ISSN No:-2456-2165

Phytochemicals Analysis of Various Invasive Plants

Tilak Raj Rana[1*], Shayana[2] and Rajinder Kumar[3]
[1]Department of Chemistry, School of Sciences, A P Goyal Shimla University, Shimla, Himachal Pradesh, India-171013
[2]GSSS Balakrupi, Distt Kangra, Himachal Pradesh, India-176082
[3]Principal, GSSS Balakrupi, Distt Kangra, Himachal Pradesh, India-176082

Abstract:- For the sustainability reason and the cost effectiveness, natural occurring chemicals and compounds are the major area of attraction for the researchers. The ease of functionalization of these matrices along with remarkable properties, tunable functional sites make them incredible materials for pharmaceutical industry.

The present study focuses on the extraction of phytochemicals from the different invasive plants (IP's) present in the local area. The IP's are collected from the local area washed thoroughly, dried in the oven at 45°C for few days and grounded to powder to from the extract by using water, ethanol and methanol subsequently phytochemicals screening was done using standard methods. Quantitative analysis of IP's extract was studied for the presence of alkaloids, carbohydrates, amino acids/ proteins, glycosides, flavonoids, reducing sugars, terpenoids, oils and fat, anthrocyanins, carboxylic acid, coumarins, tannins, phenol, quinones, and anthraquinones were determined. The results show the presence of different phytochemicals is present in the extracts of the IP's which can be used in the future research prospective. By this beneficial sustainable approach, that increases the reliance and reduces the inheritability of people and environment to climate change. So, the sustainable use of invasive plants in the equitable way promotes the social-culture, health economic, ecological and agricultural benefits.

Keywords:- *Invasive Plants, Phytochemicals, Extract, Ethanol, Methanol, Quantitative Analysis, Sustainable Approach.*

I. INTRODUCTION

Invasive alien plants are nonnative plants whose introduction spread mourning impact in the local areas and creating threat to biodiversity. These plant species spread quickly and can displace native plants, prevent growth, and create monocultures (**Raj, T., *et al.*, 2022) [25**] A healthy plant community has a variety of herbs, shrubs, and trees but they cause biological pollution by reducing plant species diversity **(Aerts *et al.*, 2018)**. Some of the IP's can colonise degraded natural ecosystem **(Keller, *et al.*, 2011 & Koziol, *et. al.*, 2019) [18, 19]** and produce inhibitory effect on the surrounding vegetation. These species mostly herbaceous tall from few centimetres to metres and rapidly colonizes in the grazing land, road sides and even in the fertile land and create monoculture. But every plant has its medicinal value and even in the ancient time most plants provide the cure to many illnesses **(Allen, *et al.*, 2020, Burge, *et al.*, 2017, Clewley, *et al.*, 2012)** In the recent years we are hugely depend on the petrochemical and synthetic drug industry, which have many adverse effects on health and create resistance to several pathogens. The pandemic Covid-19 pushed us to go back to our producers. So, indigenous knowledge and phytochemicals **(El-Mergawi, *et al.*, 2019)** becomes the major area of concern for the researchers. Due to the uneven availability, excessiveness of different IP's in the locality, fundamental studies are being performed globally to know about different chemicals that provide better potency to the antimicrobials and are environment friendly **(Dechoum, *et al.*, 2019)** [1-5].

Plants contain enormous number of natural compounds (**Raj, T., *et al.*, 2022 & Raj, T., *et al.*, 2023)** [**25-26**] with important pharmaceutical properties (**Raj, T., *et al.*, 2022, El-Mergawi, *et al.*, 2019 & Erckie, *et al.*, 2022)** and their extracts have been used for treating various diseases from the ancient to modern time. Now these natural compounds, phytochemicals revolutionized the medicinal system and play a central role in health management system in the developing countries **(Hameed, *et al.*, 2019 & Hess, *et al.*, 2019)** After pandemic, Phyto-medicines have been the matter of interest and concern in primary source of human health **(Islam, *et al.*, 2018)**. Unexceptional properties exhibit by the phytochemicals/natural compounds make their direct use in the in the drug discovery, drug delivery, making composites and scaffold material to bind against specific targets to treats many diseases. Some researcher used these plants a packaging material, film and fibreboards. The impacts of the IP's have been the subject of many studies and researchers are looking for the removal and their reuse **(Karlovits, *et al.*, 2022 & Kato-Noguchi, *et al.*, 2020)**. These species pose a major challenge to the natural ecosystem **(Kama, *et al.*, 2023 & Kapun, *et al.*, 2022)** and destroy the agriculture land and displace the native land. Much less is known about the spread of these non-native plants **(Javed, *et al.*, 2019).** Many plays a conservative role among those plants are being the prime base as they sustaining our ecosystem. The phytochemicals alkaloids, carbohydrates, amino acids/proteins, glycosides, flavonoids, reducing sugars, terpenoids, oils and fat, anthrocyanins, carboxylic acid, coumarins, tannins, phenol, quinones, and anthraquinones and many more present in the plants are used as primary health remedies and the major reservoirs for treating vital and pandemic diseases **(Kaur, *et al.*, 2021 & Kavčič, *et al.*, 2020) [6-17].**

