Asian Journal of Pharmacognosy
eISSN-0128-1119

Ethno-medicinal Usage of Invasive Plants in Traditional Health Care Practices: A Review

Prabin Adhikari*, Swastika Acharya, Sabina Sigdel, Ganga Kandel

[1]*Institute of Forestry, Tribhuvan University, Pokhara Campus, Pokhara, Nepal*

*Correspondence: adkprabin26@gmail.com

(Accepted November 4, 2022)

Abstract: Nepal is a small South Asian country with a varied geographical and bioclimatic landscape. Invasive Plant Species have already been introduced in large numbers, causing the extinction of native species, changing plant species composition, interfering with tree seedling regeneration and disrupting crop production, as well as degrading endangered animal habitats. However, it is useful in the health treatment of rural populations in developing countries like Nepal. Our study will look at and compile knowledge on the therapeutic applications of invasive plants utilized by a range of Nepalese communities. We combed through numerous websites, including Research Gate and Google Scholar, for historical and contemporary studies on the therapeutic usage of Nepal's invasive plants. 24 species from 12 families of invasive plant species were identified to be utilized for medicinal purposes by Nepalese rural people. The 39 diseases for which medicinal plants were reported were diabetes, rheumatism, fever, ulcers, bronchitis, kidney stone, asthma, urinary insufficiency, and others. Traditional knowledge of invasive plant species' uses is diminishing due to the negative effects of invasive plant species on the ecosystem; hence, rigorous documentation of ethnomedicinal knowledge on invasive plant species is needed. Thus, the medicinal potentialities of unwanted invasive species, which are sometimes neglected by others, will provide a gem for the study world.

Keywords: Exotic; Medicine; Nepal; Rural population; Traditional healers

INTRODUCTION

Plant-based traditional medical practices are founded on hundreds of years of beliefs and observations that precede the formation and dissemination of modern medicine (Aburjai et al., 2007; Mukherjee and Wahilez, 2006), and this knowledge has been passed down orally from generation to generation without the use of any written documents (Samy and Ignacimuthu, 2000). Over the last few decades, medicinal plants have seen a considerable increase in popularity for use in traditional medicine, as well as contemporary and alternative medicine, since they are inexpensive, effective at curing diseases, and relatively safe with few or no adverse effects (Sigdel and Acharya, 2021).Ethnic diversity and indigenous knowledge in Nepal have resulted in extensive ethnobotanical research (Pappan and Thomas, 2017). Because of a global renaissance in traditional and alternative

healthcare systems, the market for herbal pharmaceuticals has risen at an amazing rate, and medicinal plants are consequently very important economically (Kunwar, 2013).

Nepal is a tiny South Asian country with a diversified geographical and bioclimatic landscape (Tiwari et al., 2005). It is home to 118 different habitats and 3.2% of the world's flora (GoN/ MoFSC, 2014). Nepal has already seen the introduction of a huge number of invasive plant species due to its location in the heart of the Himalayan biodiversity hotspot and between two big economically growing Asian countries (China and India) (Shrestha et al., 2019a). Biological invasions are widespread and the fifth most significant cause of global change, with almost one-fifth of the earth's surface vulnerable to plant and animal invaders (IPBES, 2019; Sala et al., 2000). Invasive species as species whose range has been altered by humans, either unintentionally or intentionally, resulting in self-replicating populations capable of spreading across broad regions in their new home (Richardson and Rejmánek, 2011).

In Nepal, 27 species (15%) of the 182 naturalized plant species are invasive. Some invasive species, which are often farmed, may serve local societies with food, medicine, fuel, or fodder (Kull et al., 2007; Roder et al., 2007), while some are responsible for the deterioration and extinction of native species, disturbances in crop production, habitat degradation for endangered wildlife (e.g., one-horned rhinoceros; Murphy et al., 2013), changes in plant species composition (Timsina et al., 2011; Shrestha and Dangol, 2014; Thapa et al., 2016), interference with tree seedling regeneration (Thapa et al., 2017), livestock grazing, and human health deterioration (Sharma et al.,2005; Kohli et al., 2006).IAPs are being incorporated into indigenous traditional people's everyday lives (Geldenhuys and MacDevette, 1989). However, the usage of invasive plant species in ethnomedicine has grabbed less attention (Shackleton and Shackleton, 2018; Shackleton et al., 2007; Novoa et al., 2016). This study aims to discuss the medical applications of invasive plant species based on current research and to describe these species' beneficial impact on Nepalese rural residents.

