

Research Article

Ecology, ethnobotany and mineral contents of some species of Brassicaceae from Peshawar, Pakistan

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Abstract

The study was conducted in the Peshawar city to record the ecological characteristics, ethnobotanical profile and elemental composition of five members of Brassicaceae *i.e.* *Capsella bursa-pastoris* (L.) Medik., *Coronopus didymus* (L.) Smith., *Iberis amara* L., *Lepidium sativum* L. and *Sisymbrium irio* L. Biological spectra indicated that all the plant species were therophytes with nanophyllous and microphyllous dominant followed by mesophyllous leaf sizes. The plant species had dissected leaf margins. Phenological behavior showed that most of the plants were at reproductive stage. Eleven major and three minor elements (C, N, O, Na, Mg, Al, Si, P, S, K, Ca, Cl, Fe and Cu) were observed. The Carbon percentage was highest (51.32%) in *Lepidium sativum* L. and lowest (42.07%) in *Capsella bursa-pastoris* (L.) Medik. The mineral nutrients are required for plant's healthy growth and these come from the soil which are dissolved in water and take up by plant's roots so minerals content shows the relationship of soil and plants. The availability of these minerals depends upon location, soil texture and its acidity (pH)

Keywords: Brassicaceae; Ecology; Elements; Ethnobotany; life forms; phenology; Peshawar

Introduction

District Peshawar is the sixth largest city of Pakistan and capital city of the province of Khyber Pakhtunkhwa which is famous for its historic economic and cultural values. The district is situated between 35° 50' 37 north latitude and 71° 21' 45 east longitude. It is around 1173 feet (357.53 m) above sea level. It is bounded by Charsadda District on the north, Nowshera District on the east, tribal areas on the south, Mohmand District and Khyber agencies on the west (Fig. 1). The total

area of the district is 1,257 Km² which is almost plain. According to 2017 census report the city has a population of 1,970,042. The climate is extreme. Maximum temperature 38.7 °C was recorded in June 2017. Rainfall occurs in both Winter and Summer, 90.0 millimeters rainfall was measured in July 2017 (Table 1). Peshawar has a fertile land because of closeness to Kabul River making it more suitable for agricultural crops.

The Brassicaceae or Cruciferae family is one of the largest plant families. This family is commonly known as the mustard family having about 372 genera and 4060 species. They have worldwide distribution, mostly found at temperate regions and cooler climates. There are more than 10 economically important ornamental and crop species in this family which were domesticated and are grown worldwide [1]. Brassicaceae Vegetables are rich in polyphenols, flavonoids and glucosinolates, and their hydrolysis products, have antibacterial, antioxidant and anticancer

properties [2]. The antimicrobial potency of *Brassica oleracea* L. var. *italica* and *Brassica oleracea* L. var. *botrytis* against multiple drug resistance (MDR) bacteria has been investigated by Touani *et al.* [3] *Arabidopsis thaliana* (L.) Heynh., has become a model organism in studies of development, embryology, gene expression, and genome evolution and organization because of its low chromosome number ($n=5$), compact genome and rapid life cycle [4]. The potential of *Vigna radiata* L. and *Brassica campestris* L. for cadmium accumulation and tolerance has been investigated by Anjum *et al.* [5].

