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Phytochemical and proximate analysis of wild plants from the Gaza Strip, Palestine

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Abstract. *Abou Auda MM. 2025. Phytochemical and proximate analysis of wild plants from the Gaza Strip, Palestine. Biodiversitas 26: 1085-1094.* This study focused on the proximate analysis and nutritional evaluation of some mineral elements in different parts of fifteen plants collected from various locations in the Gaza Strip, Palestine. The parameters analyzed include total carbohydrates, crude fiber, moisture content, ash content, total protein, and total lipids, as well as the nutritional value. The study found significant differences in the chemical composition among the plants. The highest calculated nutritive value was for the *Polygonum equisetiforme* stem (410.01 Kcal/100g), while the lowest was for the *Silybum marianum* leaf (286.75 Kcal/100g). The findings revealed that the investigated plants might serve as valuable sources of many significant macro-nutrients, such as N, P, and K. The N concentration was highest in the *Sinapis arvensis* leaf (2.6%) and lowest in the *Polygonum equisetiforme* stem (0.44%). The P concentration was highest in *Centaurea iberica* leaf (0.3%) and lowest in *P. equisetiforme* leaf (0.18%). The K concentration was highest in the *S. arvensis* flower (4.33%) and lowest in the *P. equisetiforme* stem (1.4%). The findings revealed that these plants could serve as nutritional supplements and therapeutic aids as they are rich in essential nutrients, including proteins, carbohydrates, lipids, and fibers. Additionally, their significant mineral contents that make them beneficial for addressing malnutrition and supporting livestock growth.

Keywords: Ash content, Gaza Strip, nutritive value, Palestine, wild medicinal plants

INTRODUCTION

Wild plants are a vital natural resource for food and medicine, especially for rural communities, as they provide nutritional opportunities in an age of food scarcity (Ullah et al. 2023). In addition, they play a crucial role in the chemical, food, cosmetic, pharmaceutical, and agricultural industries to meet human nutritional needs (Karagozoglu and Kiran 2023). Research suggests that the various minerals found in the metabolites of these wild species actively contribute to the body's metabolic processes. People use a variety of plant parts, such as leaves, seeds, flowers, bark, roots, fruits, and even the whole plant (Tripathi et al. 2022).

All over the world, wild fodder plants are an important resource for livestock feed, and they also benefit smallholder farmers in particular (Geng et al. 2020). Animals are given fodder for specific purposes, and each species' nutritional value and palatability determine its importance. Therefore, knowledge of nutrient composition is crucial for increasing livestock productivity and developing effective conservation strategies for wild herbivores (Geng et al. 2020). Each plant species examined in this study has medicinal properties or is considered a fodder plant. For example, *Polygonum equisetiforme* is traditionally used to treat various diseases, such as urinary tract and skin infections, and is regarded as a palatable grazing species in Palestine (Abou Auda 2012; Mahmoudi et al. 2019). *Silybum marianum* is used to treat diabetes, liver diseases, poisoning, and other conditions. It also serves as an important fodder plant for livestock (Marceddu et al. 2022; Abou Auda 2023; Abou Auda et al. 2023). *Sonchus asper* is utilized to treat coughs, bronchitis, asthma, wounds, burns, and gastrointestinal infections. Extracts of the whole plant are used to relieve fever, reduce inflammation, and support wound healing (Rahman et al. 2017; Li and Yang 2018). *Verbascum sinuatum* is used to treat respiratory and urinary tract diseases and is rich in polyphenols and iridoids (Selseleh et al. 2020; Donn et al. 2023). *Alhagi graecorum* is valued as a diaphoretic and laxative and is also known as a fodder plant (Ahmad et al. 2015; Abou Auda et al. 2023). *Amaranthus spinosus* is recognized for its anti-inflammatory, anti-leprotic, anti-androgenic, and anti-diabetic properties and being a nutritious livestock feed (Ganjare and Raut 2019). *Notobasis syriaca* is used to treat headaches and liver diseases. Its fresh stems and leaf bases are edible (Azab et al. 2018; Abou Auda 2023). *Solanum elaeagnifolium* has antioxidant, hepatoprotective, and anti-inflammatory properties but is potentially toxic to livestock (Bouslamti et al. 2022). *Carduus getulus* is used to treat infectious diseases and to support liver function. Extracts of this plant have antihepatotoxic, antioxidant, and antimicrobial effects (Farag 2019; Abou Auda 2023). *Centaurea iberica* is traditionally used for various health problems. It is a rich source of phytochemicals with antimicrobial, antioxidant, and antifungal effects (Alper et al. 2021; Bibi et al. 2024). *Sinapis arvensis* is employed as livestock feed, food, and in traditional medicine (Keywanloo et al. 2021; Ashwini et al. 2022). *Marrubium vulgare* is known for treating various diseases and its biological effects, including antimicrobial, anti-inflammatory, and antioxidant properties (Aćimović et al. 2020). *Heterotheca subaxillaris*

is effective for treating sprains or bruises and relieving pain, swelling, and inflammation (Morimoto et al. 2009; Charles 2019). *Rumex spinosus* is both a forage plant for livestock and as food for humans. It is used to treat digestive disorders (Abu Ziada et al. 2015). Finally, *Glebionis coronaria* is known for treating diseases of the nervous and digestive systems. It also has antioxidant, anti-cholesterol, anti-cancer, and antibacterial properties (Wijaya et al. 2020; Abou Auda et al. 2023).

The current literature lacks evidence-based scientific information on the nutritional composition of medicinal and fodder plant species in the Gaza Strip, Palestine. Moreover, no studies have been conducted on their proximate composition. Therefore, this study aimed to provide valuable insights into the nutritional profiles of various indigenous medicinal and fodder plant species and the distribution of nutrients among their different plant organs.

MATERIALS AND METHODS

Study area

The investigation was conducted in the Gaza Strip, Palestine, which covers an area of 365 km^2. The Gaza Strip borders the occupied lands to the east and north and Egypt to the south. It is approximately 41 km long and ranges between 6 and 12 km wide. The different samples of leaves, stems, and flowers from various plant species belonging to different families were collected from different locations, particularly in the northeastern area, during the flowering period of 2023.