METHODS

We conducted a literature study to determine the medicinal uses of invasive species for human health. We looked through both academic and non-academic publications. The phrases "invasive," "alien," "exotic," "medicinal uses," "human well-being," and "benefit" were typed into Google Scholar and the research portal. Only case studies that directly investigated the medical use of invasive species were considered after all of the sources were filtered for relevance. Also, an evaluation of further information on the distribution pattern and diversity of invasive species was conducted. We also looked for additional sources by going through the reference lists of all of the case study articles that were included. In Nepal, there has been very little study on the medicinal uses of invasive species. Therefore, the goal is to give

RESULTS

Our study found a total of 27 invasive species, among which 24 plant species were enumerated as having medicinal values belonging to 12 families. The Asteraceae family has the most invasive species, with ten, followed by Fabaceae with three,

Table 1:Names of plants with their ethnomedicinal uses and parts used

Scientific Name	Common Name (Local Name)	Family	Parts used	Uses	References
Ageratina adenophora (Spreng.) R.M.KingandH.Rob.	Crofton weed (Kalo Banmara)	Asteraceae	Leaf and root	Treatment of skin diseases, wounds, itching, measles, uterine bleeding	Jamir et al., 2018
Ageratum conyzoides L.	Billygoat weed (Gandhe)	Asteraceae	Whole Plant	treatment of wounds and burns, fever, Pneumonia, rheumatism, headache, and colic	Ming, 1999
Ageratum houstonianum Mill.	Blue Billygoat Weed (NiloGandhe)	Asteraceae	Leaf and whole Plant	Used in cuts and wounds, Skin infections	Andrade-Cetto, 2009; Dani and Tiwari, 2018
Alternanthera philoxeroides (Mart.) Griseb.	Alligator weed (Jal Jambu)	Amaranthaceae	Whole Plant	treatment of night blindness, malaria, hazy vision, fistula, post-natal complaints, diarrhea, dysentery, puerperal fever, the menstrual flow, leucorrhea, leprosy, eczema, gonorrhea	Rahman and Gulshana, 2014
Amaranthus spinosus L.	Spiny pigweed (Lunde Kanda)	Amaranthaceae	Root and Leaf	to treat burns wounds, boils, gonorrhea, eczema, earache, galactagogue, hemorrhoids, sores, ophthalmia, menorrhagia, and antidote to snakebite poison	Alegbejo, 2013
Argemone mexicana L.	Mexican poppy (Thakal)	Papaveraceae	Seed and leaf	treatment of several diseases including tumours, warts, skin diseases, inflammations, rheumatism, jaundice, leprosy, microbial infections, and malaria.	Brahmachari et al., 2013
Bidens pilosa L.	Hairy Beggar's stick (Kalo Kuro)	Asteraceae	Leaf and plant Fluid	treatment of fever, angina, diabetes, edema	Kviecinskietal., 2008
Chromolaena odorata (Spreng.) R.M.KingandH.Ro	Siam weed (Seto Banmara)	Asteraceae	Leaf	treatment of coughs and colds, toothache, sore throat, malaria, wounds, diarrhea, skin infection, dysentery, stomach ache, convulsions, and piles.	Omokhua et al., 2016
Eichhornia crassipes (Mart.) Solms.	Water hyacinth (Jal Kumbhi)	Pontederiaceae	Root, Leaf, and Flower	Treat hair fragrance, cholera, sore throat, snake bites, and wounds, and inhibit cell growth to treat cancer and treatment of lipid disorder	Ayanda et al., 2020
Erigeron karvinskianus DC.	Karwinsky's Fleabane (Phule Jhar)	Asteraceae	Unidentified	Treatment of headache, kidney stones, bronchitis, diarrhea, body pain, hematuria, arthritis, Indigestion, enteritis, epidemic hepatitis, osteoporosis, and cystitis	Fauziana and Susandarini, 2019
Galinsoga quadriradiata Ruiz and Pav.	Shaggy Soldier (Jhuse Chitlange)	Asteraceae	Flower	To treat snake bite, cold, anemia, and jaundice	Saltos et al., 2016
Ipomoea carnea subsp. fistulosa (Mart. ex Choisy) D.F. Austin	Bush morning-Glory (Besharam)	Convolvulaceae	Leaf, seed, and flower	Used against Immunodeficiency Syndrome (AIDS), hypertension	Meira et al., 2012
Lantana camara L.	Lantana (Ban Fanda, Kirne kanda)	Verbenaceae	Leaf	treatment of colds, whooping cough, headache, asthma, chickenpox, eye injuries, bronchitis, and arterial hypertension	Kalita et al., 2012
Leersia hexandra Swartz.	Southern Cut grass (Karaute Ghans)	Poaceae	Unidentified	treatment of hypertension, improvement of liver and kidneys functions	Bilanda et al., 2019
Mesosphaerum suaveolens (L.) Kuntze	Bushmint (Ban Silam)	Lamiaceae	Leaf	treatment of digestive tract and respiratory diseases	Bezerra et al., 2020
Mikania micrantha Kunth	Mile-a-minute weed (Lahare Banmara)	Asteraceae	Leaf	used to bathe rashes, and skin itches, make a poultice for snake bites and scorpion stings, and heal sores	Li et al., 2013
Mimosa pudica L.	Sensitive plant (Lajjawati)	Fabaceae	Leaf	Treatment of diabetes, urinary infections, cancer, hepatitis, and obesity	Muhammad et al., 2016
Oxalis latifolia Kunth.	Purple wood sorrel (Thulo Chari Amilo)	Oxalidaceae	Whole Plant	treatment of cuts, fever, cold, cough, diarrhea, traumatic injuries, dyspepsia, piles, anemia, dementia and convulsions, sprains, and urinary tract infections	Sarkar et al., 2020
Parthenium hysterophorus L.	Parthenium (Pati Jhar)	Asteraceae	Unidentified	remedy for urinary tract infections, skin inflammation, rheumatic pain, malaria, diarrhea, dysentery, and neuralgia.	Patel, 2019
Pistia stratiotes L.	Water lettuce (Kumbhika, Jalakumbhi)	Araceae	The whole plant, leaves	Used for stomach disorders, throat, curing ringworm, and eczema, anodyne for eyewash, relieving ear complaints, leprosy, ulcers, piles, Chronic dermatitis, fever intestinal bacterial infections, and mouth inflammation	Tulika et al., 2015
Senna occidentalis (L.) Link	Coffee Senna (ThuloTapre, Panwar)	Fabaceae		treatment of parasitic skin infections	Essien, et al., 2019
Senna tora (L.) Roxb.	Sickle pod senna (Sano Tapre)	Fabaceae	seed and leaf	treatment of toothache, sore throat, malaria, wounds, diarrhea, skin infection, convulsions, dysentery, piles, stomach ache, coughs, and colds	Shukla et al., 2013
Spermacoce alata Aubl.	Broadleaf Botton weed (Alu Pate)	Rubiaceae	Whole plant	treatment of headache, malaria, diarrhea skin diseases, inflammation of the eye and gums, fever, hemorrhage, urinary and respiratory infections	Conservaand Jesu, 2012
Xanthium strumarium L.	Rough cockle-Bur (Bhede Kuro)	Asteraceae	whole plant, root, and fruit,	Used for headaches, gastric ulcers, urticaria, rhinitis, nasal sinusitis, fungal infections, rheumatism, and arthritis.	Fan et al., 2019

