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Metabolomics and Biological Activities of Residual Parts from Some Egyptian Green Vegetables

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SEARCHING for natural alternatives to replace the synthetic pharmaceuticals, investigations for active metabolites ith biological activities in different plant parts (seeds, grains, fruits, peels of fruits, roots, rhizomes and green vegetables) are always of great importance and interest. As an example of the nutritional leafy vegetables, *Corchorus olitorius* and *Portulaca oleracea* are widely distributed and eaten by many countries. These plants constitute the material of interest in this study. Extraction of the leafy vegetables was carried out by methylene chloride: methanol mixture (2:1 v/v). The extract was subjected to analyse their antioxidant and anticancer efficiencies. Three methods were used for antioxidant activity determination including DPPH (2,2-diphenylpicrylhydrazyl), ABTS (2,2'-azino-bis(3-ethylbenzothiazoline-6-sulfonic acid), and $KMnO_4$ (potassium permanganate). *P. oleracea* extract showed the greatest antioxidant activity by the three methods (86.55, 82.75 and 97.62%, respectively) compared to both *C. olitorius* (75.98, 57.02 and 34.98% respectively) and standard ascorbic acids (76.42, 73.93 and 99.09% respectively) at 100 µg/ml. *C. olitorius* extract exhibited highest cytotoxicity against HepG2 (Human liver cancer cell line) compared to both *P. oleracea* and the anticancer drug Doxorubicin. Gas chromatography/Mass spectroscopic analysis revealed that the leafy vegetable extracts contain 15 and 18 phytochemical compounds (in *P. oleracea* and *C. olitorius*, respectively) and the monounsaturated fatty acid oleic acid was the major constituent with 42-44.69%. The active groups in the phytochemicals were analyzed by FTIR technique. From this study, we recommend *P. oleracea* extract to be used as source of antioxidant agents, while *C. olitorius* extract can be considered as an anticancer active vegetable.

Keywords: Antioxidant activities, Common Purslane, *Corchorus olitorius*, Nalta jute, *Portulaca oleracea*, Residues extract.

Introduction

Scientific researchers are encouraged to look for natural alternatives, examining their biological activities and purchasing their modes of action for the benefit of humanity due to the rapid development in ailments and the heavy utilization of synthetic pharmaceuticals. Because plant-derived chemicals have a variety of biological functions and action mechanisms (Larçin et al., 2015; Slima et al., 2021; Mokhtar et al., 2023), there have been some investigations on the metabolites found in seeds, grains, fruits, legumes, roots, rhizomes, and green vegetative parts of commercial plants that have been extracted using water or chemicals (Abdel-Farid & El-Sayed, 2021; Elwakf et al., 2022; Gaballa et al., 2022; Soliman et al., 2022).

Leafy vegetables are sources of nutritional constituents comprising proteins, dietary fibres, vitamins, minerals and natural antioxidants (Van Jaarsveld et al., 2014; Sarker et al., 2015; Sivakumar et al., 2018; Campanaro et al., 2019; Sarker & Oba, 2019; Sergio et al., 2020). *Corchorus olitorius* and *Portulaca oleracea* are examples of those nutritional leafy vegetables.

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Corchorus olitorius (Linn.), a member of the Malvaceae family, is native to tropical Africa and Asia and has since spread throughout the entire planet. (Ekpe et al., 2021; Ghellam et al., 2022). It is also known as Molohiya or Molochas in Turkey and Cyprus, Malukhiyah in North Africa and the Middle East, Ewedu to the Yoruba in Nigeria, Ayoyo in Northern Ghana, saluyot in the Philippines, and Jute Mallow in English-speaking nations (Ekpe et al., 2021).

Without knowing the phytochemical components, their leaves are consumed and utilised extensively in traditional medicine because of beliefs in their great nutritional and therapeutic efficacy against various illnesses and disorders (Abdul et al., 2017). The plant parts of *C. olitorius*, such as the leaves, stems, roots, barks, and seeds, have been shown through a number of investigations to include polysaccharides, flavonoids, phenolics, cardiac glycosides, sterols, fatty acids, triterpenoids, and ionone (Khan et al., 2006). Additionally, because of its remarkable worth and contribution to the economies of the associated nations, *C. olitorius* is a plant that is widely used (Mibei et al., 2012). Its fresh or dried leaves is also used in soups or broths in many Arab and African regions (Giro & Ferrante, 2016; Alimi et al., 2017). According to FAO (2021), they are used to produce fibres in textiles and their by-products are involved in paints, cosmetics, medicine, and others.

C. olitorius leaves were utilised by the Egyptians and Indians 2500 years ago to treat fever, laryngitis, diarrhoea, and vomiting (Islam, 2012, 2013). Later, they were employed in folk medicine to treat aches and pains, tumours, enteritis, fever, dysentery, and pectoral pain (Zakaria et al., 2006) along with infertility, breakouts, cuts, boils, bug bites, and swellings (Soladoye et al., 2014). *C. olitorius* leaves have been reported to be a good source of bioactive compounds like vitamin C, α-tocopherol, and phenols such as chlorogenic acid, quercetin glycosides, caffeic acid, isorhamnetin (Ghellam et al., 2022). Also, studies showed that *C. olitorius* has a wide range of therapeutic applications, including the treatment of malignancies, gonorrhoea, chronic cystitis, and discomfort (Abu-Hadid et al., 1994), cardiovascular, antihistaminic, hepatobiliary, renal, anticonvulsant, antiesterogenic, antimalarial, and hematological changes (Khan et al., 2006), hypoglycemic (Abo et al., 2008; Abdel-Wahhab et al., 2015), anti- inflammatory and analgesic (Nishiumi et al., 2006; Owoyele et al., 2015), antiobesity (Wang et al., 2003; Wang et al., 2011), gastroprotective (Al Batran et al., 2013) and wound healing effects (Barku et al., 2013).

Portulaca oleracea L. (common purslane) is an important herbaceous annual plant of the family Portulacaceae Juss. It has a thick, grass-like stem, succulent leaves, tiny white or yellow flowers, and tiny black seeds. Although it originated in South America and Africa, it is now widely grown around the world in tropical and subtropical areas (Ocampo & Columbus, 2012; Rahimi et al., 2019). The Latin origin of the term Portulaca indicates that the plant's milky fluid is present. Additionally, it is known as Rudravanti in Hindi, Dahna in Oriya, and Nuner in Kashmiri. It is also known as Rigla in Egypt, Purslane in the United States and Australia, Pigweed in England, Pourpier in France, Ma-Chi Xian in China, and Ma-Chi Xian in China. (Elkhayat et al., 2008; Mubashir et al., 2011).