Plant sampling and preparation

The sample consisted of the fifteen most commonly selected wild fodder and medicinal plant species: *Silybum marianum Polygonum equisetiforme*, *Sonchus asper*, *Alhagi graecorum*, *Verbascum sinuatum*, *Amaranthus spinosus*, *Notobasis syriaca*, *Solanum elaeagnifolium*, *Carduus getulus*, *Centaurea iberica*, *Sinapis arvensis*, *Marrubium vulgare*, *Heterotheca subaxillaris*, *Rumex spinosus*, and *Glebionis coronaria*. These species were collected from eight plant families across various locations in the Northeastern Gaza Strip, which is situated between latitudes 31° and 32° N and 34° and 35° E (Table 1). Plant species were surveyed and collected using a simple random sampling technique. Subsequently, the plant samples were prepared for classification and identification using relevant standard floras, scientific literature, publications, and databases (Horvitz and Danin 2021; Ali-Shtayeh et al. 2022; Ighbareyeh et al. 2022; Abou Auda and Ighbareyeh 2024). The various parts of the plants, such as leaves, stems, and flowers, were selected to analyze their nutritional proximate and certain mineral elements, including nitrogen, phosphorus, and potassium. Nutritional properties were analyzed regarding total carbohydrates, crude fiber content, moisture content, ash content, total protein, and total lipid. Then leaves, stems, and flowers were separated from weeds and dirt, washed and rinsed with distilled water, and mixed separately to create a representative sample for each selected plant species. Each sample was dried at 60°C for two days to remove moisture. To avoid any metal contamination, the sample was ground to powder using a grinding machine and stored in clean, airtight polyethylene containers for further analysis (Kamga et al. 2013). All solvents and other chemicals used in the study, including those of analytical and HPLC grade, were purchased from Sigma-Aldrich, USA. The nutritional analysis of the fifteen selected plant parts was presented as average ± SE of three repetitions. Laboratory analysis was performed at the Laboratory of Analytical Chemistry and the Laboratory of Reclamation and Development Lab for Desert Soils at the Faculty of Agriculture Research Park, Faculty of Agriculture, Cairo University, Egypt.

Chemical analysis and nutrient composition

The moisture content, ash content, total carbohydrates, total lipid, total protein, and crude fiber content of leaves, stems, and flowers of plant species samples were determined according to procedures established and estimated based on the guidelines by the standard methods of AOAC (2000).

Determination of moisture content

An empty cup (W1) and approximately one gram of fresh plant samples (W2) were weighed and placed in a 105°C oven (Thermo Electron LED GmbH, D - 63505 Langenselbold, Germany) overnight. After drying, the sample was transferred to a desiccator. The cup with the dried sample was weighed (W3). The determination of moisture content of each part of plant species samples was calculated as a loss in weight of the original sample and expressed as the percentage moisture content using the equation: Moisture% = {(W1 + W2) - W3) / W2} × 100 (AOAC 2009).

Determination of ash content percentage

A method of AOAC (2009) was followed to assess ash content. An empty cup was weighed (W1), and 1 g of dry plant samples of leaves, stems, and flowers was added (W2). The sample was burned in a muffle furnace (MR 260 E, Heraeus, Hanau, Germany) at 550°C overnight to assess ash content until its color turned white or light gray. After cooling, the plant samples were then reweighed (W3). The determination of ash content percentage was calculated using the equation: Ash% = {(W3-W1)/W2} × 100.

Determination of total carbohydrates

A 0.2 g aliquot of the dried sample was combined with 10 mL of 0.1N sulfuric acid (H_2SO_4) in a sealed tube and subjected to digestion by heating in a sand bath at 105°C overnight. Following digestion, the sample was filtered into a 100 mL volumetric flask and diluted to the final volume with distilled water. Stock solutions of glucose were prepared at concentrations of 1000 ppm and 100 ppm, from which a series of standard solutions with varying concentrations (20 ppm, 40 ppm, 80 ppm, 160 ppm, 320 ppm, and 640 ppm) were generated.

Table 1. Botanical family, common English and Arabic names of medicinal plants, recorded in the study area

Botanical name	Family name	Common english name	Arabic name
Polygonum equisetiforme Sm.	Polygonaceae	Knotgrass, horsetail knotweed	قضاب، شبطبط، عفراج
Silybum marianum (L.) Gaertn.	Asteraceae (Compositae)	Holy thistle, milky thistle	خرفيش الجمال، سنارية، شوك الجمل، كغعوب
Sonchus asper (L.) Hill	Asteraceae (Compositae)	Prickly sow thistle Spiny sow thistle	الحور المر، خويش
Verbascum sinuatum L.	Scrophulariaceae	Mullein, scallop-leaved mullein	لبيد، عورور متعرج، خريط
Alhagi graecorum Boiss.	Fabaceae (Leguminosae)	Alhagi manna, camel thorn	شرش العاقول، عاقول، شبرق
Amaranthus spinosus L.	Amaranthaceae (Chenopodiaceae)	Spiny amaranthus, thorny amaranthus soldier-weed, pigweed,	عرف الديك الشوكي
Notobasis syriaca (L.) Cass.	Asteraceae (Compositae)	Syrian thistle	خرفيش عادي، خرفيش الكبير، خرفيش جمال
Solanum elaeagnifolium Cav.	Solanaceae	Nightshade	سجوة زيتية، باذنجان برى
Carduus getulus Pomel	Asteraceae (Compositae)	Sedge	حشروف، لسان الكلب
Centaurea iberica Trevis. ex Spreng.	Asteraceae (Compositae)	Iberian centaury	مرار شائع، مرار عادي، شوك الدردار
Sinapis arvensis L.	Cruciferae (Brassicaceae)	Wild mustard, charlock	خردل بري، لفيتة، نفيته، فجيله، اوفيته، شلوة صفراء،قرله
Marrubium vulgare L.	Labiatae (Lamiaceae)	Common white horehound	مقل الحقل، ربه شائعة، حشيشة الكلب، زقوم، روبية
Heterotheca subaxillaris (Lam.) Britton & Rusby	Asteraceae (Compositae)	Camphorweed, camphor daisy	الهيفيروثيكا، كامفوروید
Rumex spinosus L.	Polygonaceae	Spiny dock, little jack, dirs el-agooz	حميض شائك، جزر أبو على، سنينة، ركيبة، فجل
Glebionis coronaria (L.) Tzvelev	Asteraceae (Compositae)	Corn marigold, common chrysanthemum garland chrysanthemum, crown daisy, annual chrysanthemum	بسوم، قحوان، بسباس، أقحوان ذهبي

