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Phytosociological and ethnobotanical attributes of *Zantoxylum armatum* DC

Barkatullah*, Muhammad Ibrar, Ghulam Jelani, Rahmanullah, Maryam Ehsan

Department of Botany, University of Peshawar, Peshawar, Pakistan

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Abstract

Zanthoxylum armatum is a shrub or a small tree grows in shady places at a height ranges from 800m-1500m in Malakand, Swat, Dir, Hazara, Buner, Muree hills and Rawalpindi. It is an important medicinal plant used for stomach and gastric problems. Unripe fruit is used as coolant agent in summer. Young twigs were made in to toothbrush for teeth cleaning and for gum diseases. A total of 51 species including 12 trees, 14 shrubs and 25 herbs and grasses were recorded in association all the six stands studied for phytosociological attributes of *Z. armatum*. *Ailanthus altissima*, *Ajuga bracteosa*, *Cynodon dactylon*, *Dicanthium annulatum, Dodonaea viscosa, Olea ferruginea* and *Rubus fruiticosus* were the constant species while *Artemisia scoparia* and *Conyza canadensis* were the mostly present species with *Z. armatum*. Highest Density hectare^{-1} value was found in Peto Dara lower Dir while lowest value was recorded from Tor warsak, District Buner

*Corresponding Author: Barkatullah ✉ barkatullah@upesh.edu.pk

Introduction

Z. armatum prefers semi shady or no shade for its growth. It grows wild in foothills starting from about 800m up to 1500m in Malakand, Swat, Dir, Hazara, Buner, Muree hills and Rawalpindi (Shinwari *et al.,* 2006). It is one of the most important medicinal plant locally known as "Dambara" It is spiny shrub or small tree. Stem is greyish brown and provided with spines. Leaves imperpinnate compound, winged petiolate with three to eleven leaflets. Leaflets sessile to subsessile with acute apex and slightly incised margins having central prominent vein and reticulate venation. Leaflets are from 20 to 80 mm in length and 12 to 25mm in width. Adaxial surface slightly shinny, dark green with translucent oil glands. Lower surface is light green. Flower small, sessile, yellowish white. Flowers polygamous i.e. both unisexual and bisexual, calyx; 6-8 sepals, corolla; absent, androcium; 6-8 stamens, gyoecium; 2-3 carpels. Fruit is red colored drupe, splitting into two when ripe. Seeds are rounded and black shining (Fig 1) (Hassan-Ud-Din & Ghazanfar, 1980).

Generally fruit of this plant is collected from April to June, packed in plastic bags and transported to the local market for sale. Wood and branches are cut specially in winter for fuel. Thick wood, which is covered with thick thorns, is harvested for making lethal sticks. Young twigs are harvested for making Maswak (toothbrush). Extensively used part was the fruit, which was dried, powdered and used as a spice in various dishes especially in Chat and Choolay (boiled gram). It was considered as a best stomachic and good for gastric problems. Some other workers reported it is a best remedy for stomach and gastric problems, (Arshad & Ahmad, 2004); Abbasi *et al*., 2010; and Sher *et al*., 2011) which confirm its traditional uses. Unripe fruit is mixed with liquid yogurt (Lassi) and used as coolant agent in summer. Young twigs were made in to toothbrush for teeth cleaning and for gum diseases. Abbasi *et al*. (2010) and Sher *et al*. (2011) also reported same uses of this plant in other parts of the country. The woods is cut into thick stick locally called as "Dambarsoote" used weapon of offence and defence. Similar findings were also reported by Barkatullah *et al*. (2009). Leaves are not used locally, but Negi & Kanwal, (2009) reported that leaves are used for mouth wash.

In the present study detail phytosociology and ethnobotanical studies were carried out in different localities of Malakand division, Khyber Pukhtunkhwa, Pakistan.

Phytosociology describes the association of plants in communities (Ewald, 2003). Vegetation diversity in a community is primarily determined by a co association of physical and chemical factors like water temperature, solar radiation, current flow velocity, which play a major role in determining floristic diversity in a given area (Hinterlang, 1992).

