Al-Qadisiyah Journal For Agriculture Sciences (QJAS)
ISSN : 2618-1479 Vol.11, Issue. 2 ,(2021), pp. 126-136
https://jouagr.qu.edu.iq/

Analytical Study of Phytochemicals and Antioxidant Activity of Pollen (Typha Domingensis Pers.) Extracted from The Papyrus Plant and Its Use in Cake Enrichment

Nareman Adeem Shnaa Aljazy [a)] , Alaa R. Abdulstar [b)] and Jinan Mohammed Fayyad Alrakabi

Department of Food Science, College of Agriculture, University of Basrah, Iraq.

[a)] *nareman.shnaa@uobasrah.edu.iq*
[b)] *Corresponding Author: alaa.abdull_sattar@uobasrah.edu.iq*

Received : 2/12/2021
Acceptance : 29/12/2021
Available online: 31/12/2021

Abstract. The pollen (typha domingensis pers.) of the papyrus plant is one of the foods rich in minerals and active chemical compounds, known for its important properties. This study came to determine those chemical compounds and the possibility of including pollen in the development of suitable cake formulations. The active compounds in the three pollen extracts (aqueous, ethanol, and hexane) were determined by gas chromatography connected to a mass spectrometer (GCMS), The total content of flavonoids and the antioxidant activity by free radicals DPPH was estimated by hydrogen donation for all chemical extracts, The mineral elements were estimated by Inductively Coupled Plasma Mass Spectrometry (ICP-MS) as well as studying the sensory properties of pollen cake. The results showed that pollen contains many active compounds such as gamma.sitosterol, catechol, propionic acid, phenols and palmitoleic acid. The highest total flavonoids content was at the concentration of 75 mg/ml, as it ranged between 99 mg/ml for the ethanolic extract and 98 mg/ml for the aqueous and hexane extract. The pollen extracts showed that they had a good ability to inhibit free radical DPPH by donating hydrogen , the results showed that there were no significant differences in the percentage of inhibition of the extracts , which amounted to 83% ,79% and 76% for hexane ,ethanol and aqueous extracts at a concentration of 75mg/ml .The results showed that the pollen contained a good content of calcium, potassium, magnesium and zinc, which amounted to (19.794, 23.620, 4.578 and 0.08) g/L, respectively. Sensory evaluation also showed excellent potential of pollen when used as a functional ingredient in cake making.

Keywords. Unique Cake, Antioxidants, Bardy pollen, Active compounds.

I. INTRODUCTION

Bardy (papyrus) , also known as cattail , It is a long –stemmed perennial plant with spear –shaped leaves that belongs to the *typhaceae* family . It is iconic marsh plants in basrah , southern Iraq. Bardy pollen (*typha domingensis pers.*) is a high –energy nutritional material rich in vitamins , minerals and active compounds such as phenols and flavonoids , known for its free radical scavenging properties and protecting our bodies from oxidative damage , the most cause of many diseases . Flavonoids are the most important among many of the antioxidant compounds and it also contributes to the antimicrobial properties of pollen [1]. Bardy (typha *domingenisis pers*) is a concentrated phytonutrients that has antioxidant properties and powerful potential for treating mercury – contaminated water [2]. Studies have paid great attention to pollen in the remedies of polluted wastewaters as it is a low cost environmentally friendly and highly effective technique in absorbing heavy metal ions and accumulating them in the roots and leaves [3]. Papyrus pollen is used as a therapeutic agent to chelate excess iron in the body which causes oxidative stress which is the main factor in many diseases such as neurodegenerative and cancer [4] . Papyrus pollen is an important source of natural antioxidants and phenolic compounds that possess glucosidase inhibitor activity .Glucosidase inhibitors represent the first line of remedy for type 2 diabetes patients . These inhibitors can impede glucose absorption in the small intestine , thus reducing the rise in blood glucose [5]. It is always mentioned that the antioxidants in our body help neutralize the free radicals and prevent them from causing harmful effects and this promotes overall health .From a nutritional point of view , various plant substances such as beta-carotene ,vitamin C. phenols and flavonoids prevent oxidative reactions catalyzed by oxygen and peroxides . In addition , antioxidants in general and flavonoids in particular play a vital role in food preservation technology . Flavonoids are water –soluble, golden –yellow pigments . They are powerful antioxidants that sacrifice their electrons to free radicals and make them more stable , thus inhibiting the chain of oxidative reactions that end in damage to the food composition or spoilage and formation of unacceptable flavors [6] , and that flavonoids and phenolic compounds are the most important chemical compounds and to which many unique properties of pollen are attributed . In the Mesopotamian marshes , specifically in Basrah and Maysan ,

DOI: 10.33794/qjas.2021.132392.1017.

Bardy - cattail *typha domingensis* pers.(the source of pollen) grows automatically and pollen contains many biologically active compounds such as alkaloids , tannins , saponins glycosides and flavonoids [7] .In addition , *typha domingensis* was dominates on the warm wetlands of Florida in the south of the United States of America [8]. Pollen is also called the marsh treasure or yellow gold , as it was introduced into the food industry as a sweetener substance and is also used in the production of delicious sweets called "Khairat". It is a therapeutic food substances famous for its manufacture in the marshlands by collecting pollen grains from spikes and then putting it on a mat under the sun's rays .After that , the process of steam cooking is done after mixing it with a small amount of sugar and placing it in a specialized cloth at the top of a container containing water and when exposed to water vapour it becomes agglomerated , then it is broken into small pieces and sold , and there is a strong demand for its purchase [9]. Pollen has been widely introduced into the food industry . Historically , pollen consumption dates back to 1933 and 1911 . In china and southern Iraq , pollen was combined with honey and sold as a candy[10] . In addition , The marshes of Iraq and Iran are also the original source of typha pollen . Typha pollen is a life-giving food , rich in antioxidants and potent plant compounds . The flavonoids in pollen not only give the nutritional value of the food only , but also give distinctive golden colors to the products included in its composition . There is also another advantage of food pollen derivatives , which is that they are free of gluten . Therefore , it is perfectly suitable for patients who suffer from disorders and health problems due to gluten sensitivity , and that improving their health depends mainly on reducing gluten in their lifestyle . Researchers have paid great attention to special products to meet their requirements [11, 12]. The aim of this study was to evaluate the antioxidant activity of pollen extracts and to develop suitable Partial replacement of gluten cake formulations for patients with gluten sensitivity by substituting wheat flour for pollen flour to obtain high-quality products from a nutritional and sensory point of view, As well as reviving traditional knowledge and studying it scientifically to enrich this agricultural treasure and make it more appreciated.