Since ancient times, it has been utilised as traditional food and folk medicine around the world (Iranshahy et al., 2017; Chugh et al., 2019). Native societies used it to treat a variety of ailments, including diabetes, urinary infections, kidney and cardiovascular problems, diarrhoea, headaches, ulcers, and stings from snakes and insects (Faruque et al., 2019; Rahimi et al., 2019; Nemzer et al., 2020). Additionally, it functions as a febrifuge, diuretic, antiseptic, anti-spasmodic, and vermifuge (Lee et al., 2012).

According to the World Health Organization, one of the most often used medicinal plants is *Portulaca oleracea L*., also known as "Global Panacea" (Lim & Quah, 2007). When used frequently and judiciously, it can replace expensive pills, vitamins, and even some medications (Farghaly et al., 2012). Several studies show that *P. oleracea* contains many biological active compounds (oxalic acids, omega-3-fatty acids, coumarins, flavonoids and cardiac glycosides) which give its high nutritional (Uddin et al., 2014; Nafea, 2017; Petropoulos et al., 2019; Montoya-Garcia et al., 2023) and medicinal (Chowdhary et al., 2013; Miraj, 2016; Chugh et al., 2019) values. It also has phytoremediation properties and aesthetic value (Ashrafi et al., 2015), range of pharmacological effects, including analgesic, anti-bacterial, skeletal muscle-relaxant, wound-healing (Lee et al., 2012), antibacterial (Zhang et al., 2002;

El-Sayed et al., 2019), antiulcerogenic (Karimi et al., 2004), anti-inflammatory (Chan et al., 2000), antioxidant (Chen et al., 2012; El-Sayed et al., 2019), radical scavenger (Askari et al., 2016), anti-convulsant (Shakeri et al., 2015) and wound-healing properties (Rashed et al., 2003), as well as antidiabetic, antiulcerogenic, and anticancer activities (Yan-Xi Zhou et al., 2015). Because of all those properties, *Portulaca oleracea* L. is one of the most popular medicinal plants and is known as a "Global Panacea" by the World Health Organization (Lim & Quah, 2007).

This study aimed to assess the phytochemical components and biological effects of organic extract from leftover *Corchorus olitorius* and *Portulaca oleracea* parts as antioxidant and anticancer agents, as well as the potential use of these plants' leftover parts as natural substitutes.

Materials and Methods

Plant samples

Vegetative parts of *C. olitorius* and common purslane were collected from agriculture fields of Agriculture research center (ARC), Giza, Egypt.

Chemicals and reagents

2, 2 diphenyl-1-picrylhydrazyl (DPPH), 2,2'-azino-bis (ethylbenzthiazoline-6-sulfonic acid ($ABTS^{+}$), Doxorubicin (DOX), quercetin, gallic acid and ascorbic acid were obtained from Sigma-Aldrich (St. Louis, MO, USA).

Cell lines

Human hepatocellular cancer cell line (HepG-2) was obtained from and cultured in Vacsera (Giza, Egypt).

Samples extraction

The vegetative plant components were gathered, dried by air, and then ground individually into a fine powder. According to Rossenthaler's 1930 procedure, each dried powder (100g) was extracted three times with a 2:1 v/v methylene chloride: methanol combination. For each plant used, the extracts were mixed and condensed to create a dry crude extract.

Phytochemical screening for each extract

Detection of alkaloids

Alkaloids test was performed using both Wagner's and iodine tests according to the method of Shaikh & Patil (2020).

Three mL from the extract was added to 2 drops of Wagner's reagent along the sides of the test tube. The result will appear brown/reddish precipitate when positive.

Three mL extract solution was mixed with 5 drops of iodine solution in a test tube. The mixture will appear blue in color, which disappears on boiling and reappears on cooling when positive result.

Detection of Flavonoids

Flavonoids were detected using 4 different tests following the procedures of Shaikh & Patil (2020).

In alkaline reagent test, 1mL of each extract was added to 2mL of 2% NaOH solution and a few drops of dil. HCl. The positive result showed an intense yellow color, which becomes colorless with the addition of diluted acid.

In lead acetate test, 1mL of each plant extract was added to a few drops of 10% lead acetate solution. Yellow precipitate will be observed in positive result.

In Ammonia test, each extract was added to solution containing 5mL dil. Ammonia solution and conc. H_2SO_4. Yellow color will appear as a positive result.

In Conc. H_2SO_4 test, each plant extract was added to conc. H_2SO_4. The positive result will have an orange color.

Detection of Phenolic compounds

Ferric chloride test was carried out according to Shaikh & Patil (2020).

Each extract was added to a few drops of 5% ferric chloride solution. The positive result has a dark green/bluish-black color.

Determination of phytochemical compounds

Determination of total phenolic compounds

Phenolic compounds were evaluated using the method of Singleton & Rossi (1965). 750µL of Folin Ciocalteu reagent (10%) was mixed with 100µL of each extract (jute and purslane extracts). After 3min, 750µL of saturated sodium carbonate solution (6%) was added to each mixture and kept in the dark for 1.5h. The absorbance was measured using a spectrophotometer at 725nm. Phenolic

contents were estimated based on the standard curve of gallic acid.

Determination of total flavonoids

Flavonoids compounds were estimated using the method of Zhishen et al. (1999). 125µL of each extract (jute and purslane) was mixed with 75µL of $NaNO_2$ (5%) and incubated for 6 min. Then, 150µL $AlCl_3$ (10%, w/v) was added to each mixture. After 5min, 750µL NaOH (1M) was also added to the solutions and then incubated in the dark for 15min. The solutions were mixed well, and the absorbance was measured against a blank at 510nm using spectrophotometer. Quercetin was used as standard compound for the preparation of calibration curve.