For the analysis, seven tubes were prepared, each containing 100 µL of either the blank, standard solutions of varying concentrations, or the sample. To each tube, 1 mL of 5% phenol was added, followed by the addition of 5 mL of concentrated H_2SO_4. The tubes were allowed to stand for 15 minutes, after which the absorbance was measured at 490 nm. Total carbohydrate = (conc. from curve * T. volume)/(weight of sample * 1000) (Angami et al. 2020). The percentage of carbohydrate could be determined by the following equation: Total carbohydrate % = 100 – [ash % + moisture % + crude fat % + crude protein % + crude fiber%].

Determination of total lipid using the Soxhlet method

Five g of the dried sample were ground in a mortar with 50 mL of a methanol: chloroform (2:1) solvent mixture for 10 minutes. The lipid content of the sample was extracted using a Soxhlet extractor (Soxtec Avanti SE-416, Gerhardt, Germany). A pre-weighed flask was attached to the extractor to collect the extracted lipids. After extraction, the sample was filtered, and the solvent was evaporated using a water bath maintained at 60-80°C. The setup was then connected to a condenser, and the extractor was allowed to cool for about 8 hours, with cool water flowing continuously through the condenser. Once cooled, the thimble was removed from the extractor. The apparatus was then reset, and heating in the water bath was used to recover any remaining ether from the receiver flask. After disconnecting the receiver flask, it was placed in a hot air oven at 100°C for 1 hour to dry. The flask was then cooled and weighed. The lipid content was determined by subtracting the weight of the empty flask from the weight of the flask with lipid residue. The lipid percentage was calculated using the equation: Lipid% = Weight of flask with lipid – Weight of empty flask × 100/Weight of initial sample of plant material (Gouveia and Oliveira 2009).

Determination of total protein using the Kjeldahl method

Approximately 0.2 g of dried leaves, stems, and flowers samples from the fifteen plant species were weighed. The plant material was placed into the Kjeldahl tube, and 10 mL of H_2SO_4 concentration was added. The tube was then placed in a digestion instrument at 400°C. After the sample had been digested, it was diluted with water to 50 mL. Subsequently, total protein was determined using the Vapodest Vap 50 (Gerhardt Analytical Systems, Ko¨nigswinter, Germany). Finally, the total protein content was calculated using the equation: Total protein % = Total N × 6.25 (AOAC 2000).

Determination of crude fiber content

Under desired conditions, crude fiber content was determined using a fibre analyser (Fibretherm Gerhardt FT-12, C. Gerhardt GmbH & Co. KG, Königswinter, Germany) through the digestion of samples. The plant samples were prepared as follows: the plant materials were powdered

with a mechanical grinder. The powder was passed through a no. 10 sieve and kept in a container until further use. Extract 5 g of plant material with petroleum ether to remove fat (initial boiling temperature 35-38°C and final temperature 52°C). The sample was boiled with 200 mL of sodium hydroxide solution for 30 min, filtered through a muslin cloth, and washed with 25 mL of boiling 1.25% H_2SO_4, three 50 mL portions of water, and 25 mL of alcohol. The residue was transferred to the ash dish (pre-weighed dish W1). The residue was dried for 2 h at 130 ± 2°C, cooled, and weighed (W2). The residue was ignited for 30 min at 600 ± 15°C, cooled, and reweighed (W3). Crude fiber percentage was calculated using the following formula:

$$\% \text{ Crude Fiber} = \frac{(W2 - W1) - (W3 - W1)}{\text{Weight of the sample}} \times 100\%$$

Where:
W1 : Weights of residue before drying
W2 : Weight of residue after drying for 2hrs at 130 ± 2°C
W3 : Weight of residue after ignition for 30 min at 600 ± 15°C (Maynard 1970).

Determination of nutritive value

The nutritive value percentage was calculated using the equation: Nutritive value % = 4 × percentage of protein + 9 × percentage of fat + 4 × percentage carbohydrate (Banik et al. 2018).

Determination of mineral elements

The phosphorus and potassium contents in leaf, stem, and flower samples were analyzed using an atomic absorption spectrometer (iCE 3300 System, Thermo Scientific, German). This method involved acid digestion of different materials in digestion tubes using a temperature-controlled hot plate for the metal determination by spectroscopic methods (Christian and Feldman 1970; AOAC 1995). A calibration curve for the mineral elements in the leaf, stem, and flower samples was created using prepared standard stock for the elements, which is necessary before estimating the concentration of any element in the sample. Blank values for each element were deduced from the sample values. The sample amount was 0.2 g. The reagents were 7 mL H_2SO_4 and 2 mL hydrogen peroxide (H_2O_2). The procedure was as follows: The sample was weighed in a digestion tube. If any part of the sample adhered to the inner wall of the digestion tube, it was moisturized by adding acids drop by drop. Then, the sample was gently swirled to ensure thorough mixing with the acids. The sample was then heated on a hot plate to form a clear solution. The solution was cooled to room temperature. The solution was transferred to a marked flask and filtered. N in various leaves, stems, and flowers were determined using the Kjeldahl method for organic nitrogen (Bradstreet 1965).

Statistical analysis

The data were analyzed by a one-way Analysis of Variance (ANOVA), followed by Duncan's multiple range test to identify significant differences between treatments at $P<0.05$ using IBM-SPSS (version 20.0). All results are presented as means ± and Standard Deviation (SD).