Ethnobotanical knowledge characterizes traditional knowledge to establish priorities in the local communities (Ibrar *et al.,* 2007) and establish an interaction of man and plants for sustainable development (Ahmad *et al.,* 2006). It makes the most important approach to study natural resource management by the people of mountains and remote areas (Iqbal & Hamayun, 2005). Now a day, these studies gain much popularty in the development of health care system in various parts of the world (Sardar & Khan, 2009). Plants are used since the dawn of civilization by human beings for readymade food, medicines for various ailments, fodder/forage for cattle, fuel, flower for celebration an decoration, sold to earn, honey collection, making agricultural tools, timber for construction and for many more useful items (Ahmad *et al.,* 2006; Iqbal & Hamayun). The ethnobotanical information also helps ecologists, pharmocologists, taxonomists, watershed and wild life managers in their efforts for improving the economic status of the locals in the remote area (Ibrar *et al.,* 2007). This integrated approach is also necessary for the conservation of medicinal plants as well as their habitat. Ethnobatanical information of the present

research plants were collected from inhabitants of the area where *Zanthoxylum armatum* grows.

Materials and methods

Phytosociology

Many trips to different localities were undertaken for phytosociological study of *Skimmia laureola* during 2008-2010. For this purpose six localities i.e Batkhela (Malakad), Laram (Lower Dir), Maidan (Lower Dir), Peto Dara (Lower Dir), Kabal (DistrictSwat) and Warsak (Buner) for *Zanthoxylum armatum* were selected (Fig. 2). For vegetation sampling those area were selected, where there were no signs of recent disturbance. Altitude, latitude and exposure were also recorded for each stand (Siddique *et al*., 2009). Quantitative data was recorded using 10 quadrates of 10x10 m, 4x 4m, and 1x 1m for trees, shrubs and herbs respectively. The herb cover was determined by the Daubenmire's cover scale (Daubenmire, 1959). Tree diameter at breast height (1.5m) (dbh method) was measured to obtain basal area (Hussain, 1989). Density, cover and frequency were measured and then these values were converted to relative density, relative cover and relative frequency for each species (Phillips, 1959). The Importance Value (IV) for the species was determined as the sum of the relative frequency, relative density and relative coverage. Dividing this value by 3, Importance value index (IVI) was obtained (Curtis & Cottam, 1956). IV is used for determining dominant species in each stand. Density per hectare was calculated following Mueller-Dombois & Ellenberg, 1974.

Soil analysis

Soil samples from the habitat of the proposed plants were collected at a depth of 0-15 cm. The samples were air dried and analyzed for physicochemical characteristic including

Soil texture (Piper, 1966), Soil organic matter (Rayan *et al*., 1997), Nitrogen contents (Subbiah & Asija, 1956). Phosphorus (Watanabe & Olsen, 1965), Pottassium, Iron, Zinc, Cupper (Jackson, 1958) and pH (Hussain, 1989).

Ethnobotany

Open questionnaire was prepared to interview local inhabitants, hakims and pansaries (local medicine man) for ethnobotanical excursion of *Z. armatum* during the field surveys of different localities. Questionnaire was filled on the spot as majority of the respondents were illiterate. Vernacular names, harvesting, collection, processing methods and manner of recipe used to treat human ailments along with other ethnobotanical uses were recorded for the this plant. Eighty four respondents, including pansaries, elder knowledgeable people (both men and women), having information about the plant, were interviewed. Only that information was considered authentic and reported, when at least 10 interviewees attested to the name and usage of the plants (Barkatullah *et al*., 2009).

Fig. 1. *Zanthoxylum armatum*. a. flowers b. fruits c. leaves d. stem bark.

Market survey

Market surveys were carried out in nearby area of their natural habitats in order to get data from local collectors, purchasers and dealers of the proposed research plants for their collection, storage, packing and marketing status (Hamayun *et al*., 2003).

Results and discussions

Phytosociology of Zanthxylum armatum

Z. armatum is a shrub or small tree in nature, found in mixed community with other plants. Six

localities in Khyber Pukhtunkhwa, Pakistan were studied to expose the phytosociological relation of *Z. armatum*. This plant was found to grow on the north and north west slope at an elevation of 2800-4650 feet (Table 1, Fig. 2).