Determination of biological activities

Antioxidant activity methods

DPPH radical assay

Antioxidant activity of jute and purslane extracts were determined following the method of Burits & Bucar (2000). One milliliter of each extract was separately mixed with 1mL of a DPPH solution (0.03% w/v in methanol). For 30min in dark at room temperature. The absorbance of the solutions was measured using spectrophotometer at 517nm. Control was prepared by the same procedure deprived of extract. Ascorbic acid (0.03%, w/v) was utilized as a natural antioxidant standard. Radical scavenging activity (%) was estimated by the following equation:

Scavenging activity (%) = [(A control − A sample)/ A control] ×100

ABTS radical assay

The 2,2'-Azino-bis (3-ethylbenzothiazoline-6-sulfonic acid) ABTS assay was carried out as described by Re et al. (1999). The radical prepared by mixing equal volume (1/1, v/v) from ABTS (7mM) and potassium persulfate and leave the mixture in the dark at room temperature from 4 to 16 h until the reaction was completed and the absorption was stable. After incubation, The ABTS solution was diluted with distilled water to an absorbance of 0.700 ± 0.05 at 734 nm. Estimation has been made by mixing 0.9 ml of ABTS solution and 0.1 ml of each extract for 45 sec. then after 1 min the absorbance was recorded. Ascorbic acid (0.03%, w/v) was used as a natural antioxidant standard. Calculate the decrease of absorption by the following equation:

Activity (%) = [(Ac − At) / Ac] ×100

where, Ac and At are the absorption of ABTS and tested extract

$KMnO_4$ as non-radical assay

The scavenging effects of crude extract of jute and purslane were performed according to Gaber et al. (2021). A mixture of 1mL of 0.02M $KMnO_4$ solution (in methanol) was added to a test tube with equal amount of each extract. Each mixture was vortex for 1min and kept at room temperature in dark for 30min. The absorbance of all the sample solutions and ascorbic acid (as natural antioxidant standard) were measured at 514nm. The percentage (%) of scavenging activity was determined as the following:

% Antioxidant activity= (control−sample×100)/ control

where the control is $KMnO_4$ solution (0.02M).

Anticancer activity

Cell culture

Cells were maintained in RPMI-1640 supplemented with 100µg/mL streptomycin, 100 units/mL penicillin and 10% heat-inactivated fetal bovine serum in a humidified, 5% (v/v) CO_2 atmosphere at 37ºC (Freshney, 2002).

Cytotoxicity assays

The cytotoxicity of crude extracts was tested against HepG-2 cells using SRB assay as reported by Freshney (2002).

Exponentially growing cells were gathered using 0.25% Trypsin-EDTA and plated in 96-well plates at 1000-2000 cells/well. Cells were subjected to each extract for 72h and then fixed with TCA (10%) for 1h at 4ºC. After several washings, cells were subjected to 0.4% SRB {sulforhodamine B (SRB), 2-(3-diethylamino-6-diethylazaniumylidene-xanthen-9-yl)-5-sulfo-benzenesulfonate} solution in dark place for 10 min. In addition, the cells were washed with 1% glacial acetic acid. After drying overnight, the SRB-stained cells were washed with Tris-HCl and the color intensity was measured at 540 nm. Doxorubicin (DOX) was used as anticancer standard.

Identification of active groups and active ingredients

Fourier transform infrared (FTIR) spectrometer analysis

In order to investigate the functional groups involved in the secondary metabolites in each plant extract of jute and purslane, FTIR analysis was carried out. Infrared spectra of both extracts were analyzed. The samples were added to KBr disc. Infrared spectra were obtained using a FTIR spectrometer {Perkin Elmer FTIR spectra (system 2000) USA within a scanning range of 400–4000cm^{-1}.

Phytochemical Screening using GC/MS

GC-MS analysis was performed to identify and quantify the separated active compound. The chemical composition of each plant extract (jute and purslane) was performed using GC-MS QQQ 7890B GC system mass spectrometer (Agilent) with a direct capillary column HP–5MS UI (30 m × 0.25 mm × 0.25 µm film thickness). The components were identified by comparison of their retention times and mass spectra with those of WILEY 09 and NIST 11 mass spectral database.

Statistical analysis

Data were subjected to an analysis of variance and the means were compared using the least significant difference (LSD) test at 0.05 and 0.01 levels as recommended by Snedecor & Cochran (1982) using SPSS version 22.0 computer program.

Results and Discussion

In present study, jute and purslane individual extracts show biological activities such as antioxidant and anti-cancer activities as they contain wide variety of secondary metabolites. *C. olitorius* and *P. oleracea* are a biochemical factory as it contains multitude of active ingredients or secondary metabolites such as phenolic compounds, flavonoids, alkaloids, plant acids and glycosides.

Phytochemical screening

The presence of bioactive components such as alkaloids, phenolics, and flavonoids was detected in the preliminary phytochemical screening of *P. oleracea* and *C. olitorius* extracts (Table 1). Alkaloids, phenolics, and flavonoids are all present in *P. oleracea* extract, however only phenolics and flavonoids are found in *C. olitorius* extract, as shown in the table below.

TABLE 1. Phytochemical screening of *Portulaca oleracea* and *Corchorus olitorius* individual extracts

Compounds/ test	Plant extract	
	Corchorus olitorius	*Portulaca oleracea*
Alkaloids		
Wagner's	-	+
Iodine	-	+
Phenolics and flavenoids		
Alkaline reagent	+	+
Lead acetate	+	+
Ammonia	+	+
Conc. H_2SO_4	-	-

+: present; -: absent

The preliminary qualitative screening for phytochemicals of *Corchorus olitorius* and *Portulaca oleracea* individual extracts revealed that there are different natural products present in Portulaca oleracea extract, such as alkaloids, phenolics, and flavonoids, but that only phenolics and flavonoids are present in *Corchorus Olitorius*. This result was in agreement with prior data obtained by Parvin et al. (2015), Londonkar & Nayaka (2011).

Determination of phytochemical compounds

Determination of total phenolic content (TPC)

Determination of phenolic compounds in the two extracts revealed that, methylene chloride: methanol extract of *P. oleracea* has recorded the highest percentage (0.498g GAE/100g) followed the extract of purslane with 0.092g GAE/100g as shown in Table 2.

TABLE 2. Total phenolic compound content (g/100g fresh weight) in *Portulaca oleracea* and *Corchorus olitorius* extracts

Plant extract	Total phenol (g/100g fresh weight)
Portulaca oleracea (purslane)	0.498 ±0.008
Corchorus olitorius (jute)	0.092 ±0.007

Each value represents the mean of triplicates SD

As shown in Table 2, when the total phenolic compounds in *Corchorus olitorius* and *Portulaca oleracea* were compared, *Portulaca oleracea* extract had a higher phenolic content (0.4987) than *Corchorus olitorius* extract (0.0924). This result was in agreement with Yan et al. (2013), who confirmed the presence of phenolic content in *Corchorus olitorius* extract, and Alam et al. (2014), who confirmed the presence of phenolic compounds in *Portulaca oleracea*.

Determination of flavonoids content (TFC)

Determination of flavonoids compounds in the two extracts revealed that, methylene chloride: methanol extract of *Portulaca oleracea* has recorded the highest percentage of flavonoids (0.155g /100g) followed by the extract of *Corchorus olitorius* with 0.0167g /100g as shown in Table 3.