and Amaranthaceae with two and one species each belonging to Papaveracece, Pontederiaceae, Convolvulaceae, Verbenaceae, Poaceae, Lamiaceae, Oxalidaceae, Araceae, and Rubiaceae (Shrestha et al., 2018; Shrestha 2019a; Shrestha and Shrestha, 2019) (Figure 1).

Invasive species distribution and richness vary with elevation, physiographic (Terai, Siwalik, Middle Mountains, and High Mountains), and phytogeographic areas (eastern, central, and western Nepal) (Bhattarai et al., 2014) is given Figure 3. Invasive plant species richness rises with height, peaks at about 1100m above sea level, and declines as elevation rises (Bhattarai et al., 2014). The plant parts used along with their medicinal uses, altitudinal range, and phytogeographic regions (Eastern, Central, and Western) are listed in Table 1 and 2. Most plant species have multiple uses and they are used to treat 39 different ailments. Diabetes, fever, rheumatism, ulcers, bronchitis, asthma, kidney stone, urinary insufficiency, syphilis, and other disorders were among the 39 ailments for which medicinal plants were documented. Almost all the plant parts were used to cure numerous diseases. The most regularly used plant part is a leaf (14 species), followed by a whole plant (7 species), root (4 species), seed, flower (3 species), fruit (1 species), fluid (1 species), and unidentified for 3 species (Figure 2).