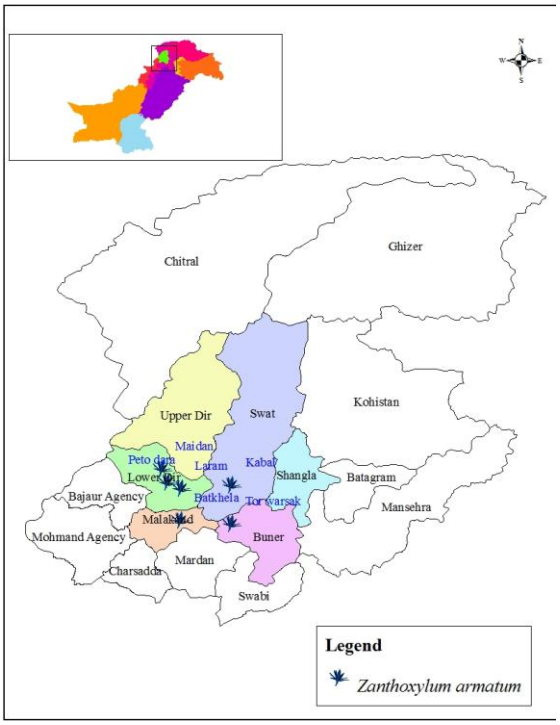

Fig. 2. Map representing natural habitate of *Zanthoxylum armatum*.

A total of 51 species including 12 trees, 14 shrubs and 25 herbs and grasses were recorded in association with *Z. armatum* in all the stands. *Ailanthus altissima*, *Ajuga bracteosa*, *Cynodon dactylon*, *Dicanthium annulatum, Dodonaea viscosa, Olea ferruginea* and *Rubus fruiticosus* were the constant species while *Artemisia scoparia* and *Conyza canadensis* were the mostly present species with *Z. armatum*. 12 species were found to be often present, 3 species were seldom and rests of the 25 species were the rare species found in only one stand (Table 2).

Z. armatum was found dominant in one site, while in rest of the sites, it was the second dominat species among the shrubby plants, on the basis of importance value (Table 2). Various numerical values for *Z. armatum* were worked out, which include average importance value (16.09) and average importance value index (5.38). Other shrubby species found in co-dominance were *Cotoneaster nummularia, Dodonaea viscosa, Gymnosporia royleana, Indigofera heterantha, Justicia adhatoda* and *Rubus fruiticosus* with variable importance values (Table 2). The herbs and grasses ranged in number from 12-14 in all stands showing rich ground flora. *Dicanthium annulatum* was recorded in five stands, was the most dominant ground specie with average importance value of 49.39 followed by *Heteropogon contortus,* recorded in three stands having average IV of 30.34 and *Sonchus asper* found in just one stand with IV of 24.90. *Datura innoxia*, *Plantago lanceolata, Oxalis corniculata* and *Parthenium hysterophorus* were also observed with comparatively highest importance values of 20.34, 23.19,20.32 and 20.40 respectively. Although *Cynodon dactylon* was observed to be constant species with *Z. armatum,* but having a comparatively lower IV (16.10) than the other grasses. In the ground flora just three species i.e. *Ajuga bracteosa, Cynodon dactylon* and *Dicanthium annulatum* were found constant species according to Raunkiaer (1934) constancy classification. It was observed that ground flora was found variable in all stands with variable importance values. 5-7 tree species were present in association with *Z. armatum*, in which *Ailanthus altissima* and *Olea ferruginea* were the constant species with average IV of 10.88 and 17.69 respectively. *Celtis australis*, *Melia azedarach* and *Reptonia buxifolia* were in class III of constancy classes. *Ficus elastica*, *Ficus racemosa*, *Robinia pseudocacia* and *Zizypus oxyphylla* were the rare species.

Density hectare^{-1} values were also recorded in all the stands of *Z. armatum* which ranged from 560 to 1020. Highest value was found in Peto Dara lower Dir while lowest value was recorded from Tor warsak, District Buner (Fig 3).