RESULTS AND DISCUSSION

The findings on the nutritional proximate composition of the leaves, stems, and flowers of fifteen medicinal and fodder plant species belonging to eight different families, Polygonaceae, Asteraceae, Scrophulariaceae, Fabaceae, Amaranthaceae, Solanaceae, Cruciferae and Labiatae, gathered from the study area, are shown in Tables 2, 3, and 4. The assessment of nutritive values in medicinal and fodder plant species was conducted based on their various purposes. The key measured variables included crude fiber content, total proteins, carbohydrates, ash content, moisture content, total lipid, nitrogen, potassium, and phosphorus. In recent years, significant research has focused on floristic analysis, diversity, taxonomy and the ecology of vascular plants in the Gaza Strip and West Bank of Palestine (Dardona 2016; Ighbareyeh et al. 2017; Abd Rabou and Radwan 2017; Ali-Shtayeh and Jamous 2018; Ighbareyeh and Carmona 2018; Abd Rabou et al. 2019; Al-Sheikh 2019; Ali-Shtayeh et al. 2022; Abou Auda 2023; Abou Auda and Ighbareyeh 2024; Abd Rabou et al. 2024; Abou Auda et al. 2024).

Table 2 shows the crude fiber content in plant parts: Leaves: Ranged from (11.01%) in *Sinapis arvensis* to (86.3%) in *Glebionis coronaria*, and significant differences across species for leaves. *Solanum elaeagnifolium* (32.4%) and *Rumex spinosus* (29.2%) are notable for high crude fiber levels compared to other species. Flowers: Showed wider variability (average: 39.1%) compared to stems (average: 46.8 %). In stems: *Alhagi graecorum* exhibited the highest fiber content (48.9%).

Proteins and Carbohydrates: Leaves: Protein content was highest in *S. arvensis* (17.2%) with marked variability compared to low protein plants like *Heterotheca subaxillaris* (4.8 %). Significant differences across species and plant parts, stems: *Polygonum equisetiforme* and *Sonchus asper* have higher protein contents (14.6% and 14.9%, respectively). Stems: Protein content varies significantly, with *Notobasis syriaca* having the lowest (3.9%). Flowers: Proteins are highest in *Silybum marianum* (16.8%). Many variables showed significant inter-species differences in P-values <0.05, while others, such as phosphorus ($P>0.05$), showed minimal variability. *G. coronaria* had extremely crude fiber in flowers, and *S. marianum* had high ash content in leaves (29.1%), indicating the differences between plants in their chemical composition. Carbohydrates were consistently high across all species, with average values around (69.3%) in leaves and (81.2%) in stems. The highest value was observed in *P. equisetiforme* stems (86.1 ± 7.3%). Mineral content (nitrogen, potassium, and phosphorus): Nitrogen showed significant inter-species variability, correlating with protein content in some cases (e.g., *S. arvensis* leaves). Phosphorus exhibited slight variation, with most values being statistically insignificant ($P>0.05$). Variability in phosphorus across all groups is minor, with statistical insignificance indicated in many cases ($P>0.05$). Many variables (e.g., proteins, carbohydrates) show significant differences between plant species ($P<0.05$).

Table 2. Mean ± SD (Standard Deviation) of leaves composition in different plant

Plant	No.	Crude fiber content	Total proteins	Total carbohydrates	Ash content	Moisture content	Total lipid	Nitrogen	Potassium	Phosphorus
P. equisetiforme	3	22.5±3.4^{e}	7.1±0.9^{ab}	81.1±8.4^{e}	10.5±0.7^{a}	8.8±0.4^{gh}	1.2±.07^{abc}	1.8±.2^{cd}	2.7±0.02^{f}	0.18±0.02
S. marianum	3	17.4±1.5^{bcde}	8.5 ±1.1^{bc}	59.9±5.5^{ab}	29.1±1.01^{e}	14.7± 0.6^{j}	1.4±0.4^{cb}	0.7±0.1^{a}	3.04±0.03^{i}	0.2±0.05
S. asper	3	18.9±2.6^{cde}	13.2 ±1.9^{ef}	64.7±5.2^{abc}	16.2±1.1^{bc}	10.1± 0.6^{i}	5.1±0.4^{g}	1.04±0.3^{ab}	3.5±0.04^{j}	0.21±0.02
V. sinuatum	4	14.5±1.9^{abcd}	11.8±1.7^{e}	63.2±3.4^{abc}	22.4±1.1^{d}	7.2±0.3^{cd}	1.6±0.2^{bc}	1.1±0.2^{ab}	2.4±0.01^{d}	0.2±0.06
A. graecorum	3	12.7±1.2^{ab}	11.3±2.3^{de}	71.8±5.9^{cde}	14.2±1.1^{bc}	8.9±0.3^{gh}	1.8±0.4^{cd}	1.8±0.1^{cd}	2.8±0.02^{g}	0.22±0.05
A. spinosus	3	19.6±2.03^{de}	12.9±1.3^{ef}	69.7±4.7^{bcd}	14.9±1.1^{b}	5.8±0.05^{b}	1.6± 0.2^{bc}	2.1±0.5^{de}	3.1±.05^{i}	0.23±0.05
S.elaeagnifolium	4	32.4±2.7^{f}	14.1±1.4^{ef}	70.3±5.2^{bcde}	12.5±2.2^{ab}	4.5±0.4^{a}	3.1±0.4^{e}	2.3 ±0.4^{de}	2.6±0.03^{e}	0.21±0.05
C. getulus	3	17.2±2.5^{bcde}	15.6±2.4^{fg}	56.2±5.9^{a}	24.4±3.6^{d}	8.5±0.5^{fg}	3.8±0.6^{f}	2.5±0.3^{e}	3.8±0.02^{k}	0.25±0.1
C. iberica	3	22.4±2.5^{e}	6.2±0.6^{ab}	73.9±5.2^{cde}	18.8±2.7^{c}	8.4±0.5^{fg}	1.1±0.2^{abc}	1±0.1^{ab}	0.9±0.04^{a}	0.28±0.06
S. arvensis	3	11.1±1.9^{a}	17.2±1.9^{g}	58.5±4.8^{a}	24.1±3.2^{d}	9.3±0. 4^{h}	0.6±0.05^{a}	2.6±0.1^{e}	2.2±0.07^{b}	0.26±0.07
M. vulgare	3	19.2±2.7^{cde}	11.96±1.3^{e}	70.7±5.9^{bcde}	16.1±2.4^{bc}	6.8±0.2^{c}	1.4±0. 3^{bc}	1.9±0.3^{cd}	3.9±.03^{l}	0.2±0.04
H. subaxillaris	3	14.2±1.8^{abc}	4.8±0.8^{a}	78.1±6.7^{de}	12.7±1.7^{ab}	8.1±0.3^{ef}	4.7±0.7^{g}	0 .8±0.3^{a}	2.3±.012^{c}	0.2±0.04
R. spinosus	3	29.2±4.1^{f}	7.3±0.8^{abc}	79.3±±6.5^{de}	12.5±2.2^{ab}	7.5±0.2^{de}	1±0.1$^{a\,b}$	1.2±0.3^{ab}	2.9±0.124^{h}	0.2±0.03
G. coronaria	3	86.3±6.1^{g}	9.1±1.01^{cd}	72.6±5.3^{cde}	15.9±2.3^{bc}	8±0.3^{ef}	2.4±0.5^{d}	1.5±0.34^{bc}	2.8±±0.035^{g}	0.2±0.05
P-value		0.0001	0.0001	0.001	0.0001	0.000	0.000	0.0001	0.0001	0.722 (NS)
Total	44	24.1±18.2	10.8±3.8	69.3±8.9	17.5±5.7	8.3±2.3	2.2±1.4	1.6±0.6	2.8±0.7	0.2±0.05