Table 2: Distribution of invasive plant species in Nepal

Scientific Name	Elevation (m asl)	Phytogeographic regions
A. adenophora (Spreng.) R.M.KingandH.Rob.	130-3280	E, C, W
A. conyzoides L.	75-2140	E, C, W
A. houstonianum Mill.	60-2160	E, C, W
A. philoxeroides (Mart.) Griseb.	65-1505	E, C, W
A. spinosus L.	60-2640	E, C, W
A. mexicana L.	65-1400	E, C, W
B. pilosa L.	100-2930	E, C, W
C. odorata (Spreng.) Remaking and H. Ro	75-1710	E, C, W
E. crassipes (Mart.) Solms.	60-1500	E, C, W
E. karvinskianus DC.	780-2110	E, C, W
G/ quadriradiata Ruiz and Pav.	560-2800	E, C, W
I. carnea subsp. fistulosa (Mart. ex Choisy) D.F. Austin	60-1350	E, C, W
L. camara L.	70-1715	E, C, W
L. hexandra Swartz.	100-800	E, C
M. suaveolens (L.) Kuntze	75-1065	E, C, W
M. micrantha Kunth	70-1200	E, C, W
M. pudica L.	75-1495	E, C, W
O. latifolia Kunth.	600-2570	E, C, W
P. hysterophorus L.	60-1990	E, C, W
P. stratiotes L.	70-800	E, C, W
S. occidentalis (L.) Link	70-1405	E, C, W
S. tora (L.) Roxb.	75-1300	E, C, W
S. alata Aubl.	110-2000	E, C, W
X. strumarium L.	60-2500	E, C, W

(Eastern=E, Western=W and Central=C)