Correlation of altitude with Density hectare-1, importance values and importance value indices was observed through linear regression analysis. Little significant correlation was found between altitude and Density hectare-1(r^2= 0.3615, P

>0.001). Weak correlation was found with Importance values (r^2= 0.0613, P >0.001) and importance values indices (r^2= 0.1676, P >0.001). Similarly there was no significant correlation present between density hectare^{-1} and importance values (r^2= 0.0.01794, P >0.001) (Fig. 4). These results are in line with that of Siddique *et al.* (2009) and Khan *et al.* (2010), which strengthen these findings.

Soil analysis

Physical and chemical characteristics of soil are the indication of habitat for an organism. The forest land exhibited variation due to difference in available natural resources such as parent materials, vegetation litter and other physicochemical characteristics. Similarly soil composition is also affected by many other anthropogenic activites leading to variation in soil texture, soil nutrients and pH etc (Rashid *et al.*, 2011). Soil profile, soil pH and various nutrients present in the soil are important parameters of soil analysis and effect the growth and distribution of plants (Sharma & Kumar, 1991). Soil analysis from six different habitat of *Z. armatum* were carried out for physical, chemical and biological properties. Texture of the soil was found to be loamy in three sites while clay loam in the other three sites (Table 4). Nitrates contents were varied from 19.53 to 35.89 ppm. Phosphorus and Potassium found maximum for Charkotli hills, Batkhela, while in other areas these have variable amount. Fe, Zn and Cu were also variable values from all localities. The pH of soil ranged from 6.00-6.10 clearly showing that soil in all site was weak acidic with organic contents ranging from 1.00 to1.01 (Table 4). Other workers like Khan *et al.* (2010), Rashid *et al.*, (2011) and *Ali et al.*, (2011) also conducted similar studies and reported that deforestation and soil erosion greatly affected soil nutrient composition both quantitatively and qualitatively. Our findings are consistent with their reports.

Table 1. Localities selected for *Zanthoxylum armatum* phytosociological studies.

S. No.	Locality	Aspect	Slop	Altitude(Feet)	Coordinates
1	Charkotli hills Batkhela	North facing	Moderate to high	2800-2850	34° 34′ 57.48″ N 71° 59′ 10.40″ E
2	Laram- lower Dir	North facing	Moderate to high	4600-4650	34° 47′ 15.07″ N 71° 59′ 25.23″ E
3	Maidan -Lower Dir	North facing	Moderate to high	3300-3350	34° 54′ 52.61″ N 71° 52′ 01.59″ E
4	Peto dara- lower Dir	North facing	Moderate to high	4250-4300	34° 49′ 36.40″ N 71° 54′ 07.42″ E
5	Panda khan kale -Kabal Swat	North facing	Moderate to high	3200-3250	34° 48′ 26.37″ N 71° 54′ 07.42″ E
6	Tor warsak District Buner	North facing	Plain	2950-3000	34° 33′ 43.00″ N 72° 18′ 40.14″ E

Table 2. Summary of the of the phytosociological attributes of *Zanthxylum armatum* and associated flora in sampling areas. Species are listed in alphabetical order.