ISSN No:-2456-2165

The main aim of this paper is to collect and summarize the information about the IP's and to classify the plants as medicinal and non-medicinal based on the studies of their phytochemicals composition as well to provide the information to the researchers to explore and investigate the IP's for future prospective.

The literature of this paper is based on the fundamental knowledge accumulated by the indigenous people to identify the IP's with medicinal values, their harmful impacts on native species, animals and human health by phytochemicals analysis. In Himachal Pradesh rural area almost all the parts of the IP's are used to treat different ailments such as ulcer, fever, skin problems, antibacterial, antitumor, wound healing and to treat the generative diseases. Sometimes some invasive plants are used as cattle feed, and as a protein source.

II. EXPERIMENTAL

➢ *Materials*

Invasive plants (IP's) were collected from Lahru at Palampur, India and dried. All chemicals and reagents used were of analytical grade. Methanol (Sisco Research Laboratory Pvt Ltd, India), ethanol (RDC Limited, Delhi, India), acetone (Pvt. Ltd., India), double distilled water and sterilising water (Sun Rise Pharma, India.

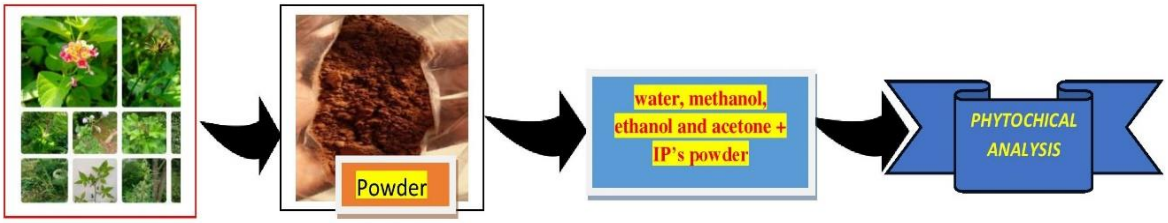

Figure 1: Schematic representation of formation of plants extracts and phytochemical analysis

➢ *Collection of samples*

Fresh different parts of the different IP's were collected in the month of July and August at flowering stage, from the studied area of Lahru at Palampur Distt Kangra Himachal Pradesh. The collected parts of IP's thoroughly washed and dried 4-5 days subsequently in the oven at 45°C for 12h. The dried parts are ground to find powder and sample stored in the tight polythene bags for further analysis.

➢ *Preparation of Extract*

1.0g of dried powder of each 11 invasive plants powder were kept in four round bottom flasks (four for each sample) for sample extraction using four solvents water, methanol, **(Kaur, *et. al.*, 2021, El-Mergawi, *et. al.*, 2019 & Islam, *et. al.*, 2018) [6, 10, 16]** ethanol and acetone. The extraction of was conducted with 15 ml of each solvent for a period of 18h leading to the concentration of sample under reduced pressure subsequently kept the sample in refrigerator for further use.

➢ *Phytochemicals analysis*

The phytochemicals analysis of IP's was carried out to determine the different phytochemicals present. The four crude extracts of each sample were screened for the presence of alkaloids, carbohydrates, amino acids/ proteins, glycosides, flavonoids, reducing sugars, terpenoids, oils and fat, anthrocyanins, carboxylic acid, coumarins, tannins, phenol, quinones, and anthraquinones by using standard procedure.

