Journal of Natural Resource Conservation and Management
Vol. 4, No. 2, pp 167-172, 2023
doi: 10.51396/ANRCM.4.2.2023.167-172

# Variation in plant leaf traits of *Rubus ellipticus* and *Berberis aristata* along the altitudinal gradient and aspects in the Lower Himalaya, Uttarakhand, India

**Dharmendra Shah* and A.K. Negi**

*Department of Forestry and Natural Resources, HNBGU (A Central University), Srinagar Garhwal-246174, Uttarakhand, India*

**Corresponding author Email: shahdharm850@gmail.com*

Received : September 11, 2023
Revised : November 10, 2023
Accepted : November 14, 2023
Published : December 31, 2023

**ABSTRACT**

The functional traits describe how a species interacts with and responds to its environment, providing a powerful way to solve ecological issues. This comprehensive study examines the functional characteristics of *Rubus ellipticus* and *Berberis aristata*, two vital medicinal plant species in the Lower Himalayas, considering both Altitude and Aspect as key environmental factors. The study concluded that the highest values of leaf traits for *Rubus ellipticus* were found in the altitudinal range of 950–1250 msl in the western Aspect, except leaf moisture, which was highest in the south-western Aspect (61.81%), and *Berberis aristata* was observed to have a greater value of leaf traits in 1250–1550 msl along with the eastern Aspect, while leaf moisture was highest in the south-western Aspect (66.46%). Overall, the present study highlights the functional attributes of two major medicinal plants in different conditions. Altogether, this research provides a nuanced understanding of how Altitude and Aspect intricately influence the Leaf traits of *Rubus ellipticus* and *Berberis aristata*, contributing valuable insights for the conservation and management of these species in the dynamic Lower Himalayan ecosystem.

***Keywords:*** Leaf traits, Altitude, Aspect, Lower Himalaya

## INTRODUCTION

The relationship between plant species and their environment is essential for ecological studies. Functional traits indicate these interactions, encapsulating the physiological characteristics that govern a species' responses to environmental factors and providing insights into complex ecological dynamics (McGill *et al.*, 2006; Violle *et al.*, 2007; Malik *et al.*, 2022). This study comprehensively investigates the functional traits of two important medicinal plant species, *Rubus ellipticus* and *Berberis aristata*, thriving in the diverse landscape of the Lower Himalayas. The Lower Himalayan region, with its dynamic environmental conditions, provides a natural laboratory for studying the impact of Altitude and Aspects on plant functional traits (Körner, 2007). *Rubus ellipticus* and *Berberis aristata* are noteworthy for their medicinal significance (Table 1).

Adaptive strategies in response to varying altitudinal and aspectual gradients. This study aims to reveal how these two species navigate the complex interplay between Altitude, Aspect, and functional traits. The significance of Altitude as a determinant of plant ecological strategies has long been acknowledged, and exploring functional traits across altitudinal gradients provides invaluable insights into species adaptation and survival (Diaz *et al.*, 2004).

Additionally, the Aspect representing the compass direction a slope faces introduces an additional layer of complexity, influencing microclimatic conditions that can significantly impact plant physiology (McGill *et al.*, 2006). This research, therefore, offers a comprehensive analysis

**Table 1.** Medicinal use of different parts of *Rubus ellipticus* and *Berberis aristata*

| Species | Plant part | Uses | References |
|---|---|---|---|
| *Rubus ellipticus* | Fruits | Fruits have anti-diabetic properties in experimental types of diabetes mellitus, and their fibrous texture aids in digestion. gastritis, dysentery, and diarrhea, usage in jelly, squash, and wine production | George *et al.*, 2015; Pandey & Bhatt, 2016; Sharma *et al.*, 2019 |
| | Leaves | Faster healing of wound. | George *et al.*, 2015 |
| | Root | The juice is thought to be beneficial against urinary tract infection. Root juice is used during fevers, diarrhea, and dysentery. During bone fracture treatment, root paste is used as a poultice.. | Uprety *et al.*, 2010; Pandey & Bhatt, 2016 |
| | Bark | Bark is used in cough, cold and various blood disorders | Wangchuk *et al.*, 2017 |
| *Berberis aristata* | Fruits | Antioxidant, bacterial infections. | Adhikari *et al.*, 2012 |
| | Leaves | Used in hepatobililary disorder. | E Siva Rami Reddy, 2018 |
| | Root | The roots are used to treat diarrhea and jaundice. It is also used to purify the blood. | Shrestha *et al.*, 2014 |
| | Bark | The bark is used to treat fevers, coughs, diabetes, skin diseases, and diarrhea. | Adhikari *et al.*, 2012; Aryal *et al.*, 2018 |

of the functional attributes of these medicinal plant species under varying environmental conditions.