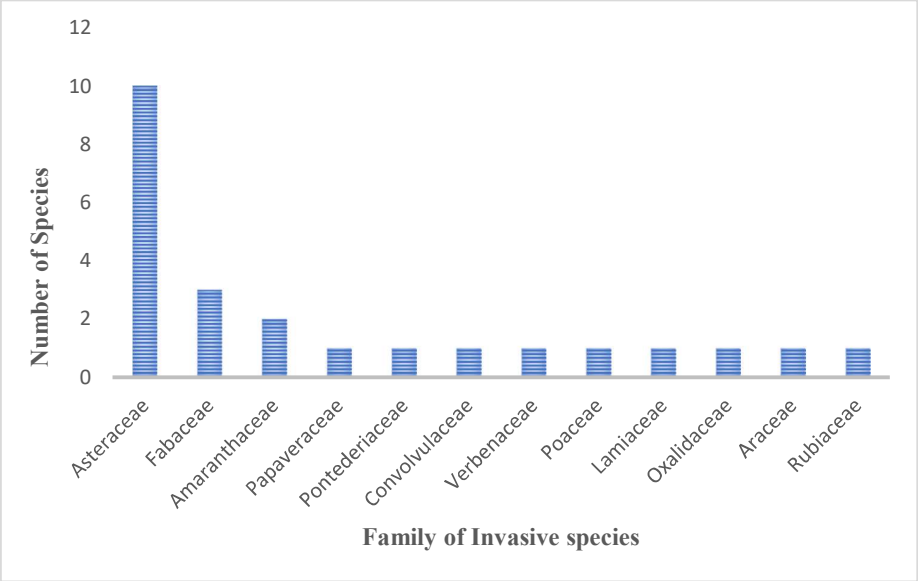

Figure 1: Division of plant species based on their family

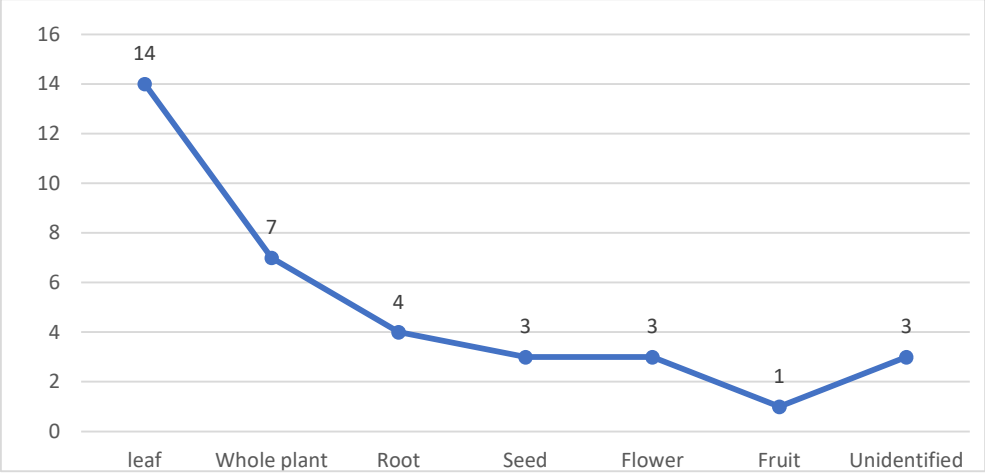

Figure 2: Line graph showing plant parts used

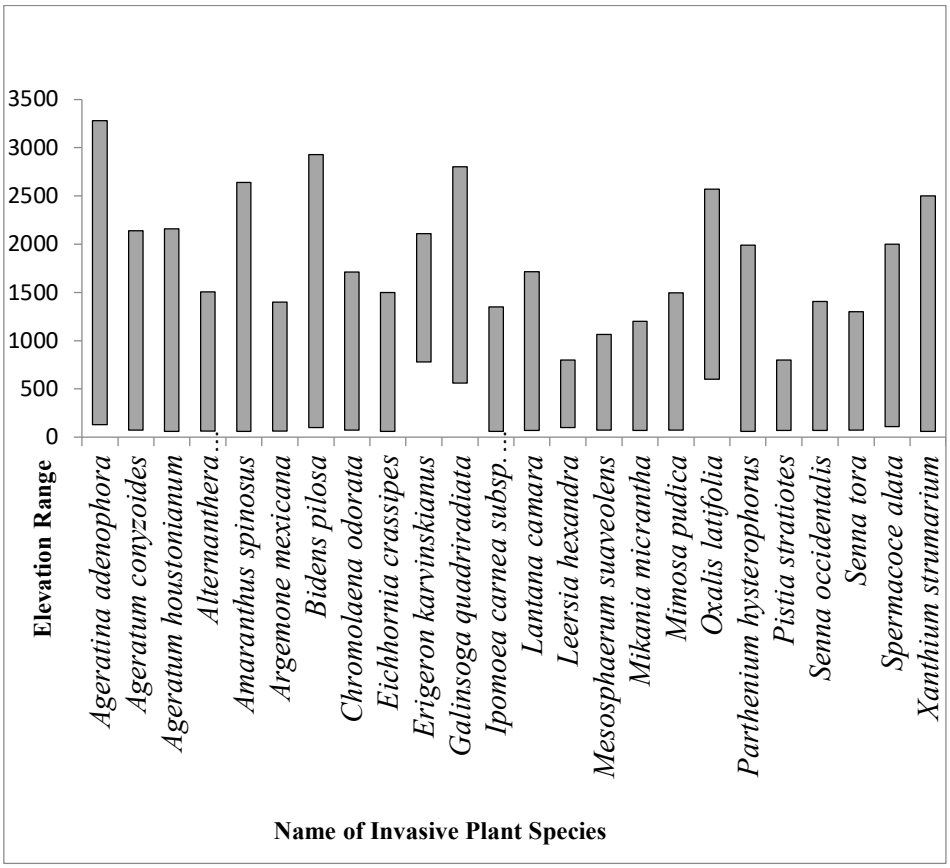

Figure 3: Elevation range of invasive species

CONCLUSION

For those living in Nepal's rural areas, invasive plant species are vital sources of medicine. A total of 24 invasive plant species belonging to 12 families have been discovered to play an important part in traditional therapeutic practices. Plant components such as roots, leaves, fruits, and even the entire plant have therapeutic properties. Invasive plants in new locations change the makeup of indigenous communities, reduce species variety, disrupt ecosystem processes, and cause massive economic and ecological imbalances. On the other side, they can be employed as a medical tool to improve human society's well-being. The advancement of these traditional medical systems with the goals of safety, efficacy, and quality will not only help to maintain this traditional legacy but also assist in rationalizing the use of natural products in health care. An invasive plant species that pose a threat to native plants and civilization can be exploited to profit in a variety of ways. The usage of invasive plants in this paper may be useful for other people to include these species in their traditional health-care practices, reducing the load on native medicinal plants. In Nepal, most people's ethnic knowledge of invasive plant species remains untapped. Traditional knowledge of invasive plant species' uses is diminishing due to the negative effects of invasive plant species on

the ecosystem; hence, rigorous documentation of ethnomedicinal knowledge on invasive plant species is needed.

DECLARATION OF CONFLICT OF INTEREST

No conflict of interest to declare.