Table 1: phytochemicals test and observations [16-24]

S. No.	***TEST NAME***	***PROCEDURE***	***OBSERVATION***
1.		***Alkaloids***	
	Wagner's test Iodine test	1ml extract + 1-2 drops of Wagner's reagent (along the sides of test tube). 1ml extract + few drops of iodine solution.	A brown precipitate. A blue colour which disappears on boiling and reappears on cooling.
2.		***Carbohydrates***	
	Barfoed's test Starch test	1ml extract +1ml Barfoed's reagent + Heated foe 2 min. Aqueous solution + 5ml 5% KOH solution.	A red precipitate A light radish brown colouration.
3.		***Amino acids and proteins test***	
	Ninhydrin test	1ml extract + 1% Ninhydrin + boiling in bath	Purple colour
4.		***Glycosides***	
	Keller Killani test	1ml extract +glacial acetic acid +5% $FeCl_3$	Reddish brown colour appears on the junction of two liquids
5.		***Flavonoids***	
	NaOH Test	1ml extract + 2-3ml 20% NaOH	Intense yellow colour becomes

			colourless on addition conc. HCl
6.		***Reducing Sugars***	
	Benedict's test Fehling's test	0.5ml extract + 0.5ml Benedict's regent + boiled for 2min. 1ml each of Fehling's soln + boiled in water bath.	Red colour A red precipitate
7.		***Terpenoids***	
		1ml plant extract + 1 ml chloroform + 3.0 ml conc. H_2SO_4 (boiled on water bath).	A grey coloured solution
8.		***Oils and Fat***	
	Spot test	Little quantity of plant extract is pressed in b/w to fitter papers.	Oils stain on the paper.
9.		***Anthrocyanins***	
	HCL Test	1 ml plant extract + 2 ml Amm. chloride (few ml ammonia)	Pink–Red solution which turns blue-violet after addition of ammonia.
10.		***Carboxylic acid***	
	Effervescence test	1 ml extract + 1ml sodium bicarbonate solution	Appearance of effervescence
11.		***Coumarins***	
	NaOH paper test	0.5gm moistened extract is taken with 1N NaOH in test tube, mouth of test tube is covered with filter paper, heated for few minutes in water bath.	Yellow fluorescence from paper under the UV light
12.		***Tannins***	
	Br_2 water test	5 ml bromine water + 2ml plant extract	Decolouration of bromine
13.		***Quinones***	
	Alc. KOH test	1ml plant extract + few ml alcoholic potassium hydroxide	Red blue colour
14.		***Anthraquinones***	
	Ammonium hydroxide test	2 ml extract disolved in isopropyl alcohol + a drop of Ammonium hydroxide in acidic medium	Formation of red colour after 2 minutes

III. RESULTS AND DISCUSSION

➢ *Phytochemicals screening [27-35]*

The phytochemicals active compounds of IP's were quantitatively analysed and the results are presented in Tables 2, 3, 4,5, 6, 7, 8, 9, 10, 11 and 12. The data indicates that the methanol and ethanol extracts of IP's showed the presence of phytochemicals active compounds such as Alkaloids, Carbohydrates, Amino acids/ proteins, Glycosides, Flavonoids, Reducing Sugars, Terpenoids, Oils and Fat, Anthrocyanins, Carboxylic acid, Coumarins, Tannins , Phenol, Quinones, Anthraquinones but acetone extract shows the mainly carbohydrates, alkaloids, quinines and anthraquinones. The phytochemicals analysis of these 11 IP's that known to exhibits medicinal properties. Almost all the IP's shows the similar phytochemicals profiles that encouraging the researchers to develop possibilities to study the traditional applications.

Table 2: Quantitative phytochemicals analysis of extracts of *Lantana camara (L)*

Test of Extract	*Aqueous Extract*	*Methanol Extract*	*Ethanol Extract*	*Acetone Extract*
Alkaloids	+++	---	---	---
Carbohydrates	+++	+++	+++	+++
Amino acids/ proteins	---	---	---	---
Glycosides	+++	---	---	+++
Flavonoids	+++	+++	+++	+++
Reducing Sugars	+++	---	---	---
Terpenoids	---	---	---	---
Oils and Fat	+--	---	---	---
Anthrocyanins	---	---	---	---
Carboxylic acid	---	+++	+++	+++
Coumarins	---	+++	+++	-
Tannins, Phenols	---	+++	+++	+++
Quinones	---	+++	+++	+++
Anthraquinones	---	+++	---	---

Table 3: Quantitative phytochemicals analysis of extracts of *Parthenium hysterophorus* L.