S. No	Species name	No, of STP*	Constancy	Importance Value (IV)			Importance value Index (IVI)		
				Max.	Min.	Aver.	Max.	Min.	Aver.
1	*Achyranthus aspera* L.	3	III	15.97	12.14	14.06	4.05	2.99	3.52
2	*Ailanthus altissima* (Miller) Swingle	5	V	19.45	2.31	10.88	6.48	0.71	3.60
3	*Ajuga bracteosa* Wall ex. Benth.	5	III	11.87	5.62	8.75	3.96	1.94	2.95
4	*Artemisia scoparia* Waldst. & Kit.	4	IV	12.65	4.71	8.68	3.87	1.43	2.65
5	*Barberis lyceum* Royle	1	I	7.49	7.49	7.49	2.50	2.50	2.50
6	*Calotropis procera* (Ait) R. Br	1	I	1.84	1.84	1.84	0.61	0.61	0.61
7	*Cannabis sativa* L.	1	I	21.97	21.97	21.97	7.32	7.32	7.32
8	*Celtis australis* L.	3	II	7.01	4.50	5.76	2.34	1.50	1.92
9	*Conyza canadensis* (L.) Cronquist	4	IV	5.44	9.10	7.27	1.81	1.34	1.58
10	*Cotoneaster nummularia* Fischer & C. A. Meyer	3	III	9.11	5.54	7.33	3.04	1.62	2.33
11	*Cynodon dactylon* (L.) Pers	5	V	28.65	3.54	16.10	9.59	3.04	6.32
12	*Datura innoxia* Miller	1	I	20.34	20.34	20.34	6.78	6.78	6.78
13	*Debregeasia saeneb* (Forsskal) Hepper & Wood,	2	I	6.92	4.81	5.87	2.31	1.60	1.96
14	*Dicanthium annulatum* (Forsk.) Stapf.	3	V	76.91	21.87	49.39	25.9	8.93	17.44
15	*Dodonaea viscosa* (L.) Jacq	5	V	29.19	8.63	18.91	9.73	2.88	6.31
16	*Dryopteris crenata* (Forssk.) Kuntze,	1	I	11.57	11.57	11.57	3.86	3.86	3.86
17	*Euphorbia prostrata* Aiton.	1	I	4.98	4.98	4.98	1.66	1.66	1.66
18	*Ficus elastica* Linn	1	I	4.70	4.70	4.70	1.57	1.57	1.57
19	*Fragaria indica* Andrew	3	III	22.03	22.09	22.06	7.97	6.50	7.24
20	*Geranium Wallichianum* D.Don Ex Sweet.	2	I	15.65	6.74	11.20	5.22	2.16	3.69
21	*Grewia optiva* J. R. Drumm. ex Burret.	1	I	1.84	1.84	1.84	0.61	0.61	0.61
22	*Gymnosporia royleana* Wall. ex Lawson	4	IV	12.85	3.92	8.39	4.28	1.32	2.80
23	*Heteropogon contortus* (L.) Beauv. ex Roemer & JA Schultes	3	III	38.82	22.03	30.43	12.9	6.62	9.79
24	*Indigofera heterantha* L.	3	III	10.68	9.15	9.92	3.56	3.05	3.31
25	*Justicia adhatoda* L.	2	II	33.13	15.86	24.50	11.1	5.29	8.22
26	*Medicago minima* (L.) Bartal.	3	III	9.69	10.39	10.04	3.33	3.06	3.20
27	*Melia azedarach* L.	3	III	8.05	6.74	7.40	2.68	2.25	2.47
28	*Micromeria biflora* (Buch.-Ham. ex D. Don) Benth.	2	II	7.97	5.82	6.90	2.66	1.94	2.30
29	*Nerium indicum* - Mill.	3	III	5.41	2.21	3.81	1.67	0.74	1.21
30	*Olea ferruginea* Royle	5	V	17.69	1.68	9.69	5.90	0.56	3.23
31	*Otostegia limbata* (Bth.) Boiss	3	III	5.67	3.33	4.50	1.92	1.11	1.52
32	*Oxalis corniculata* L.	3	III	17.80	22.84	20.32	5.79	5.32	5.56
33	*Parthenium hysterophorus* L.	1	I	20.44	20.44	20.44	6.87	6.87	6.87
34	*Periploca aphylla* Dcne.	1	I	2.80	2.80	2.80	0.93	0.93	0.93
35	*Pinus roxburghii* Sarg.	1	I	15.79	15.79	15.79	5.20	5.20	5.20
36	*Plantago lanceolata* L.	1	I	23.19	23.19	23.19	7.70	7.70	7.70
37	*Reptonia buxifolia* (Falc.) A. DC.	3	II	13.60	3.75	8.68	4.53	1.57	3.05