TABLE 3. Total Flavonoids content (g/100g fresh weight) in P. oleracea and C. olitorius extracts

Plant extract	Total flavonoids (g/100g fresh weight)
Portulaca oleracea (purslane)	0.155 ±0.002
Corchorus olitorius (jute)	0.016 ±0.004

Each value represents the mean of triplicates SD

Corchorus olitorius and *Portulaca oleracea*'s total flavonoids were calculated, and the results showed that *Portulaca oleracea* extract contained more flavonoids (0.155) than *Corchorus olitorius* extract (0.016), as shown in Table 3. This result was consistent with findings from Binici et al. (2021), who established the presence of flavonoids in *Corchorus olitorius* extract, and Chigurupati et al. (2020) who confirmed the presence of flavonoids in *Portulaca oleracea*.

Determination of biological activities

Antioxidant activity methods

The effectiveness of various antioxidant compounds as free radical scavengers is frequently assessed using the DPPH and ABTS procedures. As a non-radical test, $KMnO_4$ is a novel approach for assessing the antioxidant activity of various natural extracts. Due to the presence of hydrogen or electron donating antioxidant agent activities, DPPH and ABTS have scavenging properties. Investigation of the DPPH and ABTS data revealed a dose-dependent rise in antioxidant activity. The findings, which are summarised in Table 4, showed that all three methods operate in parallel and are influenced by the concentration of the extract and the length of the incubation period.

According to the findings, *Portulaca oleracea* extract had the highest antioxidant activity against all methods (DPPH, ABTS, and $KMnO_4$), with values of 86.55 , 82.75 and 97.62 respectively followed in descending order by *Corchorus olitorius* with values of 75.98 , 57.02, and 34.98%, respectively when compared to ascorbic acid, which had a high percentage as standard antioxidant against these radical methods at 100ug/mL.

Table 5 reflects the correlation coefficient between different antioxidant assays, and obtained results demonstrate that DPPH, ABTS, and KMO_4 have strong correlations in both plant samples.

The effectiveness of various antioxidant compounds in scavenging free radicals is commonly assessed using the DPPH, ABTS, and $KMNO_4$ techniques. Due to the presence of the hydrogen or electron donating activities of antioxidant agents, DPPH, ABTS, and $KMnO_4$ have scavenging properties. Investigation of the DPPH and ABTS data revealed an increase in antioxidant activity that was dose-dependent (Ahmeda et al., 2020). The ethanolic extract of *Corchorus olitorius* exhibits the highest scavenging activity, followed by the aqueous, petroleum ether, and methanol, according to Airaodion et al. (2019). The obtained results reported that *Portulaca oleracea* extract recorded significantly highest antioxidant activity against all methods (DPPH, ABTS and $KMNO_4$) by 86.55±0.15, 82.75±1.13 and 97.62±0.52 as shown in Table 4 followed by *Corchorus olitorius* by 75.98±1.49, 57.02±0.51 and 34.98±1.34 compared with Ascorbic acid (100ppm) as standard which recorded high percentage as antioxidant against these radical and non-radical methods by 76.42±0.31, 73.93±0.21 and 99.09±0.06. Table 5 represents the correlation coefficient between the different antioxidant assays and the result showed that there are great correlations between (DPPH, ABTS and KMO_4) in both samples. This result was in agreement with Azuma et al. (1999), Oboh et al. (2009), Dkhil et al. (2011), Yan et al. (2013), Abdul Sadat et al. (2017), Ozturk et al. (2021), and Wang et al. (2021) that confirmed the high anti-oxidant activity in *Corchorus olitorius* and *Portulaca oleracea*.

TABLE 4. Antioxidant activity (as %) of *Portulaca oleracea* and *Corchorus olitorius* extract against DPPH, ABTS and $KMnO_4$ assays at 100ug/mL

Plant extract	DPPH assay	ABTS assay	$KMnO_4$ assay
Portulaca oleracea (purslane)	86.55±0.15	82.75±1.13	97.62±0.52
Corchorus olitorius (jute)	75.98±1.49	57.02±0.51	34.98±1.34
Ascorbic acid	76.42±0.31	73.93±0.21	99.09±0.06

Each value represents the mean of triplicates SD.

TABLE 5. Correlation coefficient between different antioxidant methods of different individual extracts *(Portulaca oleracea and Corchorus olitorius)*

Plant extract		Antioxidant Method		
		DPPH	ABTS	$KMNO_4$
Portulaca oleracea (purslane)	DPPH	-	0.94	0.36
	ABTS	-	-	0.523
	$KMNO_4$	-	-	-
Corchorus olitorius (jute)	DPPH	-	0.83	0.40
	ABTS	-	-	0.25
	$KMNO_4$	-	-	-

Anti-cancer activity

Using doxorubicin (DOX) as a reference, the results in Table 6 revealed that *Corchorus olitorius* has 28.5% anticancer activity at 500ppm, which rose independently to nearly 80% at 1000ppm. Additionally, Table 6 showed that using doxorubicin (DOX) as a reference, Portulaca oleracea had anticancer activity of 25.5% at 500ppm and rose independently to reach 73.5% at 1000ppm.

Pharmacological research have revealed that *C. olitorius* demonstrates promising anti-inflammatory and antioxidant properties helpful for treating various malignancies (Tosoc et al., 2021). The anti-cancer efficacy of *Corchorus olitorius* was also confirmed by Yakoub et al. (2020). *Portulaca oleracea* L. has anti-cancer, anti-inflammatory, and anti-oxidant activities, according to Rahimi et al. (2019). Originally native to the Middle East and the Indian subcontinent, *Portulaca oleracea* is a weedy plant in the purslane family (Portulacaceae) that has since naturalised in most tropical and subtropical regions of the world (Payudara et al., 2013). It possesses very high levels of omega-3 fatty acids, which are primarily found in fish and flax seeds, as well as considerable amounts of vitamins A and C, calcium, iron, magnesium, potassium, and antioxidants (Alam et al., 2014).

TABLE 6. Cytotoxicity assay of *Portulaca oleracea.* and *Corchorus olitorius.* tested against HepG-2 cells.