Notes: NS: Non-Significant; Superscript letters: a,b,c,d,e,f,g,h, i, j,k,l within column indicate significance at P<0.05

Table 3. Mean ± SD (Standard Deviation) of stem composition in different plants

Plant	Number	Crude Fiber content	Total proteins	Total carbohydrates	Ash content	Moisture content	Total lipid	Nitrogen	Potassium	Phosphorus
P.equisetiforme	3	43.3±4.2^{b}	14.6±1.7^{b}	86.1±7.3^{b}	4.3±0.2^{a}	7.8±0.4^{b}	0.8±0.1^{a}	0.44±0.2^{a}	1.4±1.1^{a}	0.22±0.1
S. asper	3	47.2±3.8^{b}	14.9±1.9^{b}	73.3±3.8^{a}	9.7±1.9^{bc}	9.2±0.1^{c}	2.1±0.1^{b}	0.540±.2^{a}	3.5±0.03^{b}	0.233±0.03
A. graecorum	3	48.9±4.2^{a}	6.4±0.62^{a}	84.1±6.2^{ab}	8.7±1.5^{b}	8.8±0.1^{c}	0.7±0.2^{a}	1.0±0.2^{b}	2.7±0.02^{b}	0.21±.06
N. syriaca	3	47.6±4.4^{c}	3.9±0.9^{a}	81.3±5.4^{ab}	12.4±2.7^{c}	5.9±0.3^{a}	2.4±0.3^{b}	0.6±0.1^{a}	2.8±0.04^{b}	0.23±0.05
P-value		0.431	0.0001	0.01	0.004	0.001	0.0001	0.009	0.011	0.954 (NS)
Total	12	46.8±4.2	9.9±5.2	81.2±7.1	8.8±3.4	7.9± 1.3	1.5± 0.8	0.6±0.3	2.5±1	0.23±0.04

Notes: NS: Non-Significant; Superscript letters: a,b,c, within column indicate significance at (P<0.05)

Table 4. Mean ± SD (Standard Deviation) of flowers composition in different plants

Plant	Number	Crude fiber content	Total proteins	Total carbohydrates	Ash content	Moisture content	Total lipid	Nitrogen	Potassium	Phosphorus
S. marianum	3	48.8±3.7^{f}	16.8±0.9^{e}	72.3±6.3^{a}	9.23±0.7^{bc}	7.9±0.5^{c}	1.6±0.3^{ab}	0.6±0.2^{a}	2.90±.04^{c}	0.21±0.03
N. syriaca	3	35.2±2.9^{d}	6.1±0.8^{b}	80.8±5^{d}	9.2±1.7^{bc}	6.5±0.1^{a}	3.8±0.5^{d}	0.9±0.2^{a}	2.6±0.02^{b}	0.25±0.05
S.elaeagnifolium	3	27.9±2.6^{c}	13.4±1.2^{d}	72.2±4.9^{b}	11.5±1.9^{cd}	7.1±0.1^{b}	2.9±0.3^{c}	2.1±0.4^{c}	3.3±0.01^{d}	0.24±0.06
C. iberica	3	22.1±2.9^{b}	9.9±1.4^{c}	76.7±6.5^{a}	8±1.6^{bc}	8.7 ±0.3^{d}	5.1 ±0.7^{e}	1.9±0.8^{bc}	2.6±0.3^{b}	0.26±0.05
S. arvensis	3	16.4±2.1^{a}	3.9±1^{a}	80.7±6.6^{e}	13.8±2.6^{d}	7±0.1^{ab}	1.5±0.3^{ab}	0.6±0.1^{a}	4.3±0.02^{e}	0.24±0.07
M. vulgare	3	42.5±3.8^{e}	8.4±0.7^{c}	76.9±6^{a}	13.1±1.9^{d}	6.7±0.4^{ab}	1.5±0.3^{ab}	1.3±0.3^{ab}	3.2±0.04^{cd}	0.23±0.05
R. spinosus	3	37.8±3.5^{de}	8.6±1^{c}	83.7±5.8^{a}	5.6±0.7^{a}	8.2±0.2^{cd}	2±0.2^{b}	1.4±0.4^{ab}	2.1±0.02^{a}	0.25±0.05
G. coronaria	3	82.3±4.5^{g}	8.4±0.8^{c}	81.5±6.2^{a}	9±0.8^{bc}	10.2±0.3^{e}	1±0.2^{ab}	1.3±0.3^{ab}	2.7±0.03^{b}	0.23±0.05
P-value		0.000	0.000	0.220	0.000	0.001	0.001	0.002	0.000	0.957 (NS)
Total	24	39.1±19.7	9.4±3.9	78.1±6.4	9.9±2.9	7.8±1.2	2.5±1.4	1.3±0.6	2.9±0.6	0.24±0.48

Notes: NS: Non-Significant; Superscript letters: a,b,c,d,e,f,g within column indicate significance at (P<0.05)

The lipid and moisture content of four plant species' stem parts are presented in Table 3. Lipid content ranged from (0.7%) (*A. graecorum*) to (2.4%) (*N. syriaca*), with significant differences observed among species (P = 0.0001). Similarly, moisture content varied significantly (P = 0.001), with the lowest value in *N. syriaca* (5.9%) and the highest in *S. asper* (9.2%). Mean values across all species were (1.5%) for total lipid and (7.9%) for moisture content.