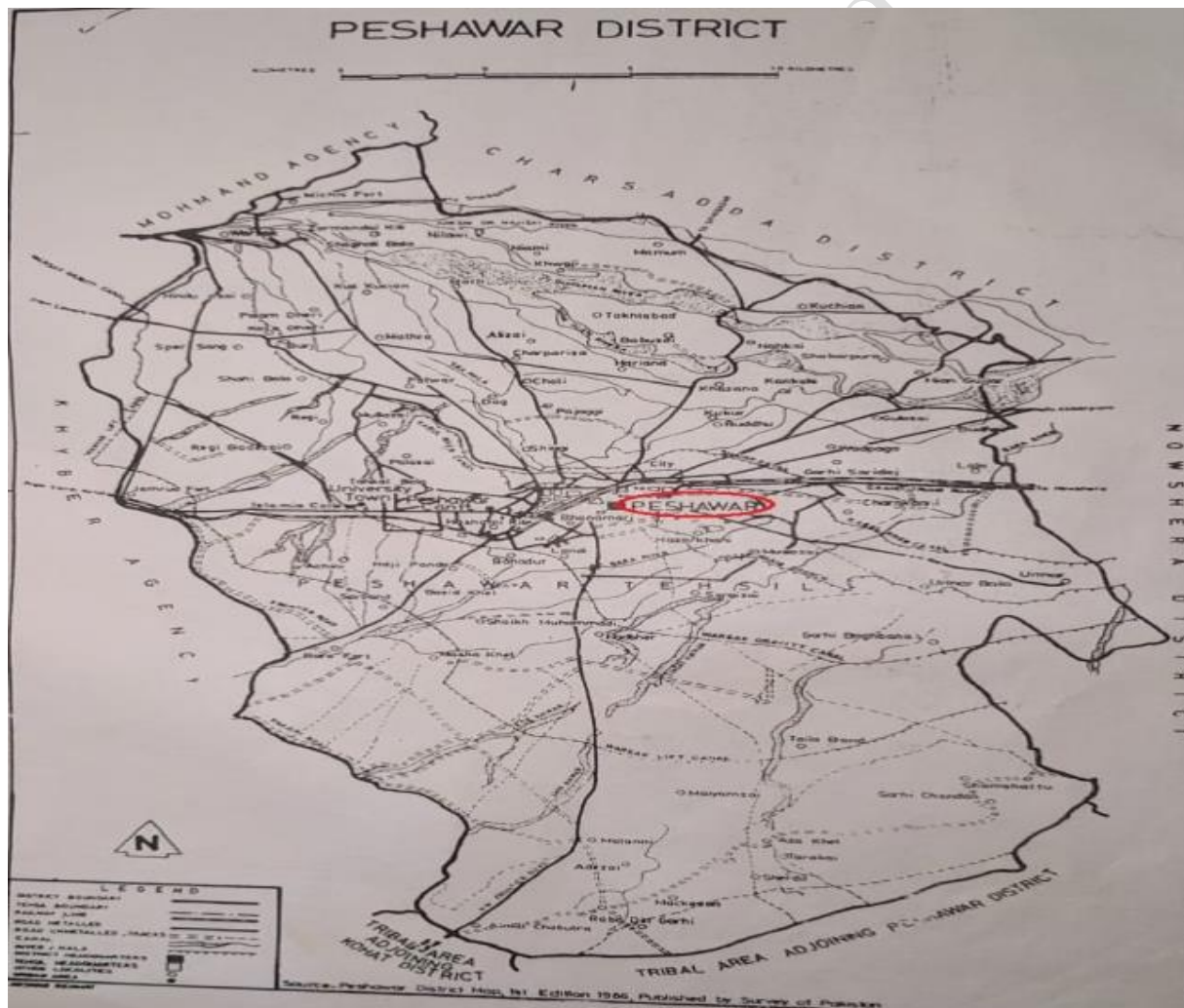


Figure 1. Map of the research area

Table 1. Temperature and Rainfall Data of District Peshawar during 2017

S.No.	Months	Monthly Temperature (°C)		Monthly Rainfall (mm)
		Minimum(°C)	Maximum(°C)	
1.	January	6.3	16.7	53.4
2.	February	8.2	22.4	31.0
3.	March	11.8	26.1	21.5
4.	April	17.7	33.6	30.0
5.	May	22.9	38.4	2.0
6.	June	25.6	38.7	43.0
7.	July	26.0	37.0	90.0
8.	August	25.4	35.6	83.0
9.	September	22.1	35.5	10.0
10.	October	16.3	32.9	0.0
11.	November	10.0	23.7	61.0
12.	December	4.9	22.0	12.3