## MATERIALS AND METHODS

### Study area

The study was conducted in the Kotdawar's foothills, located in the Lansdowne Forest Range (Figure 1). This area is situated in the Lower Himalaya region and has an altitude ranging from 400m to 1800m above sea level. The forest type in the area is classified as 9/C1a. The mean annual temperature varies between 19° in January and 38° in June, as shown in Figure 2. The average yearly rainfall is 218cm, with 90% occurring during the monsoon season.

### Data collection

To analyze shrub vegetation, we randomly set up 5×5m sampling plots in different topographic aspects (E, NE, N, N.W., W, S.W., S, S.E.) with altitude ranges (350-650, 650-950, 950-1250, 1250-1550). Then, we collected plant samples from each plot. We used "Image J 1.51j8" software to measure the whole plant's height, seed, and bark and the leaf perimeter, L.A., and S.L.A. traits.

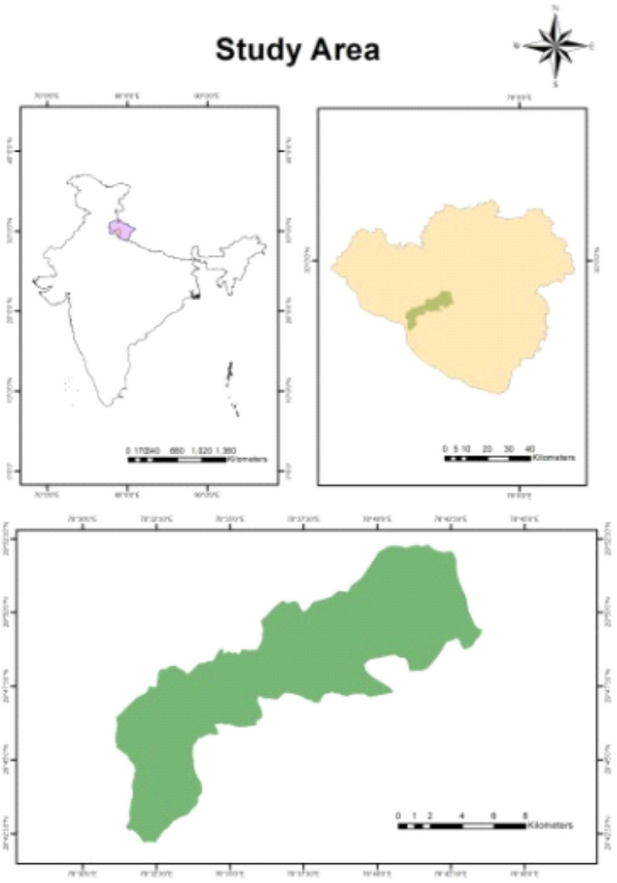


**Fig. 1.** Study area

## RESULTS AND DISCUSSION

The study area consisted of 40 randomly placed quadrates, and 102 specimens of *Rubus ellipticus* and 96 specimens of *Berberis aristata* were quantitatively analyzed. The research revealed important ecological insights. *Rubus ellipticus* was found to be distributed at an altitude between 1250 to 1550 meters above sea level on aspects that included the