Table 3 summarizes the chemical composition of *P. equisetiforme, S. asper, A. graecorum*, and *N. syriaca* crude fiber content ranged from (43.3%) (*P. equisetiforme*) to (48.9%) (*A. graecorum*), with no significant difference (P = 0.431). Total proteins: *S. asper* showed the highest value (14.9%), while *N. syriaca* has the lowest (3.9%) (P = 0.0001). Total carbohydrates: Varied significantly (P = 0.01), with the highest in *P. equisetiforme* (86.1%) and the lowest in *S. asper* (73.3%). Ash content: *N. syriaca* had the highest ash content (12.4%), and *P. equisetiforme* had the lowest (4.3%) (P = 0.004). Nitrogen: *A. graecorum* had the highest nitrogen content (1.0%), while *P. equisetiforme* had the lowest (0.44%) (P = 0.009). Potassium: *S. asper* exhibited the highest potassium levels (3.5%), whereas *P. equisetiforme* had the lowest value (1.4%) (P = 0.011). Phosphorus showed minor plant variation, with no significant differences observed (P = 0.954).

Table 4 presents flowers' lipid and moisture content from different plant species. The total lipid content ranged from (1.0%) in *G. coronaria* to (5.1%) in *Centaurea iberica*. *N. syriaca* and *S. elaeagnifolium* also exhibited relatively high lipid contents of (3.8%) and (2.9%), respectively, which were significantly different from most other species. The lowest values were observed in *G. coronaria*, *S. arvensis*, and *M. vulgare*, which showed no significant differences among themselves (P>0.05). Moisture content varied significantly, with the highest value recorded in *G. coronaria* (10.2%) and the lowest in *N. syriaca* (6.5%). Intermediate moisture content levels were found in species such as *S. marianum* (7.9%) and *R. spinosus* (8.2%), which displayed overlapping statistical groupings with other species. The overall mean values for total lipid and moisture content across all species were (2.5%) and (7.8%), respectively, indicating considerable variability among species (Table 4).

In the current research, moisture content was highest in *S. marianum* leaves (14.74%), followed by *G. coronaria* flowers (10.40%), *S. asper* leaves (10.12%), *S. arvensis* leaves (9.31%), and *A. graecorum* leaves (8.9%). Conversely, the lowest moisture content values were observed in *S. elaeagnifolium* leaves (4.53%), *Amaranthus spinosus* leaves (5.87%), *N. syriaca* stems (5.94%), *N. syriaca* flowers (6.46%), *M. vulgare* flowers (6.73%), *M. vulgare* leaves (6.78%), *S. arvensis* flowers (7.12%), and *V. sinuatum* leaves (7.16%).

The data reveal significant variations among species (P<0.001), indicating differences in their biochemical composition, likely influenced by genetic and environmental factors. The total lipid content varied significantly across the studied plants, ranging from (1.6%) in *V. sinuatum* to (4.7%) in *H. subaxillaris*. The highest lipid content observed in *H. subaxillaris* suggests its potential as a source of dietary lipids, particularly for functional food development. In contrast, *S. marianum* and *S. asper* exhibited the lowest and highest lipid levels, with values of (1.4%) and (5.1%), respectively. These variations could be attributed to differences in the physiological roles of lipids within these plants and adaptation to their native habitats. Species such as *S. elaeagnifolium* (3.1%) and *Carduus getulus* (3.8%) also demonstrated relatively high lipid content, positioning them as potential candidates for further exploration in lipid-based applications, as shown in Table 2.

Moisture content in leaves also showed a wide range among species, from (4.5%) in *S. elaeagnifolium* to (14.7%) in *S. marianum*. These findings suggest differences in water retention capacities, which could relate to their ecological adaptations. The higher moisture content in *S. marianum* may reflect its adaptation to environments requiring greater hydration for metabolic processes. In comparison, the lower moisture content in *S. elaeagnifolium* and *A. spinosus* (5.8%) might indicate adaptation to arid conditions. The total average lipid and moisture contents across all species were (2.2%) and (8.3%), as shown in Table 2.

These results indicate that these plant species have moderate lipid and relatively high moisture content, making them suitable for applications that require both hydration and lipid content. The observed differences in lipid and moisture content could be of medical and industrial importance. Thus, *S. asper* and *H. subaxillaris*, which have a higher lipid content, could be investigated for their fatty acid profiles. Plants with higher moisture content, such as *S. marianum*, may be useful for fresh consumption or hydration-centric applications.

The analysis of stem samples from four different plant species (*P. equisetiforme, S. asper, A. graecorum*, and *N. syriaca*) reveals significant differences in both total lipid content and moisture content (P = 0.0001 and P = 0.001, respectively), as shown in Table 3. The total lipid content differed significantly between species, with *N. syriaca* having the highest value (2.4%) and *A. graecorum* the lowest (0.7%). The observed differences are consistent with previous research, which indicates that lipid concentration in plant stems is often species-specific and influenced by environmental conditions. *N. syriaca*, which grows in an arid environment, may exhibit higher lipid content due to its habitat, where lipid storage is important for energy reserves and water retention. In contrast, *A. graecorum*, a desert-adapted species, may rely on alternative metabolic pathways such as polysaccharide production rather than lipid storage.