REFERENCES

Aburjai, T., Hudaib, M., Tayyem, R., Yousef, M., &Qishawi, M. 2007. Ethnopharmacological survey of medicinal herbs in Jordan, the Ajloun Heights region. Journal of Ethnopharmacology, 110(2), 294-304.

Alegbejo, J. O. 2013. Nutritional value and utilization of Amaranthus (Amaranthus spp.)–a review. Bayero Journal of Pure and Applied Sciences, 6(1), 136-143.

Andrade-Cetto, A. 2009. Ethnobotanical study of the medicinal plants from Tlanchinol, Hidalgo, México. Journal of ethnopharmacology, 122(1), 163-171.

Ayanda, O. I., Ajayi, T., &Asuwaju, F. P. 2020. Eichhornia crassipes (Mart.) Solms: Uses, challenges, threats, and prospects. The Scientific World Journal, 2020.

Bartolome, A. P., Villaseñor, I. M., & Yang, W. C. 2013. Bidens pilosa L.(Asteraceae): botanical properties, traditional uses, phytochemistry, and pharmacology. Evidence-based complementary and alternative medicine, 2013

Bilanda, D. C., Tcheutchoua, Y. C., DjomeniDzeufiet, P. D., Fokou, D. L. D., Fouda, Y. B., Dimo, T., &Kamtchouing, P. 2019. Antihypertensive activity of leersiahexandra sw. (Poaceae) aqueous extract on ethanol-induced hypertension in Wistar rat. Evidence-Based Complementary and Alternative Medicine.

Bezerra, J. W. A., Rodrigues, F. C., Gonçalo, M. A. B. F., dos Santos, M. A. F., Macedo, G. F., de Souza Bezerra, J., ... & Coutinho, H. D. M. 2020. Chemical Composition and Antibacterial Activity of the Essential Oil of Mesosphaerumsuaveolens (Lamiaceae). In Essential Oils-Bioactive Compounds, New Perspectives and Applications. IntechOpen

Brahim, M. A. S., Fadli, M., Hassani, L., Boulay, B., Markouk, M., Bekkouche, K., ... &Larhsini, M. 2015. Chenopodium ambrosioides var. ambrosioides used in Moroccan traditional medicine can enhance the antimicrobial activity of conventional antibiotics. Industrial Crops and products, 71, 37-43.

Bazylko, A., Boruc, K., Borzym, J., & Kiss, A. K. 2015. Aqueous and ethanolic extracts of Galinsoga parviflora and Galinsoga ciliata. Investigations of caffeic acid derivatives and flavonoids by HPTLC and HPLC-DAD-MS methods. Phytochemistry Letters, 11, 394-398.

Bazylko, A., Borzym, J., &Parzonko, A. 2015. Determination of in vitro antioxidant and UV-protecting activity of aqueous and ethanolic extracts from Galinsoga parviflora and Galinsogaquadriradiata herb. Journal of Photochemistry and Photobiology B: Biology, 149, 189-195.

Bartolome, A. P., Villaseñor, I. M., & Yang, W. C. 2013. Bidens pilosa L.(Asteraceae): botanical properties, traditional uses, phytochemistry, and pharmacology. Evidence-based complementary and alternative medicine, 2013.

Bhattarai, K.R., Måren, I.E., and Subedi, S.C. 2014. Biodiversity and invasibility: distribution patterns of invasive plant species in the Himalayas, Nepal. Journal of Mountain Science 11 (3): 688–696.

Conserva, L. M., & Jesu Costa Ferreira, J. 2012. Borrelia and Spermacoce species (Rubiaceae): A review of their ethnomedicinal properties, chemical constituents, and biological activities. Pharmacognosy reviews, 6(11), 46

Dani, R. S., & Tiwari, A. 2018. Medicinal weeds in the rice field of Kathmandu Valley, Nepal. Himalayan Biodiversity, 6, 16-26.

Essien, E. E., Thomas, P. S., Ascrizzi, R., Setzer, W. N., &Flamini, G. 2019. Senna occidentalis (L.) Link and Senna hirsuta (L.) HS Irwin &Barneby: constituents of fruit essential oils and antimicrobial activity. Natural product research, 33(11), 1637-1640.

Fan, W., Fan, L., Peng, C., Zhang, Q., Wang, L., Li, L., ... & Wu, C. 2019. Traditional uses, botany, phytochemistry, pharmacology, pharmacokinetics and toxicology of Xanthium strumarium L.: A review. Molecules, 24(2), 359.

Fauziana, M., &Susandarini, R. 2019. Species Diversity and Potential Use of Asteraceae in Tawangmangu, Karanganyar Regency, Central Java. Journal of Tropical Biodiversity and Biotechnology, 4(01), 18-23.