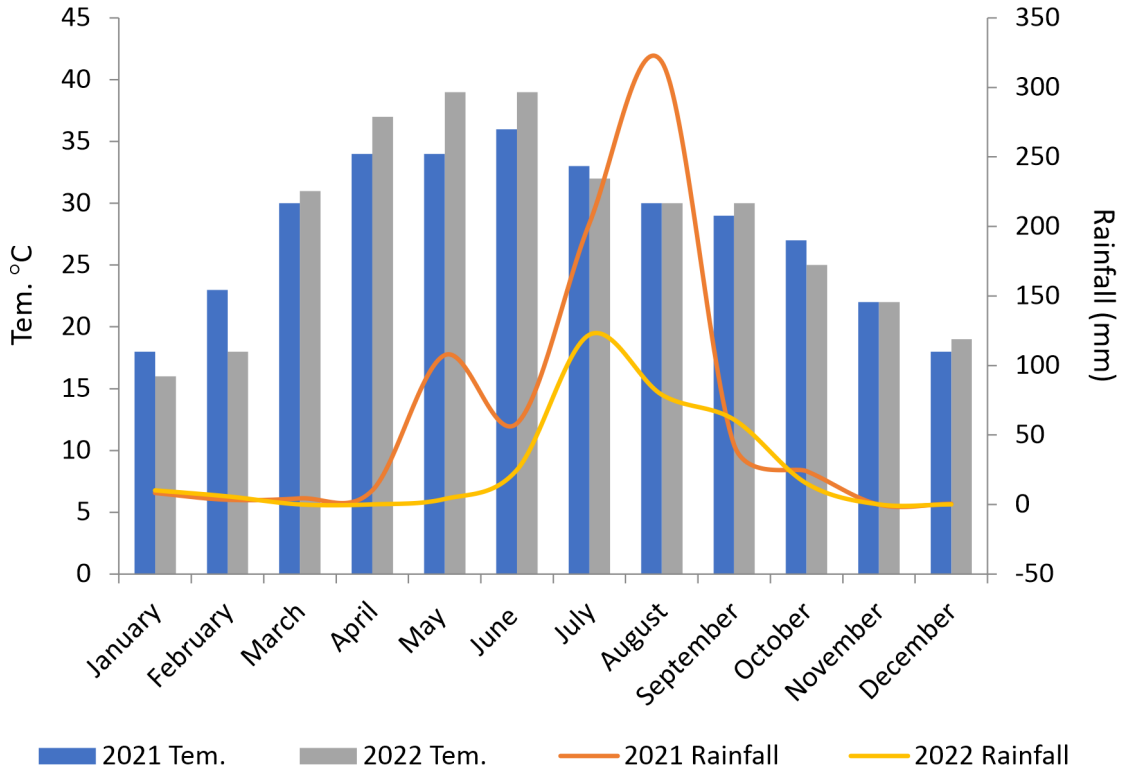


**Fig. 2.** Metrological data

eastern, western, and southwestern slopes of the lower Himalayan range. *Berberis aristata*, a notable medicinal plant, was discovered at elevations ranging from 950 to 1250 meters and 1250 to 1550 meters above mean sea level, mainly on slopes facing east and southwest. The distribution of species is influenced by temperature, air pressure, and solar radiation, which vary with elevation (Becker *et al.*, 2007).

The altitudinal range of 1250-1550 meters for *Rubus ellipticus* in the lower Himalayan range seems to significantly impact the plant's leaf characteristics across different aspects - eastern, western, and southwestern. The leaves exhibit notable differences in attributes such as leaf area, dry mass, leaf dry matter content (LDMC), specific leaf area (S.L.A.), leaf perimeter, dimensions, and moisture content. The western Aspect appears to be the most favorable for leaf development and biomass accumulation (Table 2, Figure 3), with the highest values for leaf area (8737.34 $mm^2$) and dry mass (557 mg). The western Aspect also exhibits the highest leaf perimeter (746.93 mm), which could indicate a more intricate leaf structure or greater efficiency in resource utilization. Conversely, the eastern Aspect records the highest LDMC (425.85 mg/g) despite having a smaller leaf area, suggesting a higher proportion of dry matter in leaves from that

**Table 2.** Leaf traits of *Rubus ellipticus* in different Aspect along with Altitude

| Leaf traits | Altitude | Aspect | | |
|---|---|---|---|---|
| | 1250-1550msl | Eastern | Western | South-western |
| Leaf area (always in sq mm) | 7554.67 | 6682.1 | 8737.34* | 7244.58 |
| Leaf dry mass (always in mg) | 517.33 | 507 | 557* | 488 |
| LDMC [Dry mass/fresh mass] (always in mg/g) | 406.32 | 425.85* | 411.22 | 381.89 |
| SLA [area/dry mass] (always in sq mm/mg) | 14.67 | 13.15 | 15.78* | 15.08 |
| leaf perimeter (in mm) | 683.22 | 582.32 | 746.93* | 720.43 |
| Leaf length (in mm) | 134.80 | 129.20 | 141.29* | 133.90 |
| leaf width (mm) | 104.01 | 96.32 | 112.53* | 103.18 |
| Moisture% | 59.36 | 57.41 | 58.87 | 61.81* |

**Fig. 3.** Leaf trait of *Rubus ellipticus*


**Fig. 4.** Leaf trait of *Berberis aristata*

orientation. Surprisingly, the highest S.L.A. is linked to the western Aspect (15.78 mm/mg$^2$), indicating that leaves in this direction possess a relatively larger surface area per unit of leaf mass, hinting at potential adaptation strategies. Lastly, the southwestern Aspect has the highest moisture content (61.81%), highlighting its role in maintaining elevated leaf water content. Overall, the findings suggest that various environmental factors influence the morphological and physiological attributes of *Rubus ellipticus* leaves in complex ways.