Materials and Methods

Plant species, *Capsella bursa-pastoris* (L.) Medik., *Coronopus didymus* (L.) Smith., *Iberis amara* L., *Lepidium sativum* L. and *Sisymbrium irio* L. were collected to describe their ecological features, ethnobotanical uses and elemental composition. The plants were identified with the help of Flora of Pakistan [6]. Plant species were collected from the University of Peshawar during different season of the year 2018 and 2019. Voucher numbers were assigned to plant species and deposited in the Herbarium of Department of Botany, University of Peshawar (Table 2). The ecological characteristics were reported following by Raunkiaer as cited by Hussain

[7, 8]. The ethnomedicinal information was collected from the local inhabitants and hakeems. Elemental analysis of species was carried out by using Energy Dispersive X-ray spectrometer with Scanning Electron Microscope (EDX, model Inca 200 with SEM, JSM5910) installed at Centralized Resource Laboratory, University of Peshawar. For analysis powder specimen was placed on metallic stub using double sided cello tape, coated with silver. The stub was then placed on the stage of model vacuum evaporator. By this way elements were confirmed using EDX attached to an electron microscope.

Table 2. Biological spectra of plant species of Brassicaceae

S. No.	Plant species	Life form	Leaf size	Leaf shape	pheno logy	Voucher number	
A.	Angiosperms						Voucher number
a.	Dicots						
1.	Family Brassicaceae						
1.	<i>Capsella bursa-pastoris</i> (L.) Medik.	Th	Mic	D	S2		
2.	<i>Coronopus didymus</i> (L.) Smith.	Th	N	D	S1	<i>K Sultan 2</i> (PUP)	
3.	<i>Iberis amara</i> L.	Th	N	D	S2	<i>K Sultan 3</i> (PUP)	
4.	<i>Lepidium sativum</i> L.	Th	Mic	D	S3	<i>K Sultan 4</i> (PUP)	
5.	<i>Sisymbrium irio</i> L.	Th	Mes	D	S2	<i>K Sultan 5</i> (PUP)	

Keys: 1. Th. Therophytes 2. N. Nanophylls 3. Mic. Microphylls 4. Mes. Mesophylls 5. D. Disected 6. S1 Vegetative stage 7. S2 Reproductive stage 8. S3 Post reproductive stage

Results and discussion

During the present research five plant species of Brassicaceae *Capsella bursa-pastoris*, *Coronopus didymus*, *Iberis amara*, *Lepidium sativum* and *Sisymbrium irio* were collected for their ecological, ethnobotanical and phytochemical evaluation. Biological spectra showed that all plant species were Therophytes (100%). Data showed that Nanophyllous and Microphyllous (40%) were dominant leaf size classes followed by Mesophyllous (20%) (Table 3; Fig.2). All plant species had dissected leaf margins (100%). This is the taxonomic characteristic of Barassicaceae. Phenological stages showed that maximum plants were in reproductive S2 Stage (60%) followed by pre-reproductive S1 and post reproductive S2 Stages both with (20%) (Table 3; Fig. 3). The investigated species were used as medicinal (60%), fodder (20%), Vegetable and Ornamental each with (10%) (Table 4; Fig.4). Aerial parts and seeds were the leading plant part used. Alkaloids, flavonoids, essential oils and amino acids were the active constituents of the investigated plants. Nose bleeding, coughs, rheumatism, respiratory and heart problems were the major diseases treated by these plants. Eleven major and three minor elements were analyzed. Maximum Carbon (51.32%) was observed in *Lepidium sativum* followed by *Iberis amara* (48.40%) and *Coronopus didymus* (45.00%). Highest Nitrogen (9.85) was found in *Lepidium sativum* followed by *Sisymbrium irio* (8.72%) and *Iberis amara* (7.75%). *Capsella bursa-pastoris* possessed highest Oxygen (38.67%) succeeded by *Lepidium sativum* (37.32%) and *Sisymbrium irio* (37.17%). Sodium (0.73%) was highest in *Iberis amara* followed by *Coronopus didymus* (0.35%) and *Capsella bursa pastoris* (0.29%). Magnesium ranged from (1.01%) in *Capsella*, (0.80%) in *Iberis*, *Lepidium* and *Coronopus* each with (0.56%).