Extracts	Anticancer activity %		
	500ug/mL	750ug/mL	1000ug/mL
Portulaca oleracea (purslane)	25.5±0.70	50.1±1.41	73.5±0.70
Corchorus olitorius (jute)	28.5±0.70	59±1.0	80±1.0
Doxorubicin (DOX) as anticancer standard at 10ug/mL		95%	

Each value represents the mean of triplicates SD

Identification of active groups and active ingredients

Fourier transform infrared (FTIR) of obtained extracts

The potential biomolecules in the plant methylene chloride: methanolic extracts responsible for each plant were found using FTIR measurements. FTIR measurements were used to find the promising biomolecules in *Corchorus olitorius* and *Portulaca oleracea*. Figures 1, 2 and Table 7 depict the FTIR spectra of *Corchorus olitorius* and *Portulaca oleracea* in the frequency range between 4400 and 350cm in the manner of percent transmittance. There were FTIR peaks of *Corchorus olitorius* extract (3448.19, 2980.98, 2843.64, 1639.06, 1054.41, 1032.79, 1015.47, and 576.48) as well as FTIR peaks of *Portulaca oleracea* extract (3449.66, 2981.18, 2843.75, 1640.68, 1054.56, 1032.86, 1015.35 and 508.96).

According to Ismail et al. (2018), *Corchorus olitorius* FTIR spectra revealed the existence of various functional groups. Kavosi et al. (2018) and Ezzati Ghadi et al. (2018) also claim that the functional groups of purslane samples were identified using FTIR analysis (2016). The potential biomolecules in *Corchorus olitorius* and *Portulaca oleracea* were found using FTIR measurements.

Phytochemical identification using GC/MS

The methylene chloride: methanol (1:1, v/v) extract of *Portulaca oleracea* revealed the presence of several phytocomponents using GC/MS analysis. Table 8 lists the phytocomponents of the purslane extract, and Figure displays the GC/MS chromatogram with the current extract's peak region (5). In total, 15 elements were found in the plant under investigation.

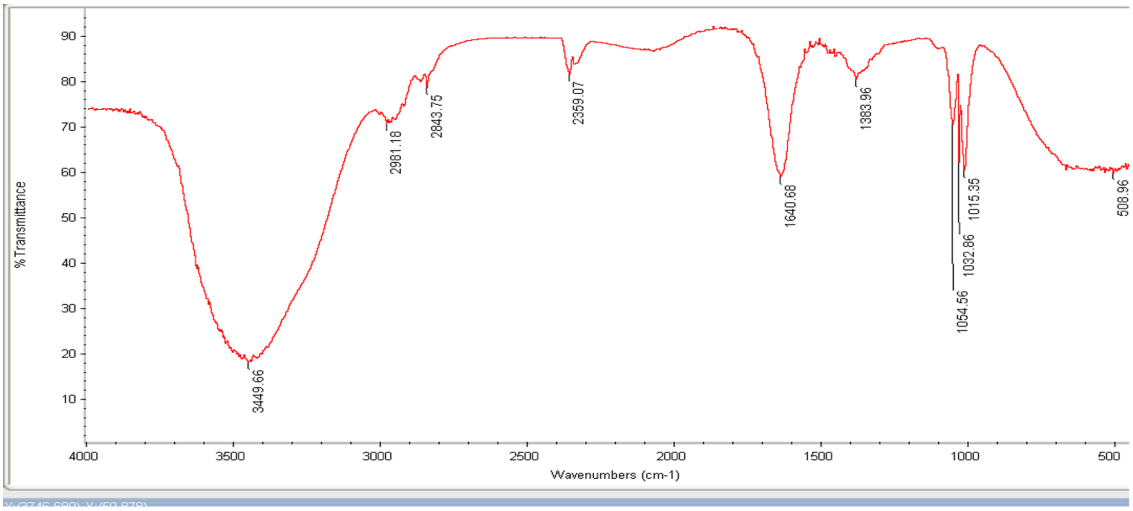


Fig. 1. FTIR spectra of *Portulaca oleracea* individual extract

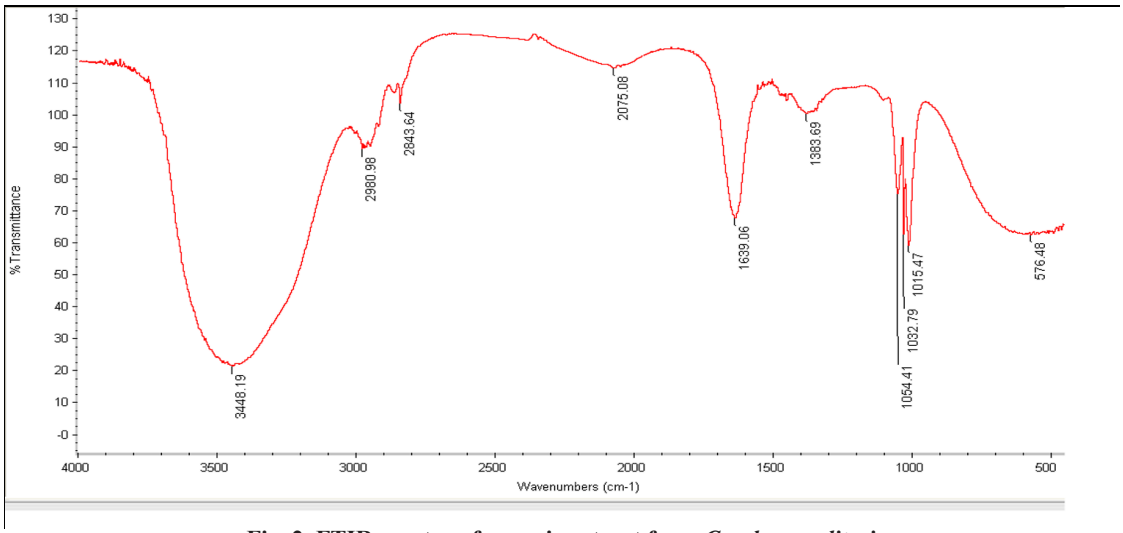


Fig. 2. FTIR spectra of organic extract from *Corchorus olitorius*

TABLE 7. Wave numbers range of characteristic bands and corresponding assignments for *Corchorus olitorius* and *Portulaca oleracea*

Wavenumber range (cm^{-1})	Function groups assigned	Sample	
		Corchorus olitorius	*Portulaca oleracea*
3300-4000	Polymeric hydroxyl compound O-H stretching	3448.19	3449.66
3100-2723	C-H stretching vibrations specific to CH_3 and CH_2	2980.98	2981.18
		2843.64	2843.75
1700-1630	C=O stretching vibration, C-N stretching , Lipids, Ester carbonyl – COOR and carboxylate ion stretching (-COO-)-	1639.06	1640.68
1600–1400	C-O stretching vibration (amide) and C-C stretching from phenyl groups, COO symmetric stretching, CH2 bending	ND	ND
1150 -1000	Stretching vibrations C-O of mono-, oligo-, and carbohydrates, Pyranoid ring	1054.41	1054.56
		1032.79	1032.86
		1015.47	1015.35
690-400	Halo compounds (Iodo and bromo)	576.48	508.96

Each value represent the mean of triplicates±SD; ND, not detected

The *Corchorus olitorius* methylene chloride: methanol (1:1, v/v) extract underwent GC/MS analysis, revealing the presence of many components. Table 9 lists the extract's constituent parts, and Figs. 3, 4 displays the GC/MS chromatogram with the extract's peak area. 18 chemicals were obviously present in the C. olitorius extracts, according to GC/MS.