The moisture content of the stem parts showed a significant difference, with *S. asper* having the highest level (9.2%) and *N. syriaca* having the lowest level (5.9%). It could indicate differences in the biological habitats and water storage mechanisms of the plants. *S. asper* is often found in wetter areas and has increased moisture retention, which could promote developmental and physiological activities in its natural habitats. On the other hand, the low moisture content of *N. syriaca* most likely helps it survive

in dry environments by reducing water loss through transpiration. The significant p-values in Table 3 show considerable differences between species, suggesting considerable physiological specialization. These results have ecological implications, particularly for understanding the adaptation of these plants to their environment. In addition, the differences in lipid and moisture content may have practical implications, such as biomass utilization for medicinal and pharmaceutical purposes. For example, species with a higher lipid content could be favored for bioenergy production.

The results of this study demonstrate significant differences in total lipid and moisture content levels among the analyzed plant flowers, with a p-value of 0.001 for both parameters, indicating statistically significant differences (Table 4). The total lipid content varied between (1.0%) for *G. coronaria* and (5.1%) for *Centaurea iberica*. *C. iberica* had the highest lipid content, indicating its potential as a source of bioactive lipids. *G. coronaria* had the lowest lipid concentration, indicating a particular metabolic or ecological adaptation. Moisture content differed variable, with *N. syriaca* having the lowest value (6.5%) and *G. coronaria* the highest (10.2%). A higher moisture content could indicate physiological adaptations to different environmental conditions. *C. iberica* and *N. syriaca* may be beneficial for nutraceuticals or cosmetics due to their high-fat content. Meanwhile, *G. coronaria*'s high moisture content may suggest vulnerability to post-harvest preservation methods.

The study found that the leaves of *S. arvensis* had the highest protein level (17.22%), followed by the flowers of *S. marianum* (16.8%), the leaves of *C. getulus* (15.55%), the stems of *S. asper* (14.87%), the stems of *P. equisetiforme* (14.57%), and finally the leaves of *S. elaeagnifolium* (14.12%). Conversely, the results revealed that the lowest protein level values were observed in *S. arvensis* flowers (3.91%), *N. syriaca* stems (3.94%), *H. subaxillaris* leaves (4.81%), *N. syriaca* flowers (6.09%), *C. iberica* leaves (6.23%), *A. graecorum* stems (6.44%), and *P. equisetiforme* leaves (7.1).

The study found that the leaves of *S. asper* and the flowers of *C. iberica* had the most total lipid content (5.11%). These were followed by the leaves of *H. subaxillaris* (4.47%), the flowers of *N. syriaca*, and the leaves of *C. getulus* (3.78%). The researcher also noted the leaves of *S. elaeagnifolium* had a total lipid content of 3.06%, and the flowers were 2.87%). On the other hand, the leaves of *S. arvensis* had a total lipid content of (0.6%), the stems of *A. graecorum* had (0.7%), the stems of *P. equisetiforme* had (0.8%), the leaves of *R. spinosus* had (1.02%), the flowers of *G. coronaria* had (1.09%), and the leaves of *C. iberica* had (1.14%).

Glebionis coronaria leaves had the highest value fiber concentrations (86.3%), followed by *G. coronaria* flowers (82.3%), *A. graecorum* stems (48.93%), *S. marianum* flowers (48.8%), *N. syriaca* stems (47.64%), and *S. asper* stems (47.2%). In contrast, the minimum value of fiber was estimated in *S. arvensis* leaf, *A. graecorum* leaf, *H. subaxillaris* leaf, *V. sinuatum* leaf, *S. arvensis* flower, and *S. marianum* leaf to be (11.01%), (12.7%), (14.18%), (14.52%), (16.38%), and (17.38%), respectively.

The lipid and moisture content of the plant leaves were analyzed, and significant variations were observed among the species ($p<0.001$) in Table. 2. The total mean of lipid content across all species ranged from (1.6%) in *V. sinuatum* to (4.7%) in *H. subaxillaris*. Similarly, the average moisture content was (8.3%), with the lowest value observed in *S. elaeagnifolium* (4.5%) and the highest value in *S. marianum* (14.7%). Statistical analysis revealed significant differences in total lipid and moisture content across the species ($p = 0.000$). These findings highlight the diversity in lipid and moisture composition among the plant species, which may affect their ecological adaptation and potential uses.

The findings of this study revealed that the calculated nutritive value of *P. equisetiforme* stems (410.01 Kcal/100g) was the highest, followed by *C. iberica* flower (392.46 Kcal/100g), *R. spinosus* flower (387.73 Kcal/100g), *N. syriaca* flower (381.58 Kcal/100g), *S. asper* leaf (375.83 Kcal/100g) and *S. asper* stem (371.34 Kcal/100g). The calculated nutritive value of *S. marianum* leaf, *S. arvensis* leaf, *V. sinuatum* leaf, *C. getulus* leaf, and *C. iberica* leaf were estimated to be the lowest (286.75 Kcal/100g), (307.81 Kcal/100g), (314.77 Kcal/100g), (321.1 Kcal/100g), and (330.74 Kcal/100g), respectively as shown in Table 5.

In the current work, the maximum level of N was estimated in *S. arvensis* leaf (2.76%), followed by *C. getulus* leaf (2.49%), *S. elaeagnifolium* leaf (2.26%), *S. elaeagnifolium* flower (2.14%), *A. spinosus* leaf (2.08%), *M. vulgare* leaf (1.90%), *A. graecorum* leaf (1.81%), *P. equisetiforme* leaf (1.78%), and *C. iberica* flower (1.59%). *P. equisetiforme* stem had the least amount of N (0.44%), followed by *S. asper* stem (0.54%), *S. arvensis* flower (0.63%), *N. syriaca* stem (0.63%), *S. marianum* flower (0.63%), *S. marianum* leaf (0.7%), and *H. subaxillaris* leaf (0.77%).