According to a comprehensive analysis of *Berberis aristata* leaf traits, the plant displays distinct patterns in response to altitudinal and directional factors (Table 3, Figure 4). The highest leaf area, measuring 560.83 mm$^2$, is observed at an altitude of 1250-1550 meters, with a notable emphasis on the eastern Aspect (measured at 540.33 mm$^2$). On the other hand, the species' adaptive plasticity to varying light exposures is indicated by the lowest leaf area found at the southwestern Aspect. Dry mass, a critical indicator of biomass, also follows a similar trend, with the highest values recorded at 1250-1550 meters (92 mg) and the eastern Aspect (82 mg), highlighting the plant's preference for these specific environmental conditions. Moreover, the leaf dry matter content (LDMC) peaks at an altitude of 1250-1550 meters (502.15 mg/g) and with an eastern aspect (512.04 mg/g), underscoring the nuanced interplay between Altitude and Aspect in shaping leaf density. The study found that the specific leaf area (S.L.A.) is highest at an altitude of 1250-1550 meters and with an eastern perspective, which suggests that the plant has optimized resource allocation strategies.

Additionally, morphological attributes like leaf perimeter, length, and width exhibit their maximum values at the same Altitude (Table 3) and with an eastern aspect, indicating the plant's intricate adjustments in response to specific environmental gradients. Interestingly, the highest moisture content is found at an altitude of 950-1250 meters and with a

**Table 3.** Leaf traits of *Berberis aristata* in different Aspect along with Altitude

| Leaf traits | Altitude | | Aspect | |
|---|---|---|---|---|
| | 950-1250msl | 1250-1550msl | Eastern | South-western |
| Leaf area (always in sq mm) | 301.66 | 560.83* | 540.33* | 318.68 |
| Leaf dry mass (always in mg) | 54 | 92* | 82* | 56 |
| LDMC [Dry mass/fresh mass] (always in mg/g) | 335.36 | 502.15* | 512.04* | 355.42 |
| SLA [area/dry mass] (always in sq mm/mg) | 5.98 | 6.19* | 6.13* | 6.08 |
| leaf perimeter (in mm) | 88.49 | 126.47* | 96.87* | 89.62 |
| Leaf length (in mm) | 31.88 | 44.72* | 46.45* | 43.87 |
| leaf width (mm) | 15.17 | 24.02* | 21.09* | 25.26 |
| Moisture% | 66.46* | 49.78 | 64.85 | 64.74* |

southwestern aspect, which showcases the plant's remarkable ability to adapt its water regulation mechanisms in diverse altitudinal and directional settings. These findings provide a deeper understanding of *Berberis aristata* adaptive strategies, highlighting the complex relationships between leaf traits and environmental factors in the studied region. Numerous prior investigations have affirmed the link between leaf size and various plant functional characteristics, underscoring the connection between the development of leaf size and the energy balance within the leaf (Craine and Lee, 2003; Read *et al.*, 2014; Wang *et al.*, 2019). In a parallel study, An *et al*. (2021) conducted research and observed that environmental factors accounted for most of the variability in leaf traits. Expanding on this body of research underscores the intricate interplay between environmental conditions and the morphological characteristics of leaves. This connection suggests that environmental factors play a pivotal role in shaping leaf size and the broader spectrum of plant functional traits, offering valuable insights into the adaptive strategies of plants in response to their surroundings.

## CONCLUSION

The outcomes of this research study have contributed significantly to our understanding of how Altitude and Aspect intricately shape the functional traits of *Rubus ellipticus* and *Berberis aristata*. These findings show how these factors affect plant growth, morphology, and physiology. For instance, the study has revealed how different aspects affect the microclimate of the plant's habitat, influencing its water availability, photosynthetic rates, and nutrient uptake. Similarly, the study has uncovered how Altitude affects the plant's ability to cope with extreme weather conditions, such as frost, drought, and high radiation.