In C. olitorius, the main components were oleic and hexadecanoic acids (42 and 12%), and in P. oleracea, they were oleic acid and hexadecanamide (44.69 and 10.48%). According to Fontana (2013) and Kim (2020), all of these main chemicals have antioxidant action. In addition to other compounds from the total of 15 compounds reported antioxidant activity. These findings go parallel with the results obtained in antioxidant assays of this study.

Conclusion

Corchorus olitorius (Nalta jute, Malukhiyah) and *Portulaca oleracea* (Common purslane, Rigla) are plant vegetables of great nutritional values. They are found to contain large number of phytochemical compounds, minerals and vitamins as well as phenolics and flavonoids to which attributed the exhibited biological activities (antioxidant and anticancer) of their extracts.

Future perspectives

We have to think seriously about vegetables and fruits used for human nutrition and their valuable compounds and elements. Illness and diseases have to be treated through the natural phytochemicals contained in different edible plants, seeds and vegetables. Thus, more researches are needed to focus and highlight on the important constituents in various parts of plant origin which include vitamins, macro& micro-elements, pigments, phenolic compounds, fatty acids and alkaloids that exhibit diverse biological activities needed for humans and animals health.

TABLE 8. List of phytochemical constitutes of organic extract of *Portulaca oleracea*.(purslane)

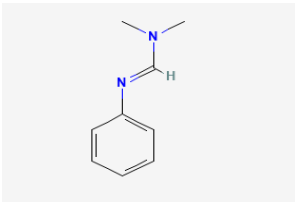
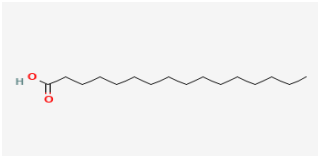
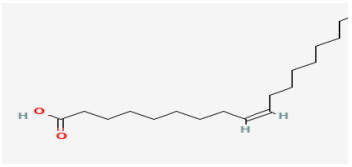
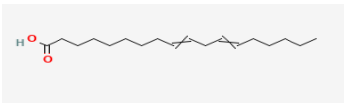
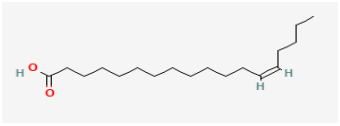
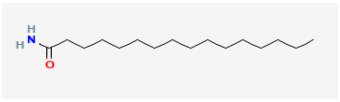
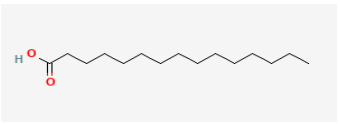
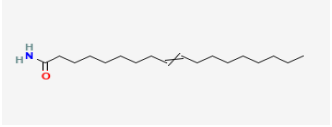
S.N (min)	R.T	Compound name	Conc. Mg/kg	Chemical structure	Biological activities	Reference
1	39.42	Formamidie, N, N-dimethyl-N-(4-pyridyl)	1.55		Antimicrobial activity	Godhani et al. (2017)
2	42.00	n-Hexadecanoic acid	12.33		Anticancer activity	Bharath et al. (2021)
3	46.10	Oleic acid	44.69		Antioxidant activity	Fontana et al. (2013)
4	46.59	9, 12-Octadecadi-enoic acid	1.33		Antioxidant activity	Rossellia et al. (2007)
5	46.74	Cis-13-Octadecae-noic acid	2.43		antifungal activity	Pohl et al. (2011)
6	46.98	Hexadecanamide	10.48		Antioxidant and anti in-flammatory	Kim et al. (2020)
7	49.55	1,15-Pentadecane-dioic acid	2.05		Antioxidant and anti in-flammatory	Ujah et al. (2014)
8	51.41	9-Octadecenamide	2.27		Antimicrobial, antioxidant and hepato-protective activities.	Idan et al. (2015)
9	53.51	Octadecaenoic acid, 3-oxo-, methyl ester	3.46		Antioxidant and antimicro-bial activity.	Siswadi & Saragih (2021)

TABLE 8. Cont.

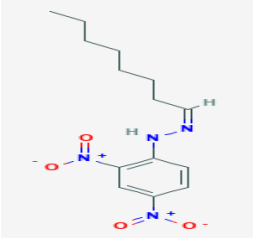
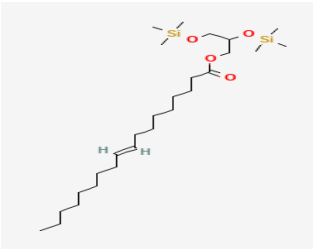
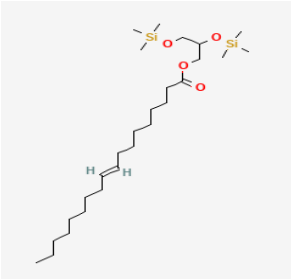
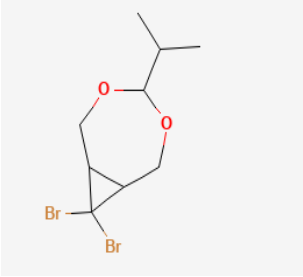
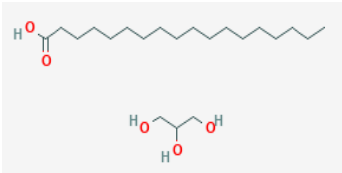
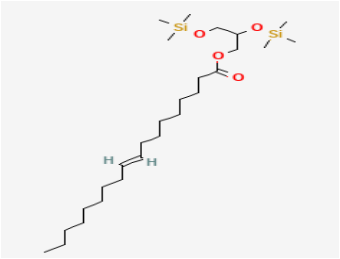
S.N (min)	R.T	Compound name	Conc. Mg/kg	Chemical structure	Biological activities	Reference
10	54.17	Octanal, (2,4-dinitrophenyl) hydrazone	1.43		Antioxidant and antimicrobial activity.	Nemba et al. (2012)
11	56.48	1-Monolinoleoylglycerol trimethylsilyl ether	4.6		Antibacterial, antioxidant, chemo preventive activities.	Shahare et al. (2019)
12	58.41	Carnegine	2.38		Antimicrobial and antioxidant.	Bouaziz et al. (2016)
13	59.67	1,8-Dioxa-5-thiaoctane, 8-(9-borabicyclo(3,3,1) non-9-yl)-3-(9-borabicyclo(3,3,1) non-9-yloxy)-1-phenol	2.01		Antioxidant activity	Floris (2021)
14	61.70	9-Octadecaenoic acid, 1,2,3-propanetriyl ester	1.22		Antioxidant and antidiabetic activity.	Yang et al. (2020)
15	61.86	1-Monolinoleoylglycerol trimethylsilyl ether	7.76		Antimicrobial, anti-inflammatoryand antioxidant activity.	Şimşek Sezer & Uysal (2021)