Iberis amara possessed maximum Aluminium (1.33%) followed by *Capsella bursa-pastoris* (0.86%) and *Coronopus didymus* (0.59%). *Iberis amara* contained highest Silicon (3.73%) followed by *Capsella bursa-pastoris* (2.22%) and *Coronopus didymus* (1.95%). Maximum Phosphorus (1.01%) was observed in *Capsella bursa-pastoris* followed by *Coronopus didymus* (0.64%) and *Lepidium sativum* (0.53%). *Lepidium sativum* had highest value of Sulphur (1.73%) followed by *Coronopus didymus* (1.70%) and *Capsella bursa-pastoris* (1.18%). Maximum Potassium (1.01%) was observed in *Coronopus didymus* followed by *Sisymbrium irio* (6.09%) and *Iberis amara* (5.15%). *Capsella bursa-pastoris* possessed maximum content of Calcium (6.37%) followed by *Iberis amara* (5.23%) and *Coronopus didymus* (4.22%). Maximum Chlorine (1.65%) was observed in *Coronopus didymus* followed by *Iberis amara* (1.44%) and *Sisymbrium irio* (1.38%). Maximum Ferrous (1.53%) was observed in *Iberis amara* followed by *Coronopus didymus* (1.28%) and *Capsella bursa-pastoris* (1.00%). *Sisymbrium irio* possessed (0.08%) of Copper (Table 6). Members of Brassicaceae have a main role in Phyto remediation technology. Many wild species of this family hyper accumulate heavy metals and possess genes for resistance to the toxic effects of a wide range of metals [9]. Brassicaceae contain vegetable crop and important model plant species in comparative evolutionary research such as *Arabidopsis*, *Brassica* and *Arabis* species [10]. Total isothiocyanates content (ITC) is a good indicator of bioactive compounds responsible for beneficial effects related to vegetables in Brassicaceae [11]. The present research is the first ever report on the investigated plant species in this area which will help in future intensive and extensive researches on the plant species.

Table 3. Life form, leaf size and leaf shape of plant species of Brassicaceae

A. Life form classes

S.No.	Life form classes	No. of species	Percentage (%)
i.	Therophytes (Th)	5	100
Total		5	100

B. Leaf sizes classes

S. No.	Leaf sizes classes	No. of species	Percentage (%)
i.	Nanophylls (N)	2	40
ii.	Microphylls(Mic)	2	40
iii.	Mesophylls (Mes)	1	20
Total		5	100

C. Leaf shapes D. Phenological stages

S. No.	Parameters	No. of species	Percentage (%)
C.	Leaf shapes		
1.	Dissected (D)	5	100
Total		5	100
D.	Phenological stages		
1.	Reproductive stage (S2)	3	60
2.	Pre-reproductive stage (S1)	1	20
3.	Post reproductive stage (S3)	1	20
Total		5	100