Test of Extract	*Aqueous Extract*	*Methanol Extract*	*Ethanol Extract*	*Acetone Extract*
Alkaloids	+++	+++	+++	+++
Carbohydrates	+++	+++	+++	+++
Amino acids/ proteins	+++	+++	+++	---
Glycosides	+++	++-	++-	+++
Flavonoids	+++	+++	+++	+++
Reducing Sugars	+++	---	---	---
Terpenoids	---	---	---	---
Oils and Fat	---	---	----	---
Anthrocyanins	---	---	----	---
Carboxylic acid	+++	+++	+++	+++
Coumarins	---	---	---	+--
Tannins , Phenols	---	+++	+++	+++
Quinones	+++	+++	+++	+++
Anthraquinones	---	---	---	+--

Table 4: Quantitative phytochemicals analysis of extracts of *Ageratum conyzoides L.*

Test of Extract	*Aqueous Extract*	*Methanol Extract*	*Ethanol Extract*	*Acetone Extract*
Alkaloids	+++	+++	+++	+++
Carbohydrates	+++	+++	+++	+++
Amino acids/ proteins	+++	+++	+++	---
Glycosides	+++	+++	+++	+++
Flavonoids	+++	+++	+++	+++
Reducing Sugars	+++	---	---	---
Terpenoids	---	---	---	---
Oils and Fat	+++	---	----	---
Anthrocyanins	---	+--	+---	+--
Carboxylic acid	+++	+++	+++	+++
Coumarins	+++	+++	+++	+++
Tannins, Phenols	---	+++	+++	+++
Quinones	+++	+++	+++	+++
Anthraquinones	---	+++	+++	+++

Table 5: Quantitative phytochemicals analysis of extracts of *Biden pilosa L* .

Test of Extract	*Aqueous Extract*	*Methanol Extract*	*Ethanol Extract*	*Acetone Extract*
Alkaloids	---	+++	+++	+++
Carbohydrates	+++	+++	+++	+++
Amino acids/ proteins	+++	+++	+++	+++
Glycosides	+++	+++	+++	+++
Flavonoids	+++	+++	+++	+++
Reducing Sugars	---	+--	+--	+--
Terpenoids	---	---	---	---
Oils and Fat	+++	---	----	---
Anthrocyanins	---	---	----	+--
Carboxylic acid	+++	+++	+++	+++
Coumarins	+++	+++	+++	+++
Tannins, Phenols	+++	+++	+++	+++
Quinones	+++	+++	+++	+++
Anthraquinones	+++	+++	+++	---

Table 6: Quantitative phytochemicals analysis of extracts of *Cyperus iria L* .

Test of Extract	*Aqueous Extract*	*Methanol Extract*	*Ethanol Extract*	*Acetone Extract*
Alkaloids	---	---	---	---
Carbohydrates	+++	+++	+++	+++
Amino acids/ proteins	---	+--	+--	+--
Glycosides	+++	+++	+++	+++
Flavonoids	+++	+++	+++	+++

Reducing Sugars	---	---	---	---
Terpenoids	---	---	---	---
Oils and Fat	+--	---	----	---
Anthrocyanins	---	---	----	---
Carboxylic acid	+++	+++	+++	+++
Coumarins	+++	+++	+++	+++
Tannins, Phenols	+++	+++	+++	+++
Quinones	---	+++	+++	---
Anthraquinones	---	+++	+++	---

Table 7: Quantitative phytochemicals analysis of extracts of *Crassocephalum crepidioides.*

Test of Extract	***Aqueous Extract***	***Methanol Extract***	***Ethanol Extract***	***Acetone Extract***
Alkaloids	---	+++	+++	+++
Carbohydrates	+++	+++	+++	+++
Amino acids/ proteins	---	+--	+--	+--
Glycosides	+++	+++	+++	+++
Flavonoids	+++	+++	+++	+++
Reducing Sugars	---	+++	+++	+++
Terpenoids	---	---	---	---
Oils and Fat	+--	---	----	---
Anthrocyanins	---	+++	+++	+--
Carboxylic acid	+++	+++	+++	+++
Coumarins	+++	+++	+++	+++
Tannins, Phenols	+++	+++	+++	+++
Quinones	---	---	---	---
Anthraquinones	---	---	---	---

Table 8: Quantitative phytochemicals analysis of extracts of *Digitaria abyssinica* .