38	*Robinia pseudocacia* L.	1	I	4.46	4.46	4.46	1.49	1.49	1.49
39	*Rubus fruiticosus* Agg.	6	V	13.44	4.93	9.19	4.48	1.64	3.06
40	*Salvia lanata* Roxb.	1	I	19.91	19.91	19.91	6.64	6.64	6.64
41	*Salvia moorcroftiana* Wall.	1	I	9.74	9.74	9.74	3.25	3.25	3.25
42	*Solanum nigrum* L.	3	III	12.88	8.91	10.90	4.29	3.04	3.67
43	*Sonchus asper* L.	1	I	24.90	24.90	24.90	8.30	8.30	8.30
44	*Sorghum helepense* (L) Pers	1	I	4.51	4.51	4.51	4.29	4.29	4.29
45	*Tribulus terestris* L.	1	I	17.51	17.51	17.51	5.84	5.84	5.84
46	*Urtica dioica* L.	1	I	4.24	4.24	4.24	1.41	1.41	1.41
47	*Verbascum thapsus* L.	1	I	5.13	5.13	5.13	1.71	1.71	1.71
48	*Voila odorata* L.	1	I	9.81	9.81	9.81	3.27	3.27	3.27
49	*Xanthium strumarium* L.	3	III	8.46	4.05	6.26	2.82	1.27	2.05
50	*Zanthoxylum armatum* DC	6	V	19.60	12.57	16.09	6.56	4.19	5.38
51	*Zizyphus nummularia* (Burm. f.) Wight & Arn.	1	I	2.20	2.20	2.20	0.73	0.73	0.73
52	*Zizyphus oxyphylla* Edgew	1	I	2.01	2.01	2.01	0.67	0.67	0.67

*Number of stands present.

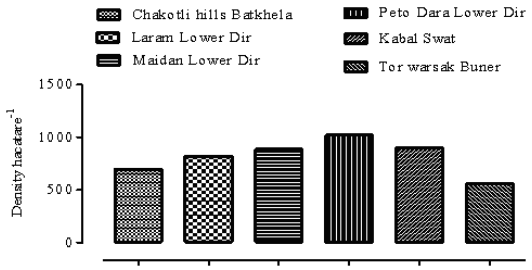

Fig. 3. Bar reperesent density hectare^{-1} values of *Zanthxylum armatum* in different localities.

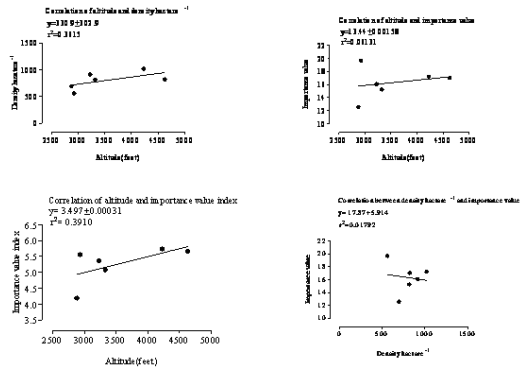

Fig. 4. Regression among some variables for phytosocialogical study of *Zanthoxylum armatum*.

As it was observed that biotic pressure and human activities have ruined the natural habitat, there for population density of *Z. armatum* was seem to be unstable. It is suggested to undertake precautionary measure for conservation of this and associated plants to save economy and environment.

Ethnobotany of *Zanthoxylum armatum*

Lcal name: Dambara

Part used: Leaves, Stem and fruit.

Harvesting and collection: Generally fruit is collected from April to June from the plants, packed in plastic bags and transported to the local market. Wood and branches are harvested especially in winter for fuel. Thick wood, which is covered with thick thorns is harvested for making defense sticks. Young twigs are harvested for Maswak (toothbrush) formation.

Uses: Extensively used part is the fruit, which is dried, powdered and used as condiment in various dishes specially Choolay (boiled gram). It is considered a best stomachic and good for gastric problems. Some other workers, Arshad & Ahmad (2004), Abbasi *et al* (2010) and Sher *et al.*, (2011) reported it as best remedy for stomachic and gastric

problems which conform the traditional uses. Unripe fruit are mixed as such with liquid yogurt (Lassi) in summer and used as coolant agent. Young twigs are made in to toothbrush and used for teeth cleaning and for gum diseases. Abbasi *et al* (2010) and Sher *et al*., (2011) also reported this plant for the same purposes, strengthening our findings. The woods is cut into thick stick locally called as " Dambarsoote" which is then used for offence and defence. Similar findings were also reported by Barkatullah *et al*., (2009). Although leaves are not used medicinally by the locals, but it is reported to used for mouth wash (Negi & Kanwal, 2009).

Table 3. Dominant shrubby species on the bases of important value in the selected localities for *Zanthoxylum armatum*.