II. MATERIALS AND METHODS

- *Material of Pollen Papyrus*

Pollen flour *typha domingensis pers*. was purchased from the popular markets in Basrah governorate , southern Iraq.

- *Preparation of Pollen Papyrus Extracts*

Pollen ethanolic, aqueous and hexane extract prepared by weighing 10g of pollen powder with 100ml ethanol solution (800ml /liter of distilled water), then the mixture was placed in a shaking incubator at 40 C , Then use a quality paper to filter the extract and then rotary evaporator until the extract is completely dry, it is kept at 4°C until testing [13] .

- *Diagnostics of Active Compounds Using Mass Spectrometry Gas Chromatography*

The active compounds in pollen extracts identified by a gas chromatograph connected to a Mass Spectrometer , GC-MS analysis was carried out at the Basra oil company Laboratory, by using an Agilent Technologies , 7890B GC system coupled to an Agilent Technologies 5977A MSD with EI Signal detector , using HP-5ms 5% phenyl , 95% methyl siloxane (30m*250um*0.25) , the oven temperature was set at 40 C hold for 5 min then raised to 10C/min to 300 C for 20 min , Helium carrier gas flow rate was 1 ml/min and purge flow 0f 3 ml/min . The injection mode was pulsed Split less with injection temperature 290 C and the injection sample volume was 1 micro letter. The mass spectrometer used Ion Source Temperature 230 C , With scan speed 1562(N_2) , and the mass range 44-750 m/z , Data was run through the NIST 2014 ,and Wiley 9 Library data base as an additional tool to confirm identity of compounds.

- *Metal Detection Using ICP-OES OPTIMA 8300 Perkinelmer (Inductively Coupled Plasma Optical Emission Spectroscopy)*

The mineral elements in pollen powder were estimated by ICP-OES OPTIMA 8300 DV (Perkin-Elmer, Waltham, Massachusetts, USA) in accordance with [14] , The sample was diluted 20 once before the measurement process.

- *Gluten Test*

Gluten test was performed according to [15] , 25 g of pollen flour weighed and 15 ml of water was added to it and kneaded into a ball that was placed in a glass of water for an hour and then the ball washed under a stream of calm water until the starch was removed, after which the percentage of residual gluten was calculated by the following relationship

$$\text{Percentage of residual gluten \%} = \frac{\text{Weight of the remaining dough}}{\text{Total sample weight}} \times 100$$

DOI: 10.33794/qjas.2021.132392.1017.

- *Determination of The Amount of Flavonoids*

A method followed [16, 17] . For the determination of flavonoids in aqueous , alcoholic and hexane pollen extracts by dissolving 8.5, 12.5 ,25,50,75 mg/ml . Also , the rutin standard solution was prepared in ethanol with concentrations from 10 to 160 mg/ml , and depending on the graphic relationship between rutin concentration and absorbance at a wavelength 430nm, The amount of flavonoids in the extracts was calculated by drawing the standard curve between the absorbance reading for each concentration of rutin to get the straight line equation through which the amount of flavonoids in pollen extracts was calculated .

- *DPPH Radical Scavenging Assay (DPPH . RSA)*

The ability of typha pollen to scavenge free radical DPPH (2,2 Diphenyl-1-picryl-hydrazyl) was measured by reacting 0.5 ml of pollen extract(8.5, 12.5 ,25,50,75 mg/ml) with 0.3 ml of ethanol with 0.3 ml (0.5 mM DPPH , and the mixture was incubated at 45 minutes at room temperature , after which the absorbance was read at 517 nm using a spectrophotometer [18] ,Then it calculated by the following relationship: {1- [Abs sample / Abs control] } × 100

- *Manufacture of Pollen Cake*

The cake mix was prepared in an electric mixer with the addition of eggs ,oil ,milk , backing powder, sugar , then placed in a preheated electric oven at a temperature of 180 C for 40 minutes. The mixture prepared with wheat flour without pollen (sample A) as control , and (sample B)by replacing 50% of the wheat flour with gluten-free pollen flour and pollen grains occupied in the third sample C 75% . The sensory and structural evaluation of the cake was conducted through the sensory acceptance form , which consisted of 5 qualitative characteristics, namely color , texture ,appearance ,odor and taste , with the participation of 100 tasters and depending on what they prefer [19].

- *Statistical Analysis*

The Statistical Package of Social Sciences (SPSS) software package (version 26.0) was used to analyze all scientific experiment data in three replicates and the data were evaluated using one-way ANOVA and the results were considered statistically significant at ($p < 0.05$).

III. RESULTS AND DISCUSSION

- *Diagnostics of Active Compounds in Gas Chromatography–Mass Spectrometry*

All extracts contained many bioactive compounds that identified by GC-MS and differenced in their percentage according to the type of solvent. All extracts share with some bioactive compound as , gamma .sitosterol , catechol , propionic acid , phenols , palmitoleic acid. The results show the appearance of 49 peaks representing the active compounds in the aqueous extract of pollen , as the compound n-Hexadecaneoic acid appeared with a percentage of 14.16% at the peak 38 and a retention time 23.724 , followed by the compound 2,3,1-Benzodiazaborine ,1,2-dihydrro-1-methyl at a percentage of 8.7005 in the peak 25 and with a retention time of 14.045.The results diagnosed with GC –Mass revealed the dominance of the following active compounds in ethanolic extracts : linolaidic acid with a percentage of 38.2431% in the peak 16 and a retention time of 25.343 , as well as the compound n-hexadecanoic acid with a percentage 22.9509% at the peak 15 and a retention time of 23.681 , while other classes of compounds contributed small percentage , such as gamma –sitosterol 2.6354% at the peak 23 and catechol by 1.0231% at the peak 11, As for the hexane extract , appeared 23 peaks , and the 9,12 octadecandienoic acid z-z compound occupied the highest percentage of 40% at the peak 17.