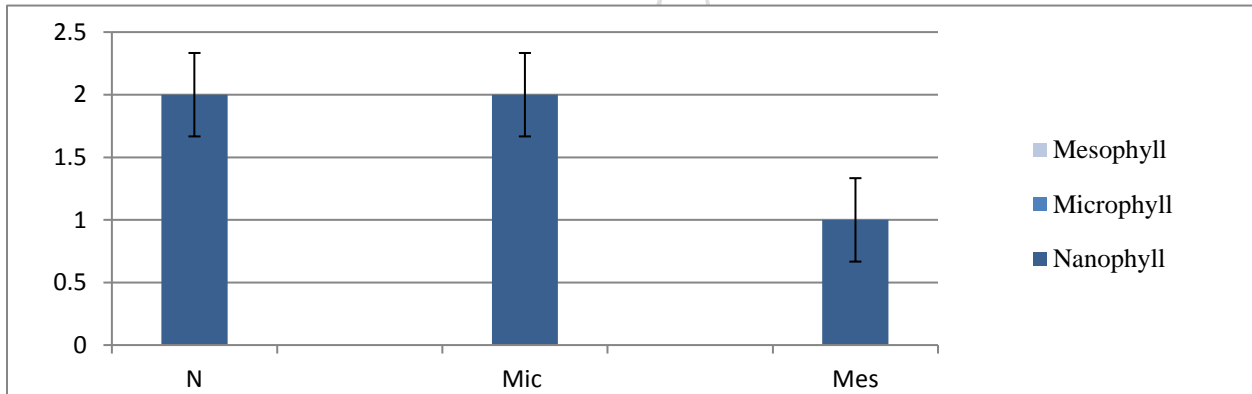


Figure 2. Error bars for the leaf sizes

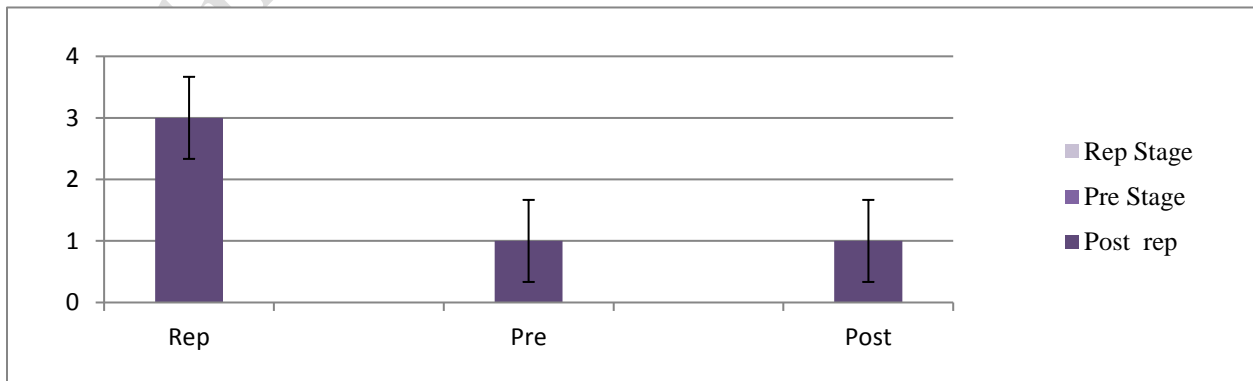
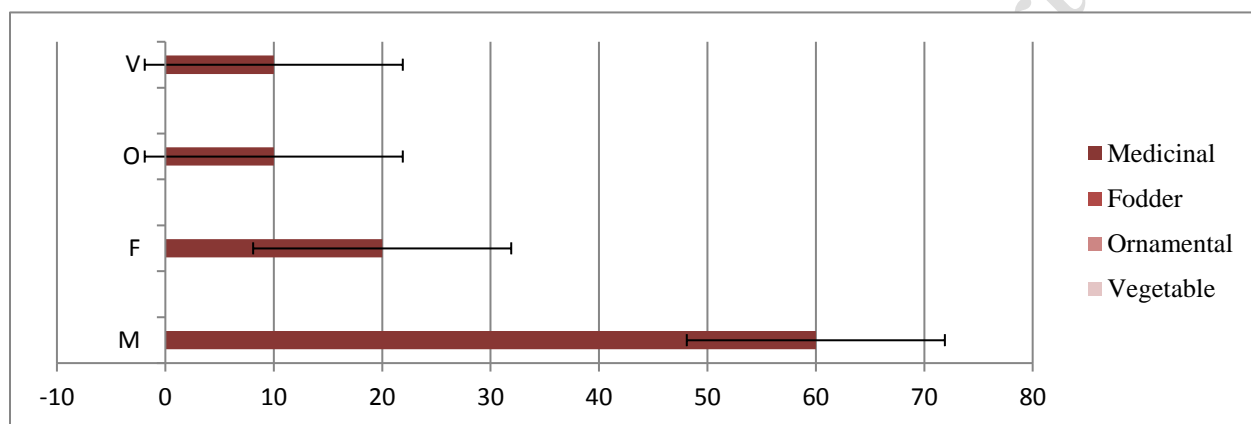