Geldenhuys, C. J., &MacDevette, D. R. 1989. Conservation status of coastal and montane evergreen forest. Biotic diversity in southern Africa: concepts and conservation. Oxford University Press, Cape Town, 224-238.

GoN/MoFSC, 2014. National biodiversity strategy andaction plan 2014-2020. Government of Nepal, Ministry ofForests and Soil Conservation, Singhadurbar, Kathmandu,Nepal

IPBES 2019. Summary for Policymakers of the Global Assessment Report on Biodiversity and Ecosystem Services of the Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services (eds. S. Díaz, J. Settele, E.S. Brondízio, et al.). Bonn: IPBES Secretariat.

Jamir, N., Mazumder, M. U., Khazeo, P., Puro, K. N., Jyrwa, R., &Sailo, L. 2018. Pharmacognostic study of the leaf of Ageratinaadenophora. Adv. Eng. Res, 178, 155-158.

Jesus, N. Z. T., Falcão, H. S., Lima, G. R. M., Caldas Filho, M. R. D., Sales, I. R. P., Gomes, I. F., & Batista, L. M. 2013. Hyptissuaveolens (L.) Poit (Lamiaceae), a medicinal plant protects the stomach against several gastric ulcer models. Journal of ethnopharmacology, 150(3), 982-988.

Kalita, S., Kumar, G., Karthik, L., & Rao, K. V. B. 2012. A Review on Medicinal Properties of Lantana camara Linn. Research Journal of Pharmacy and Technology, 5(6), 711-715.DOI: 10.20959/wjpps20189-12195

Kohli, R. K., Batish, D. R., Singh, H. P., & Dogra, K. S. 2006. Status, invasiveness and environmental threats of three tropical American invasive weeds (Parthenium hysterophorus L., Ageratum conyzoides L., Lantana camara L.) in India. Biological Invasions, 8(7), 1501-1510.

Kull, C. A., Tassin, J., &Rangan, H. 2007. Multifunctional, scrubby, and invasive forests?. Mountain Research and Development, 27(3), 224-231.

Kunwar, R. M., Mahat, L., Acharya, R. P., & Bussmann, R. W. 2013. Medicinal plants, traditional medicine, markets and management in far-west Nepal. Journal of ethnobiology and ethnomedicine, 9(1), 1-10.

Li, Y., Li, J., Li, Y., Wang, X. X., & Cao, A. C. 2013. Antimicrobial Constituents of the Leaves of Mikaniamicrantha HB K. Plos one, 8(10), e76725.

Meira, M., Silva, E. P. D., David, J. M., & David, J. P. 2012. Review of the genus Ipomoea: traditional uses, chemistry and biological activities. RevistaBrasileira de Farmacognosia, 22, 682-713.

Ming, L. C. 1999. Ageratum conyzoides: A tropical source of medicinal and agricultural products. Perspectives on new crops and new uses, (Alexandria), 469-473.doi=10.1.1.408.6561

Muhammad, G., Hussain, M. A., Jantan, I., & Bukhari, S. N. A. 2016. Mimosa pudica L., a high-value medicinal plant as a source of bioactives for pharmaceuticals. Comprehensive Reviews in Food Science and Food Safety, 15(2), 303-315

Murphy, S. T., Subedi, N., Jnawali, S. R., Lamichhane, B. R., Upadhyay, G. P., Kock, R., & Amin, R. 2013. Invasive mikania in Chitwan National Park, Nepal: the threat to the greater one-horned rhinoceros Rhinocerosunicornis and factors driving the invasion. Oryx, 47(3), 361-368.

Mukherjee, P. K., &Wahile, A. 2006. Integrated approaches towards drug development from Ayurveda and other Indian system of medicines. Journal of ethnopharmacology, 103(1), 25-35.

Novoa, A., Kaplan, H., Wilson, J. R., & Richardson, D. M. 2016. Resolving a prickly situation: involving stakeholders in invasive cactus management in South Africa. Environmental Management, 57(5), 998-1008.

Patel, S. 2011. Harmful and beneficial aspects of Parthenium hysterophorus: an update. 3 Biotech, 1(1), 1-9.

Pappan, A., & Thomas, B. 2017. Contribution of invasive plants in herbal medicinal practices. International Journal of Herbal Medicine, 5(2), 73-77.