TABLE 1. Active compounds present in the aqueous extract.

Peak	R.Time	Area	Area Pct.	Compound
1	4.819	3167129	0.5699	Ethyl aminomethylformimidate
2	5.332	1900134	0.3419	3H-Pyrazol-3-one, 1,2-dihydro-5-methyl
3	6.217	3807699	0.6852	Pyridine
4	6.576	826398	0.1487	2-Butanone, 4-hydroxy-3-methyl
5	7.023	9521448	1.7133	1-Octen-3-ol
6	7.389	44758518	8.054	Hexanal, 2-ethyl
7	8.634	936891	0.1686	6-Methyl-2-pyridinecarbaldehyde
8	8.7	819825	0.1475	4,4,6-Trimethyl-3,7,9-trioxabicyclo[4.2.1]nonane

DOI: 10.33794/qjas.2021.132392.1017.

Peak	R.Time	Area	Area Pct.	Compound
9	9.681	14471655	2.6041	Furan, tetrahydro-3-methyl
10	10.45	4366110	0.7857	2-Furancarboxaldehyde, 5-methyl
11	11.006	1765453	0.3177	Formic acid phenyl ester
12	11.284	18551422	3.3382	1,4-Benzenediamine, 2-methyl
13	11.929	25655677	4.6166	Benzeneacetaldehyde
14	12.038	7287226	1.3113	Cyclohexanol, 2,6-dimethyl
15	12.163	2386550	0.4294	1-Hexyne, 5-methyl
16	12.302	1548038	0.2786	2-Nonanone
17	12.588	4001483	0.72	Propanoic acid, 2-mercapto-2-methyl
18	12.712	15460973	2.7821	Pyrazine, 3-ethyl-2,5-dimethyl
19	13.005	18553173	3.3385	Furaneol
20	13.115	3125620	0.5624	2,3-Pentadienoic acid-, ethyl ester
21	13.452	3006238	0.541	6,8-Dioxabicyclo[3.2.1]octan-4-one, oxime
22	13.591	1623152	0.2921	1H-Azonine, octahydro
23	13.664	1887006	0.3396	Decanal dimethyl acetal
24	13.737	3938253	0.7087	endo-2-Aminonorbornane
25	14.045	48351082	8.7005	2,3,1-Benzodiazaborine, 1,2-dihydro-1-methyl
26	14.704	10019071	1.8029	Hexane, 2,3,4-trimethyl
27	15.509	32504725	5.849	1,3-Propanediamine, N,N-dimethyl
28	16.066	6577011	1.1835	N-Formyl-dl-alpha-aminobutyric acid
29	16.227	1736020	0.3124	3,4-Diethylphenol
30	16.3	10785951	1.9409	Pyrazine, 2,5-dimethyl-3-(3-methylbutyl)
31	16.966	5055730	0.9097	Piperidine, 1-methyl
32	18.365	8697530	1.5651	Pyridine, 2-phenyl
33	19.719	5883398	1.0587	4-Pyridinamine, 2,6-dimethyl
34	21.865	6647628	1.1962	Bicyclo[2.2.1]hept-2-ene, 2-methyl
35	22.831	12898671	2.321	2H-imidazole-2-thione, 1,3-dihydro-4-(2-methylpropyl)
36	23.475	13996811	2.5186	Benzoic acid, 3,5-dihydroxy
37	23.636	11558239	2.0798	Pyrrolo[1,2-a]pyrazine-1,4-dione, hexahydro-3-(2-methylpropyl)
38	23.724	78693531	14.1604	n-Hexadecanoic acid
39	24.105	5341557	0.9612	9H-Pyrido[3,4-b]indole, 1-methyl
40	25.328	30531092	5.4939	9,12-Octadecadienoic acid (Z,Z)
41	26.089	7247423	1.3041	9,12-Octadecadienoic acid (Z,Z)
42	26.697	24840018	4.4698	Hexadecane, 2,6,10,14-tetramethyl
43	27.056	8997464	1.619	9-Octadecyne
44	28.315	11768422	2.1177	Heptadecane
45	29.824	2555750	0.4599	Eicosane
46	31.09	5994870	1.0787	Nonacos-1-ene
47	32.664	2681609	0.4825	Fumaric acid, pent-4-en-2-yl tridecyl ester
48	32.921	4522551	0.8138	Fumaric acid, pent-4-en-2-yl tridecyl ester
49	35.71	4477175	0.8056	gamma.-Sitosterol

DOI: 10.33794/qjas.2021.132392.1017.

Al-Qadisiyah Journal For Agriculture Sciences (QJAS)
ISSN : 2618-1479 Vol.11, Issue. 2 ,(2021), pp. 126-136
https://jouagr.qu.edu.iq/