Centaurea iberica leaf (0.28%) had the highest phosphorus (P) concentrations, followed by *S. arvensis* leaf (0.26%), *C. iberica* flower (0.26%), *R. spinosus* flower (0.25%), *N. syriaca* flower (0.25%), and *C. getulus* leaf (0.25%). Conversely, the minimum value of P was found in the *P. equisetiforme* leaf (0.18%), followed by the *V. sinuatum* leaf (0.20%). The leaves of *G. coronaria*, the flowers of *S. marianum*, the stem of *A. graecorum*, the leaves of *S. asper*, and the leaves of *S. elaeagnifolium* all had a P content of (0.21%). Furthermore, the stems of *P. equisetiforme* and the leaves of *A. graecorum* had a P content of (0.22%).

Table 5. Nutritive value in some selected plant species from the study area

Botanical name	Plant part used	Nutritive value Kcal/100g
Polygonum equisetiforme	Leaf	363.96
	Stem	410.01
Silybum marianum	Leaf	286.75
	Flower	371.1
Sonchus asper	Leaf	375.83
	Stem	371.34
Verbascum sinuatum	Leaf	314.77

Alhagi graecorum	Leaf	348.56
	Stem	368.37
Amaranthus spinosus	Leaf	345.34
Notobasis syriaca	Flower	381.58
	Stem	362.47
Solanum elaeagnifolium	Leaf	365.14
	Flower	368.39
Carduus getulus	Leaf	321.1
Centaurea iberica	Leaf	330.74
	Flower	392.46
Sinapis arvensis	Leaf	307.81
	Flower	352.48
Marrubium vulgare	Leaf	343.39
	Flower	354.85
Heterotheca subaxillaris	Leaf	371.75
Rumex spinosus	Leaf	355.38
	Flower	387.73
Glebionis coronaria	Leaf	347.87
	Flower	369.05

Sinapis arvensis flowers had the highest estimated potassium (K) content (4.33%), followed by the *M. vulgare* leaves (3.93%), the *C. getulus* leaves (3.76%), the *S. asper* leaves (3.54%), the *S. asper* stems (3.52%), the *S. elaeagnifolium* flowers (3.32%), and the *M. vulgare* flowers (3.15%). The lowest level of K was recorded in *P. equisetiforme* stems (0.79%), *C. iberica* leaf (0.94%), *R. spinosus* flower (2.12%), *S. arvensis* leaf (2.21%), *H. subaxillaris* leaf (2.34%), *V. sinuatum* leaf (2.42%), and *N. syriaca* flower (2.56%).

Plant biodiversity plays a vital role in human health and serves as a crucial resource for livestock feed. The findings align with previous research, which suggests that lipid and moisture contents can vary between species due to genetic and environmental factors. Variations in moisture content often relate to the plants' ecological roles and water retention mechanisms (Brown et al. 2022).

According to Ullah et al. (2023), the ash content shows the total amount of elements and is linked to the biological traits of the plant specimen. This is why medicinal plants typically exhibit a high level of ash content (Keta et al. 2018). Combustion produces ash content, which serves as an indicator of a food's overall mineral composition. The quantity of ash after burning plant material can vary significantly based on the plant's age, time of burning, and the specific plant organ involved (Karagozoglu and Kiran 2023). The results of this research work mentioned that the maximum level of ash content was detected in the leaf *S. marianum* (29.1%), followed by the leaf of *C. getulus* (24.4%), the leaf of *S. arvensis* (24.1%), the leaf of *V. sinuatum* (22.4%), the leaf of *C. iberica* (18.8%), the leaf of *S. asper* (16.2%), and the leaf of *M. vulgare* (16.1%). Conversely, the findings of the current research showed that the minimum ash content was found in the stem of *P. equisetiforme* (4.3%), the flower of *R. spinosus* (5.6%), the flower of *C. iberica* (8%), the stem of *A. graecorum* (8.7%), the flower of *G. coronaria* (9%), the flower of *N. syriaca* (9.21%), and the flower of *S. marianum* (9.2%).

Carbohydrates are regarded as one of the most abundant compounds in living plants. They play a vital part in energy production in the body, and a deficiency can lead to tissue damage (Berto et al. 2015; Ullah et al. 2023). In the current work, leaves, stems, and flowers were evaluated for the total carbohydrate content, and a notable difference was observed between the various samples. Total carbohydrates in leaf samples ranged from (81.1%) in *P. equisetiforme* to (56.2%) in *C. getulus. P. equisetiforme* had the highest value of estimated total carbohydrate in its stems (86.1%), while *S. asper* had the lowest at (73.3). Additionally, we estimated the maximum carbohydrate in the flowers of *R. spinosus* (83.7%) and the lowest value in the flowers of *S. elaeagnifolium* (72.2%).

Previous studies utilized the Kjeldahl method to determine protein content. Protein is crucial as a building material for skin, bones, muscles, and other body tissues. According to reports, plants provide about (12%) of the caloric value of protein, which makes up approximately (20%) of the human organism (Satter et al. 2016).

The wide range of chemical and elemental components enhances the medicinal efficacy of the plant. Determining mineral elements in plants is crucial, as the concentration and types of minerals significantly affect the quality of numerous food items (Radha et al. 2021). Various botanical properties influence the presence and concentration of minerals in certain plants. The analysis of different elements in the plant species revealed their presence in all samples, highlighting their importance in treating various illnesses. Several factors have contributed to the growing public enthusiasm for plant treatments, including the high costs and side effects of many modern medications (Radha et al. 2021).

In conclusion, the present investigation reveals that the fifteen plant species are valuable sources of medicinal and fodder resources. They not only aid in treating and alleviating diseases but also provide energy-rich nutrients essential for the growth and development of livestock. Some of these plant species are rich in carbohydrates, proteins, fats, and fiber, which makes them helpful in treating malnutrition. These medicinal plants have a high nutritional value and contain significant amounts of essential minerals. In addition to treating various diseases, these plants can also be used as animal feed and nutritional supplements. Protecting and selecting important medicinal and fodder plant species is crucial, and further research is needed. Future studies should investigate how environmental elements such as soil type, water availability, and meteorological conditions influence these traits. Examining the lipid profile and certain moisture-retaining molecules could provide more insight into their potential use.

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