TABLE 9. Phytochemical constitutes of organic extract of *Corchorus olitorius* (jute)

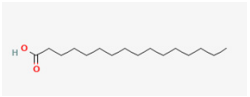
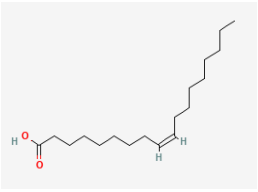
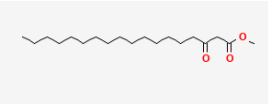
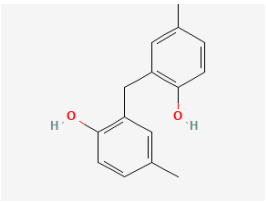
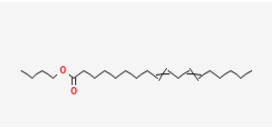
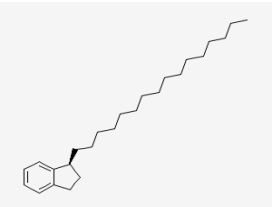
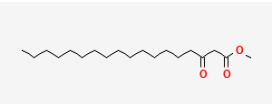
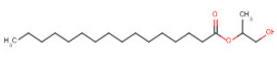
S.N (min)	R.T	Compound name	Relative percentage	Chemical structure	Biological activity	Reference
1	42.10	n-Hexadecanoic acid	12.65		Anticancer Activity.	Bharath et al. (2021)
2	46.06	9,12-Octadecadienoic acid (Z,Z)	3.7		Antioxidant Activity	Rossellia et al. (2007)
3	46.27	Oleic acid	42.79		Antioxidant Activity	Fontana et al. (2013)
4	49.59	Octadecanoic acid, 3-oxo-methyl ester	4.21		Antioxidant and antimicro-bial activity.	Siswadi & Saragih (2021)
5	51.85	Phenol, 2,2-methylene bis(6-(1,1-dimethylethyl)-4-methyl	0.7		Antioxidant activity.	Nemba et al. (2012)
6	53.08	Butyl 9,12-octadecadienoate	2.17		Antimicrobial, anticancer and antioxidant activity.	Santhiya & Ramasamy (2019)
7	53.57	1H-Indene, 1-hexadecyl-2,3-dihydro	2.24		Antioxidant Activity.	Arora & Kumar (2018)
8	53.73	Octadecanoic acid, 3-oxo-methyl ester	1.73		Antioxidant and antimicro-bial activity.	Siswadi & Saragih (2021)
9	53.94	Hexadecanoic acid, 1-(hydroxymethyl)-1,2-eth-anediyl ester	1.38		Anti-inflam-matory and anti-bacterial activity.	Arora & Meena (2017)

TABLE 9. Cont.

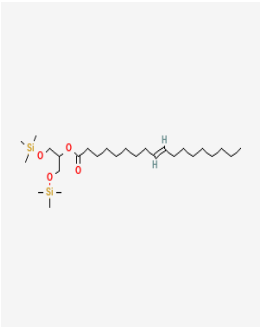
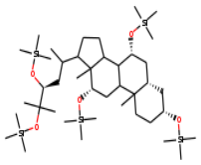
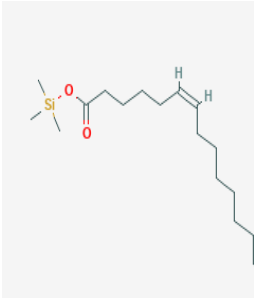
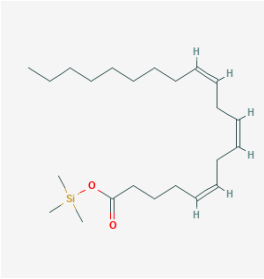
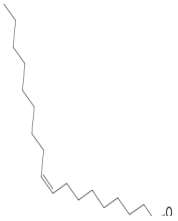
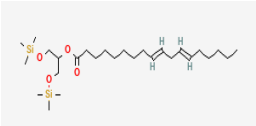
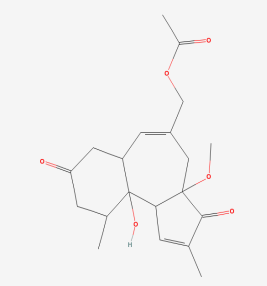
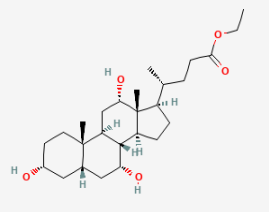
S.N (min)	R.T	Compound name	Relative percentage	Chemical structure	Biological activity	Reference
10	56.44	9-Octadecenoic acid, 2-((trimethylsilyl)oxy)-1-((trimethylsilyl)oxy)ethyl ester	1.01		Antioxidant and anti diabetic Activity.	Yang et al. (2020)
11	56.54	5-beta-cholestene-3-alpha, 7-alpha, 12-alpha, 24-alpha, 25-pentol TMS	7.78			Not reported
12	56.86	Cis, 6-Octadecenoic acid, trimethylsilyl ester	4.55		Antimicrobial and anticancer activity.	Vermaa et al. (2020)
13	57.01	Cis-5,8,11-Eicosatrienoic acid, trimethylsilyl ester	1.59		Antioxidant activity.	Hirata et al. (2016)
14	57.33	9-Octadecenoic acid (Z)-2-hydroxy-1-(hydroxymethyl) ethyl ester	4.51		Antitumor, antioxidant and antimirobial Activity.	Balaji & Kilimozhi (2014)

TABLE 9. Cont.