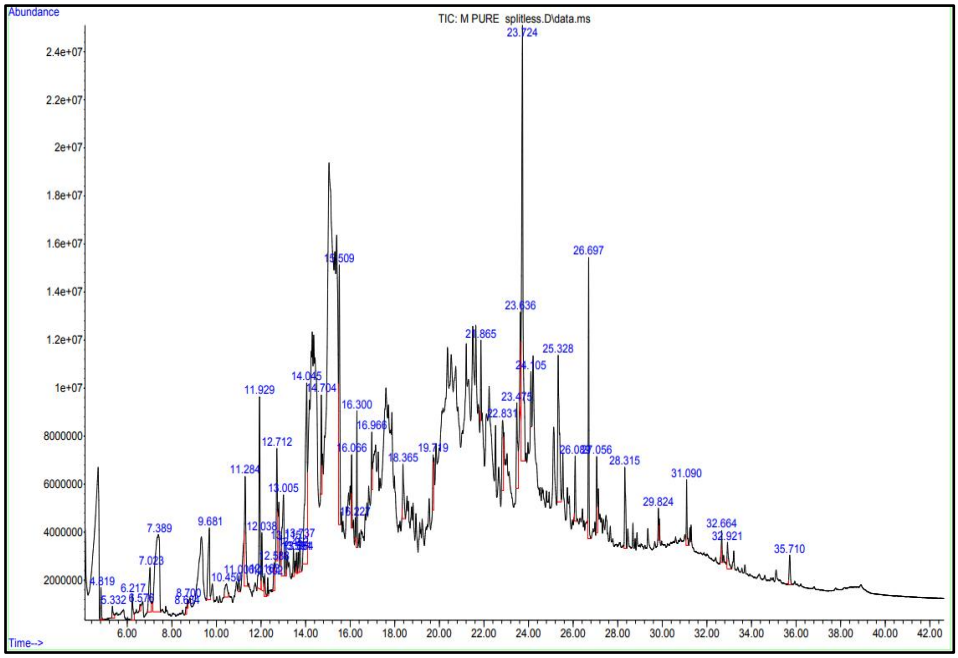

FIGURE 1. Active compounds present in the aqueous extract.

TABLE 2. Active compounds present in the ethanolic extract.

Peak	R.Time	Area	Area Pct.	Compound
1	5.947	8961302	2.2677	Methylamine, N,N-dimethyl
2	6.276	2318977	0.5868	Acetamide, oxime
3	6.364	9578522	2.4239	Urea, methyl
4	7.697	3908906	0.9892	3,5-Dimethylpyrazole
5	10.01	3301952	0.8356	3-Azabutyl-1-ol, O-acetyl-4-cyclopropyl-N,N-dimethyl-, bromide
6	11.482	26632860	6.7396	Pentanal, 2,4-dimethyl
7	11.826	2735827	0.6923	3-Methylcyclopentane-1,2-dione
8	12.493	8738986	2.2115	2,5-Dimethylfuran-3,4(2H,5H)-dione
9	12.785	2994154	0.7577	Mequinol
10	12.99	2603621	0.6589	Hexanal, 2-ethyl
11	14.748	4042868	1.0231	Catechol
12	15.143	6695583	1.6944	5-Hydroxymethylfurfural
13	17.706	2036356	0.5153	2,6-Difluoro-.alpha.-methylbenzyl alcohol, acetate
14	21.557	2221674	0.5622	Tetradecanoic acid
15	23.681	90694498	22.9509	n-Hexadecanoic acid
16	25.343	15112457	38.2431	Linoelaidic acid
17	25.526	6409083	1.6219	Octadecanoic acid
18	25.723	5857163	1.4822	9,12-Octadecadienoic acid (Z,Z)
19	26.06	4188473	1.0599	9,12-Octadecadienoic acid (Z,Z)
20	27.034	9432822	2.387	Z-1,6-Tridecadiene
21	28.454	11153924	2.8226	Hexadecanoic acid, 2-hydroxy-1-(hydroxymethyl)ethyl ester
22	29.831	16934382	4.2854	9,12-Octadecadienoic acid (Z,Z)-, 2,3-dihydroxypropyl ester
23	35.711	10414108	2.6354	.gamma.-Sitosterol
24	35.937	2187171	0.5535	Tris(tert-butyldimethylsilyloxy)arsane

Al-Qadisiyah Journal For Agriculture Sciences (QJAS)
ISSN : 2618-1479 Vol.11, Issue. 2 ,(2021), pp. 126-136
https://jouagr.qu.edu.iq/

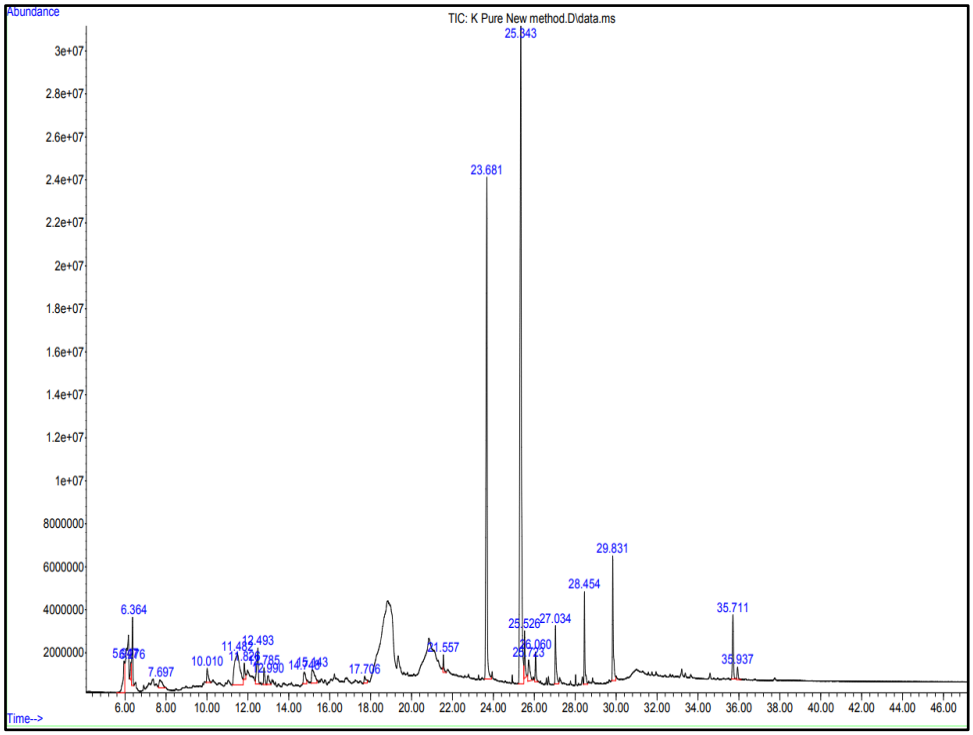

FIGURE 2. Active compounds present in the ethanolic extract.

TABLE 3. Active compounds present in the hexane extract.