Figure 3. Error bars for the phenological stages

Table 4. Ethnobotanical profile of plants of Brassicaceae

S.No.	Plants speices	1	2	3	4	Vernacular names
1.	Brassicaceae					
1.	<i>Capsella bursa-pastoris</i> (L.) Medik.	+	-	+	-	Shepard's purse
2.	<i>Coronopus didymus</i> (L.) Smith.	-	-	+	-	Swine cress
3.	<i>Iberis amara</i> L.	-	-	-	+	Bitter candy tuft
4.	<i>Lepidium sativum</i> L.	+	+	-	-	Garden cress
5.	<i>Sisymbrium irio</i> L.	+	-	+	-	London rocket
Total		3	1	2	1	
Percentage		60	10	20	10	

Keys: 1: Medicinal 2: Vegetable 3: Fodder 4: Ornamental

**Figure 4. Error bars for the local uses of plants****Table 5. Ethnomedicinal uses of plant speices of Brassicaceae**

S. No.	Plant species	Part used	Chemical constituents	Diseases/Health problems	Mode of application
1.	<i>Capsella bursa-pastoris</i> (L.) Medik.	Aerial parts	Flavonoids	Nose bleeding and Heart diseases	The fresh shoots are cooked as vegetable and eaten.
2.	<i>Coronopus didymus</i> (L.) Smith.	Leaves	Essential oils, alkaloids, flavones, chrysoeriol and stigmastanol	Anti-inflammatory, rheumatism, headache, antipyretic and wound healing	Leaves are edible.
3.	<i>Iberis amara</i> L.	Seed	Essential oils, Amines, cucurbitacines, flavonoglycosides and mustard oil glycosides.	Gout, antirheumatic, anti-asthmatic, antiscorbutic and arthritis	The plants are almost entirely edible as a bitter herb.
4.	<i>Lepidium sativum</i> L.	Seed and Aerial portion	Amino acids	Respiratory problems	The seeds and fresh leaves are eaten.
5.	<i>Sisymbrium irio</i> L.	Aerial portion and seed	Essential oil and Alkaloids	Coughs, rheumatism and antiwormal	The fresh aerial portion are cooked and eaten. Seed powder is used as antiwormal.

Table 6. Elemental composition of plant species of Brassicaceae

S. No.	Plant species	Elements (%)													
		Major elements												Minor elements	
		C	N	O	Na	Mg	Al	Si	P	S	K	Ca	Cl	Fe	Cu
1.	<i>Sisymbrium irio</i> L.	44.35	8.72	37.17	0.26	0.32	0.26	0.58	0.45	0.94	6.09	3.43	1.38	0.45	0.08
2.	<i>Capsella bursa-pastoris</i> (L.) Medik.	42.07	7.58	38.67	0.29	1.01	0.86	2.22	1.01	1.18	5.06	6.37	1.08	1.00	–
3.	<i>Lepidium sativum</i> L.	51.32	9.85	37.32	0.15	0.56	0.38	1.13	0.53	1.73	4.72	3.47	0.62	0.87	–
4.	<i>Iberis amara</i> L.	48.40	7.75	35.82	0.73	0.80	1.33	3.73	0.46	1.12	5.15	5.23	1.44	1.53	–
5.	<i>Coronopus didymus</i> (L.) smith.	45.00	7.67	36.63	0.35	0.56	0.59	1.95	0.64	1.70	6.99	4.22	1.65	1.28	–

Conclusion

The Raunkiaerian classification of investigated plant species showed that all the plants were therophytes with nanophyllous and mesophyllous leaf sizes. The plant species were used for various local uses in the research area. The mineral contents were found in permissible quantities. It was also concluded that the plant species showed vigorous growth in the research area due to prevailing favorable climatic and edaphic factors.

Authors' contributions

Conceived and designed the experiments: K Sultan & A Gulshad, Performed the experiments: K Sultan, Analyzed the data: K Sultan & S M Shah, Contributed materials/analysis/ tools: K Sultan & M Mujeeb, Wrote the paper: K Sultan.

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