: p. 414419.

[8] Ahuja, S. 2003. Chromatography and separation science. Academic Press.

[9] Al-Farsi, M., C. Alasalvar, A. Morris, M. Barron & F. Shahidi. 2005. "Compositional and sensory characteristics of three native sundried date (Phoenix dactylifera L) varieties grown in Oman". Agricultural and Food Chemistry. Vol. 53: p. 75867591.

[10] Al-Farsi, M., C. Alasalvar, K. Al-Abid, M. Al-Shoaily, Al-Amry& F. Al-Rawahy. 2007. "Compositional and functional characteristics of dates, syrups and there byproducts". Food Chemistry. Vol. 104: p. 943-947.

[11] Ali, M. A. 2011. "Optimization of phenolics and dietary fibre extraction from date seeds". Food chemistry. Vol. 108: p. 977-985.

[12] Al-Redhaimani, K. N. 2005. "Chemical changes during storage of Barhi Dates under controlled Atmosphere Conditions". Horticulture science. Vol. 5: p. 1413-1415.

[13] Al-Shahib, W. & R. Marshall, 2002. "Dietary fiber content of 13 varieties of date palm (Phoenix dactylifera L.)". Journal of Food Science and Technology. Vol. 37: p. 719-721.

[14] Chandrasekaran, M. & A. H. Bahkali. 2012. "Valorization of date palm (Phoenix dactylifera) fruit processing by-products and wastes using bioprocess technology". Saudi Journal of Biological Sciences. Vol. 20: p. 105-120.

[15] Chavan, U. D. & R. Amarowicz. 2013. "Effect of various solvent systems on extraction of phenolics, tannins and sugars from beach pea (Lathyrus maritimus L.). International Food Research Journal. Vol. 20: p. 1139-1144.

[16] Farag, M., H. A. Gad & A. G. Heiss. 2014. "Metabolomics driven analysis of six Nigella species seeds via UPLC-qTOF-MS and GC–MS coupled to chemometrics. Food chemistry. Vol. 151: p. 333-342.

[17] Ferrer, I. & E. M. Thurman. 2007. "Multi-residue Method for the Analysis of 101 pesticides and their degraders in food and water samples by liquid chromatography/time-of-flight mass spectrometry". Journal of Chromatography. Vol. 1175: p. 24-37.

[18] Ferrer, I. & E. M. Thurman. 2010. "Analysis of sucralose and other sweeteners in water and beverage samples by liquid chromatography/time-of-flight-mass spectrometry.

[19] Mathavi, P., S. Nethaji & Velavan. 2013. "GC-MS Analysis of Phytocomponents in the Methanolic Extract of Shorea Robusta". International Journal of Science and Research. Vol. 6014: p. 2319-7064.

[20] Noura, V., I. Trandafirb& C. Cosmulescua. 2014. "Antioxidant capacity, phenolic compounds and minerals content of blackcurrant (Ribes nigrum L.) leaves as influenced by harvesting date and extraction method. Industrial Crops and Products. Vol. 53. p. 133-139.