Peak	R.Time	Area	Area Pct.	Compound
1	5.8	4077538	1.2788	Methylamine, N,N-dimethyl
2	6.005	3288122	1.0313	Hydrazine, 1,1-dimethyl
3	6.218	4927581	1.5454	N-Nitrosodimethylamine
4	6.305	8676767	2.7213	Urea, methyl
5	6.488	2370343	0.7434	Propanoic acid
6	7.067	1349955	0.4234	N-Methylpivalamide
7	9.944	2828595	0.8871	3-Azabutyl-1-ol, O-acetyl-4-cyclopropyl-N,N-dimethyl-, bromide
8	11.402	21472513	6.7344	Butane, 1,4-dimethoxy
9	11.797	2556883	0.8019	2-Cyclopenten-1-one, 2-hydroxy-3-methyl
10	12.471	7068785	2.217	2,5-Dimethylfuran-3,4(2H,5H)-dione
11	12.785	2498777	0.7837	Mequinol
12	12.961	2563009	0.8038	1,4-Dioxane-2,6-dimethanol
13	14.726	3985785	1.2501	Catechol
14	15.158	4746753	1.4887	5-Hydroxymethylfurfural
15	21.55	1466634	0.46	Tetradecanoic acid
16	23.666	68435815	21.4635	n-Hexadecanoic acid
17	25.335	1298483	40.7242	9,12-Octadecadienoic acid (Z,Z)
18	25.526	6101841	1.9137	9,12-Octadecadienoic acid (Z,Z)
19	27.027	6967951	2.1854	Linoleic acid ethyl ester
20	28.447	8576883	2.69	Hexadecanoic acid, 2-hydroxy-1-(hydroxymethyl)ethyl ester
21	29.831	13537452	4.2457	9,12-Octadecadienoic acid (Z,Z)-, 2,3-dihydroxypropyl ester
22	35.71	9578497	3.0041	.gamma.-Sitosterol
23	35.937	1923203	0.6032	1,4-Bis(trimethylsilyl)benzene

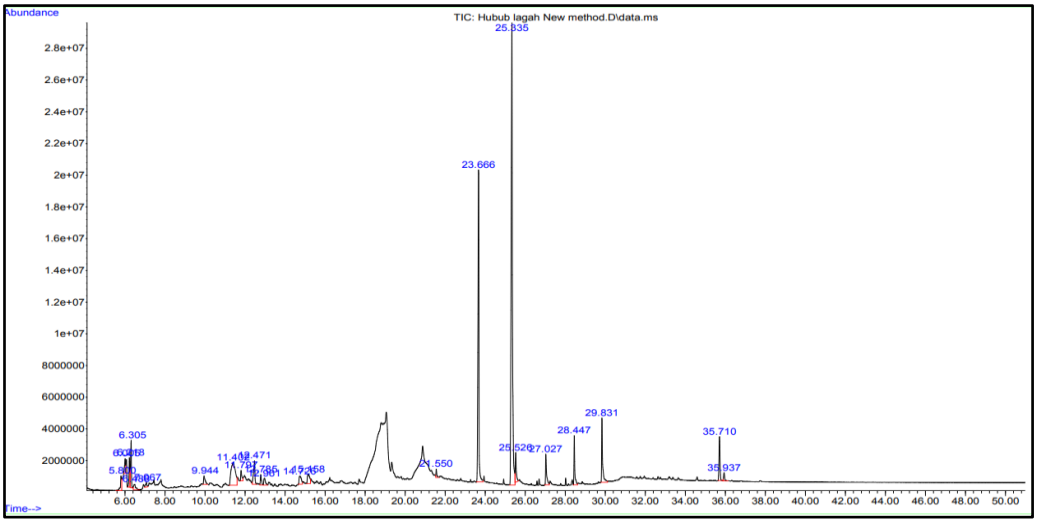

FIGURE 3. Active compounds present in the hexane extract.

- *Metal Detection Using ICP-OES OPTIMA 8300 PERKINELMER (Inductively Coupled Plasma Optical Emission Spectroscopy)*

The results in Table 4 indicated a high percentage of calcium, where it reached after multiplication by dilution factor (20 Once) to 19.794 g/L, as well as a high percentage of potassium 23.620 g /L, while magnesium was 4.578 g /L and zinc was 0.080 g /L . These results were the highest found by [20], this may be due to the soil quality and water environment of the Iraqi marshes rich in mineral elements. This gives a good indication of pollen from a nutritional point of view in providing the body of important metallic elements.

TABLE 4. Mineral elements in pollen *typha domingensis.*

Metallic Elements	Amount g/L
Arsenic (AS)	0.005
Calcium (Ca)	19.794
Cadmium (Cd)	0.0004
Chromium (Cr)	0.002
Copper (Cu)	0.007
Iron (Fe)	0.086
Magnesium (Mg)	4.578
Manganese (Mn)	0.108
Nickel (Ni)	0.005
Potassium (K)	23.620
Sodium (Na)	2.300
Strontium (Sr)	0.037
Zinc (Zn)	0.080

- *Gluten Test*

The test Result showed that the gluten mass did not remain after washing and the paste melting with the washing water . This indicates that the flour is free of gluten and does not combine with more water.

DOI: 10.33794/qjas.2021.132392.1017.

FIGURE 4. Stages of washing pollen paste under water.

- *Determination of The Amount of Flavonoids*

Natural antioxidants , especially flavonoids , are one of the most appropriate tradeoffs to avoid the consequences of oxidation and deterioration of food products when compared to industrial antioxidants and their health problems , in addition to forming a distinctive color imprint in the products included in their composition . On the other hand ,they enhance the nutritional value and health benefits [1, 21]. Through the standard curve of rutin , the amount of flavonoids present in aqueous , ethanol, and hexane pollen extracts was calculated , as shown in the following figure 5 **.** The results in Figure 6 showed a clear convergence in the flavonoid content ranged between 95-99 mg/ml for the three extracts (ethanol, aqueous and hexane) at concentration 50 and 75 mg/ml , as the ethanolic extract gave the highest content of flavonoids that reached 99 and 97 mg/ml at concentrations 75 and 50 mg/ml. respectively, compared to the rest of the concentrations of the other extracts. While the aqueous extract recorded the highest concentration (74, 40, 38) mg/ml at 25, 12.5, 8.5 mg/ml respectively, These results were approach what was reached [7] , it was found that the total content of flavonoids for the pollen extract was 71.3 mg total flavonoid in each 50 gm of pollen.