S.N (min)	R.T	Compound name	Relative percentage	Chemical structure	Biological activity	Reference
15	57.67	1-Monolinoleoylglycerol trimethylsilyl ether	1.85		Antibacterial, antioxidant, chemo preventive activities.	Shahare et al. (2019)
16	58.54	Benz(e)azulene-3,8-dione, 5-((acetyloxy) methyl)3a,4,6a,7,9,10a,10b-octahydro-3a,10a-dihydro	0.81		Anti-bacterial activity	Gajjala (2019)
17	62.82	1-Heptatriacotanol	2.78		Antimicrobial and antibacterial activity	Mohammed et al. (2016)
18	62.99	Ethyl iso-allocholate	1.26		Antimicrobial and antibacterial.	Malathi & Ramaiah (2017)

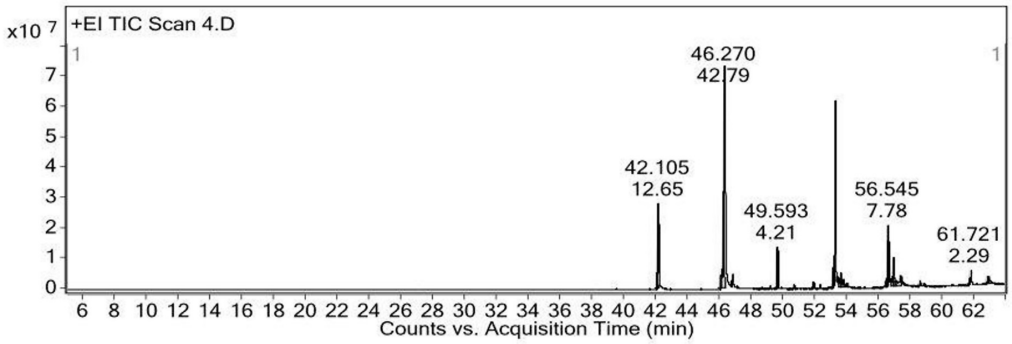


Fig. 3. GC/MS chromatogram of *Portulaca oleracea*

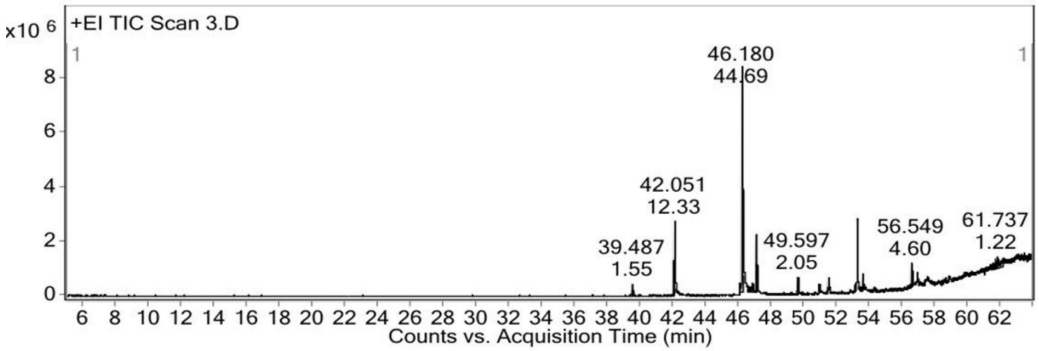


Fig. 4. GC/MS chromatogram of *Corchorus olitorius* individual extract

Competing interests: The authors report no conflicts of interest regarding this work.

Authors' contributions: Conceptualization: EAS, SMS, RMH and AEE. Data curation; EAS, SMS, RMH and AEE. Funding acquisition; EAS, SMS, RMH and AEE. Investigation; EAS, SMS, RMH and AEE. Methodology; EAS, SMS, RMH and AEE. Resources EAS, SMS, RMH and AEE. Software; EAS, SMS, RMH and AEE. Validation; EAS, SMS, RMH and AEE. Writing—original draft; EAS, SMS, RMH and AEE. Writing—review and editing EAS, SMS, RMH and AEE.

Ethics approval: Not applicable.

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الأيض الغذائي والأنشطة البيولوجية للأجزاء المتبقية من بعض الخضروات الخضراء المصرية

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إن البحث عن بدائل طبيعية لتحل محل المستحضرات الصيدلانية الاصطناعية، والبحث عن المستقلبات النشطة مع الأنشطة البيولوجية في أجزاء النبات المختلفة (البذور، الحبوب، الفواكه، قشور الفاكهة، الجذور، والخضروات الخضراء) دائمًا ما تكون ذات أهمية واهتمام كبير. كمثال على الخضروات الورقية المغذية ، يتم توزيع *Corchorus olitorius* و *Portulaca oleracea* على نطاق واسع وتناولها في العديد من البلدان. تشكل هذه النباتات مادة الاهتمام في هذه الدراسة. تم استخلاص الخضار الورقية بواسطة ميثيلين كلوريد: خليط ميثانول (2: 1 حجم / حجم). تم إخضاع المستخلص لتحليل كفاءته كمضاد للأكسدة ومضاد للسرطان. تم استخدام ثلاث طرق لتقدير نشاط مضادات الأكسدة وهي:

DPPH (2,2-diphenylpicrylhydrazyl), ABTS (2,2'-azino-bis(3-ethylbenzothiazoline-6-sulfonic acid)

KMnO4 (برمنجنات البوتاسيوم). أظهر أكبر نشاط مضاد للأكسدة بالطرق الثلاث (86.55 و 82.75 و97.62٪ على التوالي) مقارنة بكل من 75.98 *C. olitorius* و 57.02 و 34.98٪ على التوالي وأحماض الأسكوربيك القياسية (76.42 و 73.93 و 99.09٪ على التوالي) عند 100 ميكروغرام. / مل. أظهر مستخلص *C. olitorius* أعلى سمية خلوية ضد HepG2 (خط خلايا سرطان الكبد البشري) مقارنة بكل من *P. oleracea* والعقار المضاد للسرطان Doxorubicin. أظهر التحليل اللوني للغاز / التحليل الطيفي الكتلي أن المستخلصات النباتية الورقية تحتوي على 15 و 18 مركبًا كيميائيًا نباتيًا (في *P. oleracea* و *C. olitorius* على التوالي) والحمض الدهني الأحادي غير المشبع كان حمض الأوليك المكون الرئيسي بنسبة 42-44.69٪ وتم تحليل المجموعات النشطة في المواد الكيميائية النباتية باستخدام تقنية FTIR ومن هذه الدراسة، نوصي باستخدام مستخلص *P. oleracea* كمصدر لمضادات الأكسدة، بينما يمكن اعتبار مستخلص *C. olitorius* نباتًا نشطًا مضادًا للسرطان.