Rahman, A. H. M. M., &Gulshana, M. I. A. 2014. Taxonomy and medicinal uses on amaranthaceae family of Rajshahi, Bangladesh. Applied Ecology and Environmental Sciences, 2(2), 54-59. DOI:10.12691/aees-2-2-3

Richardson, D. M., &Rejmánek, M. 2011. Trees and shrubs as invasive alien species–a global review. Diversity and distributions, 17(5), 788-809

Roder, W., Dorji, K., & Wangdi, K. 2007. Implications of white clover introduction in East Himalayan grasslands. Mountain Research and Development, 27(3), 268-273.

Sala, O. E., Stuart Chapin, F. I. I. I., Armesto, J. J., Berlow, E., Bloomfield, J., Dirzo, R., ... & Wall, D. H. 2000. Global biodiversity scenarios for the year 2100. science, 287(5459), 1770-1774.

Saltos, R. V. A., Vásquez, T. E. R., Lazo, J. A., Banguera, D. V., Guayasamín, P. D. R., Vargas, J. K. A., &Peñas, I. V. 2016. The use of medicinal plants by rural populations of the Pastaza province in the Ecuadorian Amazon. ActaAmazonica, 46(4), 355-366.

Samy, R. P., &Ignacimuthu, S. 2000. Antibacterial activity of some folklore medicinal plants used by tribals in Western Ghats of India. Journal of Ethnopharmacology, 69(1), 63-71.

Sarkar, T., Ghosh, P., Poddar, S., Choudhury, S., Sarkar, A., & Chatterjee, S. 2020. Oxalis corniculata Linn.(Oxalidaceae): A brief review. Journal of Pharmacognosy and Phytochemistry, 9(4), 651-655.

Sharma, G. P., Singh, J. S., &Raghubanshi, A. S. 2005. Plant invasions: emerging trends and future implications. Current science, 726-734.

Shrestha, B.B. 2019a. Management of invasive alien plants in Nepal: current practices and future prospects. In: Tropical Ecosystems: Structure, Functions and Challenges in the Face of Global Change (eds. S.C. Garkoti, S.J. van Bloem, P.Z. Fule and R.L. Semwal), 45–68. Singapore: Springer.

Shrestha, U.B. and Shrestha, B.B. 2019. Climate change amplifies plant invasion hotspots in Nepal. Diversity and Distributions 25 (10): 1599–1612

Shrestha, B. K., &Dangol, D. R. 2014. Impact of Mikania micrantha HBK invasion on diversity and abundance of plant species of Chitwan National Park, Nepal. Journal of Institute of Science and Technology, 19(2), 30-36.

Shackleton, S. E., & Shackleton, R. T. 2018. Local knowledge regarding ecosystem services and disservices from invasive alien plants in the arid Kalahari, South Africa. Journal of arid environments, 159, 22-33.

Shackleton, C. M., McGarry, D., Fourie, S., Gambiza, J., Shackleton, S. E., &Fabricius, C. 2007. Assessing the effects of invasive alien species on rural livelihoods: case examples and a framework from South Africa. Human Ecology, 35(1), 113-127.

Shukla, S. K., Kumar, A., Terrence, M., Yusuf, J., Singh, V. P., & Mishra, M. 2013. The probable medicinal usage of Cassia tora: an overview. Online journal of biological sciences, 13(1), 13-17.

Sigdel& Acharya. 2021. Ethnomedicinal study of home garden species in Palpa District-Western Nepal.

Thapa, L. B., Kaewchumnong, K., Sinkkonen, A., &Sridith, K. 2016. Impacts of invasive Chromolaena odorata on species richness, composition and seedling recruitment of Shorea robusta in a tropical Sal forest, Nepal. Songklanakarin Journal of Science and Technology, 38(6), 683-689.

Thapa, L. B., Kaewchumnong, K., Sinkkonen, A., &Sridith, K. J. W. R. 2017. Plant invasiveness and target plant density: high densities of native Schimawallichii seedlings reduce negative effects of invasive Ageratinaadenophora. Weed Research, 57(2), 72-80.

Timsina, B., Shrestha, B. B., Rokaya, M. B., & Münzbergová, Z. 2011. Impact of Parthenium hysterophorus L. invasion on plant species composition and soil properties of grassland communities in Nepal. Flora-Morphology, Distribution, Functional Ecology of Plants, 206(3),233-240.

Tulika, T., & Mala, A. 2015. Pharmaceutical potential of aquatic plant Pistia stratiotes (L.) and Eichhornia crassipes. Journal of Plant Science, Special Issue: Medicinal Plants, 3, 10-18.