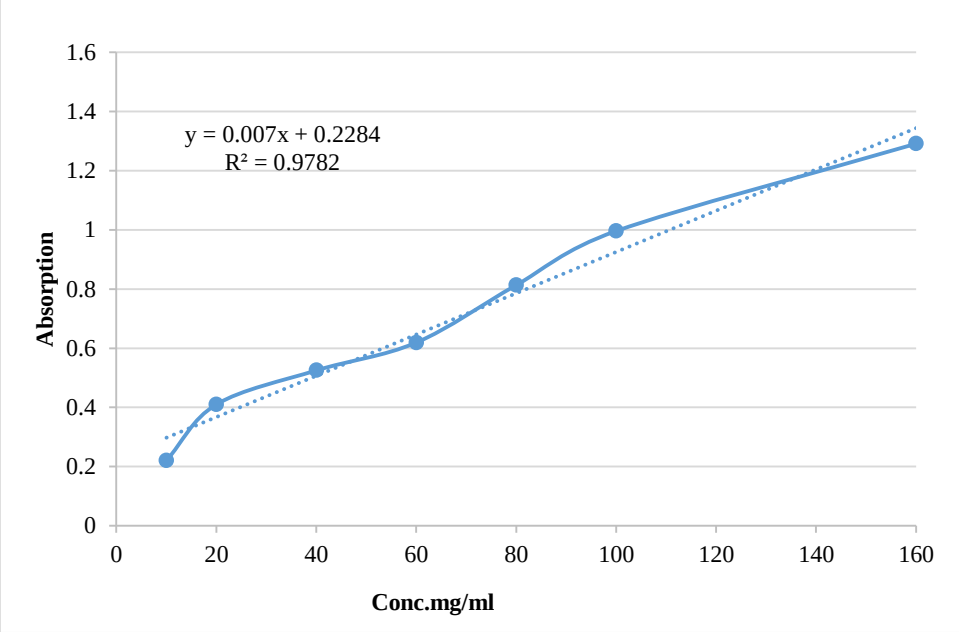

FIGURE 5. Standard curve of Rutin.

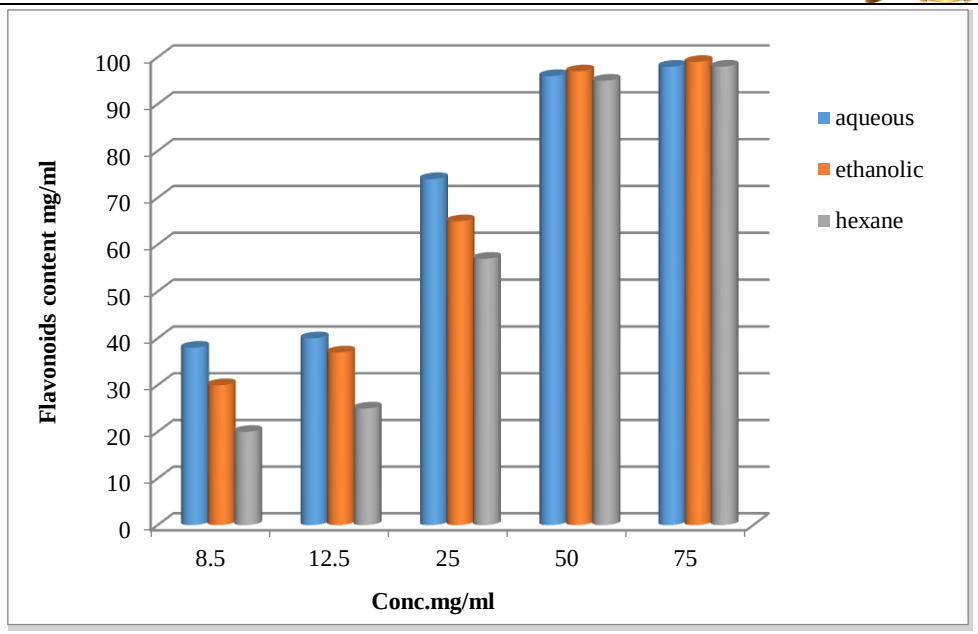

FIGURE 6. Flavonoids content of pollen extracts.

- *DPPH Radical Scavenging Assay*

The antioxidant activity of pollen was evaluated using DPPH reagent , which is an unstable free radical that is converted to diphenyl-1-picrylhydrazine-2,2 by reacting with the hydrogen –donated pollen extract .This led to the disappearance of the purple color and the formation of a yellow color and a decrease in the absorption value at 715 . Pollen extracts showed good inhibition of DPPH roots, this ability increased with increasing concentration. The highest percentage of DPPH inhibition was at 75 mg/ml (83, 79 and 76 %) for the extract (hexane, ethanol, and aqueous) respectively, while the concentration is 8.5 mg / ml, the lowest inhibition rate was (60, 55 and 45)% for the extract (hexane, ethanol, and aqueous), respectively, This is consistent with what was indicated by [7] that pollen has the ability to inhibit DDPH radical of a percentage of 36.21% at a concentration of 250 µg/ ml.