S. No.	Locality	Ist dominant	2nd dominant	3rd dominant	Position of *Z. armatum*
1	Charkotli hills Batkhela	*Rubus fruiticosus*	*Zanthoxylum armatum*	*Gymnosporea royeleana*	2nd
2	Laram- lower Dir	*Dodonea viscose*	*Zanthoxylum armatum*	*Justicia adhatoda*	2nd
3	Maidan- Lower Dir	*Zanthoxylum armatum*	*Indigofera heterantha*	*Dodonea viscose*	1st
4	Peto dara- lower Dir	*Dodonea viscose*	*Zanthoxylum armatum*	*Rubus fruiticosus*	2nd
5	Panda khan kale- Kabal Swat	*Dodonea viscose*	*Zanthoxylum armatum*	*Cotoneaster nummulaia*	2nd
6	Tor warsak District Buner	*Dodonea viscose*	*Zanthoxylum armatum*	*Rubus fruiticosus*	2nd

Table 4. Physicochemical analysis of the soil in different localities of *Zanthoxylum marmatum*

Sl. no	Sample	Textural Class	NO^{3-} (ppm)	P (ppm)	K (ppm)	Fe (ppm)	Zn (ppm)	Cu (ppm)	pH	Organic matter
1	Charkotli hills Batkhela	Clay loamy	35.89	19.68	110	28.86	1.34	3.88	6.04	1.01
2	Laram- lower Dir	Loamy	19.53	10.33	54	15.34	1.38	3.53	6.01	1.00
3	Maidan- Lower Dir	Loamy	33.07	17.70	89	20.67	1.19	2.99	6.10	1.00
4	Peto dara- lower Dir	Loamy	23.53	8.33	70	44.01	1.92	3.09	6.00	1.00
5	Panda khan kale- Kabal Swat	Clay loamy	33.81	17.58	91	22.85	1.41	3.11	6.10	1.01
6	Tor warsak District Buner	Clay loamy	27.55	15.51	101	23.75	1.39	3.22	6.10	1.01

Table 5. Market value chain of minimum, maximum and average prices in Pakistani Rupees (PRs.) per kilogram of *Zanthoxylum armatum* fruit at different market points on the basis of data collected from local dealers, hakims and Pansaries.

S. No	Market	Purchase (PRs./Kg)			Sale (PRs./Kg)			Annual trade (Kg) approximatly.
		Min.	Max.	Ave.	Min.	Max.	Ave.	
1	Mingora	110.00	150.00	130.00	160.00	200.00	180.00	360
2	Buner	115.00	150.00	132.50	170.00	210.00	190.00	175
3	Upper Dir	120.00	150.00	135.00	175.00	190.00	182.50	75
4	Temergara	120.00	145.00	132.50	160.00	195.00	177.50	130
5	Batkhela	115.00	155.00	135.00	155.00	220.00	187.50	120
6	Dargai	120.00	165.00	142.50	175.00	240.00	207.50	95

Many people in the mountainous regions dependupon the collection and sale of plants for earning their livelihood without caring conservation or future status of these plants (Sher and Al-Ymn, 2011), which resulted in extinction of many indigenous plants. The vegetation of all the selected areas (Table 1 & 5) is under intense biotic pressure in the form of deforestation, improper collection, slashing, burning and overgrazing. These factors also greatly affected the population size of *S. laureola* and *Z. armatum* in these areas. Strict measure involving the participation of local community should be planned to conserve important medicinal plants, for more economic and sustainable use.

Market survey of Zanthoxylum armatum

Market survey was also conducted for *Z. armatum*, in different markets. Generally it was observed that fruit of this plant is collected by the local inhabitant and supply it to the local market, nearest to them. As *Z. armatum* grows in foothills, there for it is easily available and not transported to far off places. Main markets for this plant in Malakand division are Mingora, Buner, Batkhela, Temergara and Upper Dir. Very little amount is supplied to other parts of the country. Variation was observed in purchase and sale prices of this important medicinal plant from place to place and season to season and on the destination from their place of collection (Table 5). Low prices were observed during summer season due to easy availability as compared to winter. Local dealers in Mingora, Buner , Batkhela and Upper Dir purchase fruits of this plant in bulky amounts, packed in sacs and then supply it to small dealers and nearby towns. Some dealers make collection directly through their agents and supply it to local markets. Various purchase rate, sale rate and approximate annual consumption of *Z. armatum* in different markets are summarized in Table 5.

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