## REFERENCES

Adhikari, B., Pendry, C.A., Pennington, R.T., and Milne R.I., (2012). A revision of *Berberis* S.S. (Berberidaceae) in Nepal. *Edinburgh Journal of Botany, 69*, 447-522.

An, N., Lu, N., Fu, B., Wang, M., and He, N., (2021). Distinct Responses of Leaf Traits to Environment and Phylogeny between Herbaceous and Woody Angiosperm Species in China. *Frontier in Plant Science*, *12*,799401.

Aryal, K.P., Poudel, S., Chaudhary, R.P., Chettri, N., Chaudhary, P., Ning, W., and Kotru, R., (2018). Diversity and use of wild and non-cultivated edible plants in the Western Himalaya. *Journal of Ethnobiology and Ethnomedicine*, *14*,1-18.

Becker, A., Korner, C., Brun, J.J., Guisan, A., and Tappeiner, U., (2007). Ecological and Land-Use Studies along Elevational Gradients. *Mountain Research and Development*, *27*, 58-65.

Craine, J.M., and Lee, W.G., (2003). Covariation in leaf and root traits for native and non-native grasses along an altitudinal gradient in New Zealand. *Oecologia*, *134*, 471-478.

Diaz, S., Hodgson, J.G., Thompson, K., Cabido, M., Cornelissen, J.H.C., Jalili, A., and Zak, M.R., (2004). The plant traits that drive ecosystems: Evidence from three continents. *Journal of Vegetation Science*, *15*(3), 295-304.

George, B.P., Parimelazhagan, T., Kumar, Y.T., and Sajeesh, T., (2015). Antitumor and Wound Healing Properties of Rubus ellipticus Smith. *Journal of acupuncture and meridian studies*, *8*(3), 134-141.

Körner, C., (2007). The use of 'altitude' in ecological research. *Trends in Ecology & Evolution*, *22*(11), 569-574.

Malik, K., Rani, M., Sharma, P., and Bhardwaj, A.K., (2022). Rice straw compost: a sustainable residue recycling solution for soil health and productivity enhancement in the rice-wheat cropping system. *Journal of Natural Resource Conservation and Management*, *3*(2), 143-151.

McGill, B.J., Enquist, B.J., Weiher, E., and Westoby, M., (2006). Rebuilding community ecology from functional traits. *Trends in Ecology & Evolution*, *21*(4), 178-185.

Pandey, Y., and Bhatt, S.S., (2016). Overview of Himalayan yellow raspberry (Rubus ellipticus Smith.): A nutraceutical plant. *Journal of Applied and Natural Science*, *8*(1), 494-499.

Read, Q.D., Moorhead, L.C., Swenson, N.G., Bailey, J.K., Sanders, N.J., and Fox, C., (2014). Convergent effects of elevation on functional leaf traits within and among species. *Functional Ecol*ogy, *28*, 37-45.

Reddy, S.R., (2018). A Review on Phytochemical and Pharmacological studies of Berberis Aristata. *International Journal of Trend in Scientific Research and Development*, *2*(2), 2456-6470.

Sharma, M., Kaur, J., Kumar, V., and Sharma, K., (2019). Nutraceutical potential of *Rubus ellipticus*: a critical review on phytochemical potential, health benefits, and utilization. *Think India Journal*, *22*(37), 878-898.

Shrestha, N., Prasai, D., Shrestha, K.K., Shrestha, S., and Zhang, X.C., (2014). Ethnomedicinal practices in

the highlands of central Nepal: A case study of Syaphru and Langtang village in Rasuwa district. *Journal of Ethnopharmacology, 155*, 1204-1213.

Violle, C., Navas, M.L., Vile, D., Kazakou, E., Fortunel, C., Hummel, I. and Garnier, E. (2007). Let the concept of trait be functional. *Oikos*, *116*(5), 882-892.

Wang, X.Y., Cao, J.J., Zhang, X.F., Zhang, X.F., Kong, Y.Y., and Tian, H., (2019). Effects of topographic factors on leaf traits of apricot in the Loess Plateau, Northwest China. *Chin. Journal of Applied Ecology, 30*, 2591-2599.

Wangchuk, P., Yeshi, K., and Jamphel, K., (2017). Pharmacological, ethnopharmacological, and botanical evaluation of subtropical medicinal plants of Lower Kheng region in Bhutan. *Integrative medicine research*, *6*(4), 372-387.