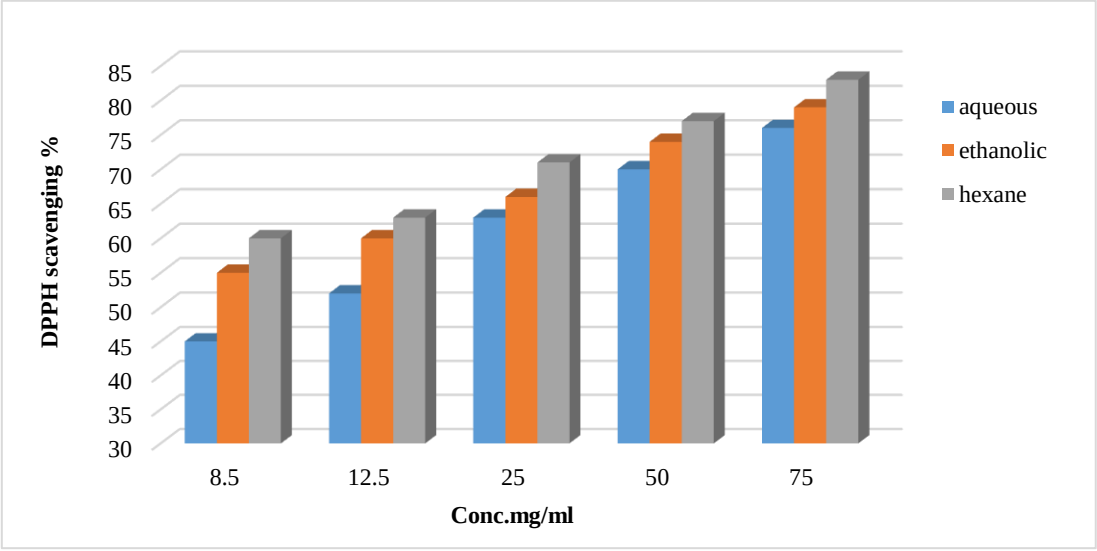

FIGURE 7. DPPH Scavenging by pollen extracts (aqueous , ethanol and hexane).

- *Manufacture of Pollen Cake*

Wheat flour was replaced by pollen flour at 50% for sample B and 75% for sample C when making the sponge cake. Compared with the pollen-free sample A, the sensory test results showed significant differences in the color trait of the samples under study where the sample B and C were distinguished by a golden color Unique compared to sample A, the

sensory test results also showed unique characteristics of sample B and C in terms of odor and flavor with a significant difference from sample A, the incorporation by 75% led to a significant decrease in the degree of cake cohesion and this is due to the lower percentage of Glutein in sample C compared to the rest of the sample. This is consistent with what was indicated by [22] that the partial replacement of wheat flour with avocado seed flour by 75% had a significant effect on the sensory properties of the processed cake, as it gave it a bitter taste, a fragrant smell, a somewhat rough texture and a brown color compared to the control sample.

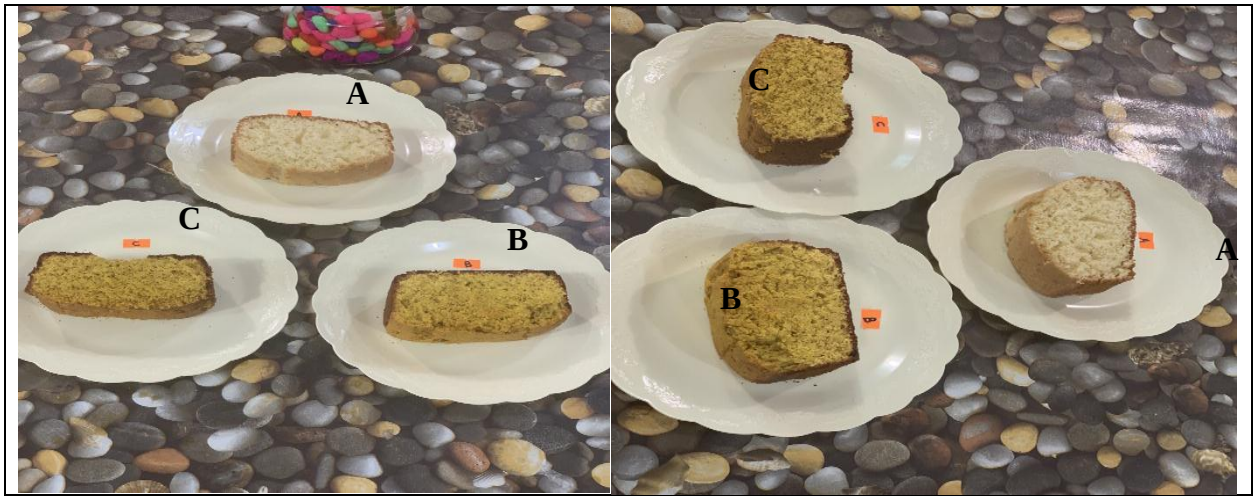

FIGURE 8. A/ pollen free cake , B / cake containing 50% of pollen , C/ cake containing 75 % of pollen.

TABLE 5. Sensory evaluation form.

Treatment	Color	Textures	Appearance	Odor	Taste	Total
A	13.3 ±0.55 b	18.5 ±0.45 a	17.2 ±0.62 a	15.2±0.46 b	17.5 ±0.47 b	81.7 ± 1.22 b
B	19.1 ±0.23 a	18.3 ±0.39 a	18.5 ±0.50 a	19.3±0.26 a	19.2 ±0.20 a	94.4 ±0.87 a
C	18.3 ±0.42 a	16.3 ±0.55 b	17.7 ±0.47 a	13± 0.29 c	14.1 ±0.37 c	79.4 ±0.88 b

CONCLUSION

Typha domingensis pers .pollen is an important food source that contains the most important antioxidant compounds and vital minerals important in enhancing the body's immunity, The available research that can be cited on this subject is very little. Pollen extracts are distinguished by their high content of bioactive compounds such as gamma .sitosterol , catechol , propionic acid , phenols , palmitoleic acid As well as its good content of flavonoids and minerals important for the human body, pollen extracts showed good inhibition of DPPH radicals, and this ability increased with increasing concentration. , With this research paper, we were able to conclude that it is possible to develop suitable cake mixes with low gluten content with up to 75% pollen to meet the needs of a range of people with gastrointestinal disorders or partial gluten sensitivity. Replacing wheat flour with pollen flour did not partially affect the spongy texture or appearance of the cake, especially on treatment B (50% pollen cake) This is consistent with what was indicated by [23] that the partial replacement of wheat flour pearl with millet flour showed a significant change in the rheological properties compared with the control sample, But incorporation by 75% led to a significant decrease in the degree of cake cohesion and this is due to the lower percentage of gluten. From a functional point of view, the presence of pollen in cake ingredients gives it a longer shelf life due to the presence of antioxidant flavonoids that break the chain of reactions that cause fat oxidation and quality deterioration, so industrial antioxidants can reward in protection and delay food spoilage. Finally, more work needs to be done to evaluate the efficiency and bioavailability of the pollen extract in vivo.

ACKNOWLEDGMENTS

The authors would like to thanks Basrah University , the marsh research center marshes and Dr. Sabah Kadhum Al-Hummod for their support and assistance in carrying out this research.

REFERENCES

[1] Al-Kalifawi , E. J., Al-Azzawi, Y. J. , Al-Fartousi , K. K. and Mezher, H. 2017. Physicochemical, phytochemical profiling and Biological activities of leaves extract of Bardy (Typha domingensis Pers.) from Al-Chibayish marshes in southern Iraq (pp. 128–143).
[2] Gomes, M. V. T., de Souza, R. R., Teles, V. S., & Mendes, É. A. 2014. Phytoremediation of water contaminated with mercury using Typha domingensis in constructed wetland. Chemosphere, 103, 228–233.
[3] Hegazy, A. K., Abdel-Ghani, N. T., & El-Chaghaby, G. A. 2011. Phytoremediation of industrial wastewater potentiality by Typha domingensis. International Journal of Environmental Science & Technology, 8(3), 639–648.
[4] Heli, H., Mirtorabi, S., & Karimian, K. 2011. Advances in iron chelation: an update. Expert opinion on therapeutic patents, 21(6), 819–856.
[5] Tundis, R., Loizzo, M. R., & Menichini, F. 2010. Natural products as α-amylase and α-glucosidase inhibitors and their hypoglycaemic potential in the treatment of diabetes: an update. Mini reviews in medicinal chemistry, 10(4), 315–331.
[6] Liu, H., Mou, Y., Zhao, J., Wang, J., Zhou, L., Wang, M., … Yang, F. 2010. Flavonoids from Halostachys caspica and their antimicrobial and antioxidant activities. Molecules, 15(11), 7933–7945.
[7] Karbon, M. H., Azeez, R. J., Mohammed, Z. Y., & Hasan, A. N. Y. 2019. Phytochemical properties and antioxidant activity of pollen typha domingenisis pers . grown marshes of maysan governorate southern of Iraq. Journal of Global Pharma Technology, 11(9), 564–570.
[8] Smith, S. G. 2000. Titleyphaceae. In: Flora of North America Editorial Committee (eds.), Flora of North America. vol. 22. Oxford University Press, New York-Oxford:278-285. http://www.efloras.org/florataxon.aspx?flora_id=1&taxon_id=134063.
[9] Lakshmi, K. S., Sailaja, V. H., & Reddy, M. A. 2017. Phytoremediation-a promising technique in waste water treatment. International Journal of Scientific Research and Management (IJSRM), 5(06), 5480–5489.
[10] Morton, J. F. 1975. Cattails (Typha spp.)—weed problem or potential crop. Economic Botany, 29(1), 7–29.
[11] Gomes, L. de O. F., Santiago, R. de A. C., Carvalho, A. V., Carvalho, R. N., Oliveira, I. G. de, & Bassinello, P. Z. 2015. Application of extruded broken bean flour for formulation of gluten-free cake blends. Food Science and Technology, 35, 307–313.
[12] Conte, P., Del Caro, A., Balestra, F., Piga, A., & Fadda, C. 2018. Bee pollen as a functional ingredient in gluten-free bread: A physical-chemical, technological and sensory approach. LWT, 90, 1–7.
[13] de Florio Almeida, J., dos Reis, A. S., Heldt, L. F. S., Pereira, D., Bianchin, M., de Moura, C., … da Luz, C. F. P. 2017. Lyophilized bee pollen extract: A natural antioxidant source to prevent lipid oxidation in refrigerated sausages. LWT-Food Science and Technology, 76, 299–305.
[14] ASTM, D. (1976). 07 2007. Standard Test Method for Elements in Water by Inductively-Coupled Argon Plasma Atomic Emission Spectroscopy. West Conshohocken, PA, DOI: 10.1520/D1976-07.
[15] PN-77/A-74041. 1977. Ziarno zbóż i przetwory zbożowe - Oznaczanie ilości i jakości glutenu. Polski Komitet Normalizacyjny, Warsaw, Poland.
[16] Djeridane, A., Yousfi, M., Nadjemi, B., Boutassouna, D., Stocker, P., & Vidal, N. 2006. Antioxidant activity of some Algerian medicinal plants extracts containing phenolic compounds. Food chemistry, 97(4), 654–660.
[17] El-Baky, H. H. A., El Baz, F. K., & El-Baroty, G. S. 2009. Production of phenolic compounds from Spirulina maxima microalgae and its protective effects. African Journal of Biotechnology, 8(24), 7059-7067.
[18] Brand-Williams, W., Cuvelier, M.-E., & Berset, C. 1995. Use of a free radical method to evaluate antioxidant activity. LWT-Food science and Technology, 28(1), 25–30.
[19] A.A.C.C. 2002. Approved Method of American Association of Cereal Chemists, published by American Association of Cereal Chemists, Ins. St.Paul, Minnesota, USA.
[20] Charpentier, M. 1996. Comer del monte: volver amis, o un paso adelante. Cuadernos Agroforestales 1. Productos Forestales No Madereros. Desarrollo Agroforestal y Comunidad Campesina 20:59-66.
[21] Aljazy, N. A. S. & Abdulstar, A. R. 2021. Potential Effects Of Natural Antioxidants In The Treatment Of Some Viral Diseases : Review. Al-Qadisiyah Journal For Agriculture Sciences (QJAS), 11(2).
[22] Puspitasari, M., Hasri, R. N., & Wahyuni, T. 2021. The Substitution of Avocado Seed Flour to Rice Flour in the Manufacture of Traditional Palembang Food Gandus Cake. In First International Conference on Health, Social Sciences and Technology (ICOHSST 2020) (pp. 37-40).
[23] El Tanahy, H. H., Sharoba, A. M., Ghazal, G. A., Abd Elmola, E. M., & Zamzam, E. H. 2021. Improve the Nutritive Value of Produced Cake by Replacement Wheat Flour with Pearl Millet Flour. Food Biotechnology, 445-454