Test of Extract	***Aqueous Extract***	***Methanol Extract***	***Ethanol Extract***	***Acetone Extract***
Alkaloids	---	---	---	---
Carbohydrates	+++	+++	+++	+++
Amino acids/ proteins	---	+--	+--	+--
Glycosides	+++	+++	+++	+++
Flavonoids	+++	+++	+++	+++
Reducing Sugars	---	---	---	---
Terpenoids	+++	+--	+--	+--
Oils and Fat	---	---	----	---
Anthrocyanins	---	---	---	+--
Carboxylic acid	+++	+++	+++	+++
Coumarins	+++	+++	+++	+++
Tannins, Phenols	+++	+++	+++	+++
Quinones	---	+++	+++	---
Anthraquinones	---	---	---	---

Table 9: Quantitative phytochemicals analysis of extracts of *Mirabilis jalapa* .

Test of Extract	***Aqueous Extract***	***Methanol Extract***	***Ethanol Extract***	***Acetone Extract***
Alkaloids	---	+++	+++	+++
Carbohydrates	---	+++	+++	+++
Amino acids/ proteins	---	---	---	---
Glycosides	---	+++	+++	+--
Flavonoids	---	+++	+++	+++
Reducing Sugars	+++	---	---	---
Terpenoids	---	+++	+++	+++
Oils and Fat	---	---	----	---
Anthrocyanins	---	---	---	---
Carboxylic acid	---	+++	+++	+++
Coumarins	---	+++	+++	---
Tannins, Phenols	+++	+++	+++	---
Quinones	---	---	---	+--

Anthraquinones	---	---	---	---

Table 10: Quantitative phytochemicals analysis of extracts of Rubus ellipticus .

Test of Extract	*Aqueous Extract*	*Methanol Extract*	*Ethanol Extract*	*Acetone Extract*
Alkaloids	---	+++	+++	+++
Carbohydrates	+++	+++	+++	+++
Amino acids/ proteins	+++	+++	+++	---
Glycosides	+++	+++	+++	+--
Flavonoids	+++	+++	+++	+++
Reducing Sugars	+++	+++	+++	---
Terpenoids	+++	+++	+++	+++
Oils and Fat	---	---	----	---
Anthrocyanins	---	---	---	---
Carboxylic acid	---	+++	+++	+++
Coumarins	+++	+++	+++	---
Tannins, Phenols	+++	+++	+++	+++
Quinones	---	---	---	---
Anthraquinones	---	---	---	---

Table 11: Quantitative phytochemicals analysis of extracts of Solanum nigrum L .

Test of Extract	*Aqueous Extract*	*Methanol Extract*	*Ethanol Extract*	*Acetone Extract*
Alkaloids	+++	+++	+++	+++
Carbohydrates	+++	+++	+++	+++
Amino acids/ proteins	+++	+++	+++	+++
Glycosides	+--	+++	+++	+++
Flavonoids	+++	+++	+++	+++
Reducing Sugars	---	---	---	---
Terpenoids	+++	+++	+++	+++
Oils and Fat	---	---	----	---
Anthrocyanins	---	---	---	---
Carboxylic acid	---	+++	+++	+++
Coumarins	+++	+++	+++	---
Tannins, Phenols	+--	+++	+++	+++
Quinones	---	---	---	---
Anthraquinones	---	---	---	---

Table 12: Quantitative phytochemicals analysis of extracts of Xanthium strumarium L .

Test of Extract	*Aqueous Extract*	*Methanol Extract*	*Ethanol Extract*	*Acetone Extract*
Alkaloids	+++	+++	+++	+++
Carbohydrates	---	+++	+++	+++
Amino acids/ proteins	---	+++	+++	+++
Glycosides	---	+--	+--	+--
Flavonoids	+++	+++	+++	+++
Reducing Sugars	---	---	---	---
Terpenoids	+++	+++	+++	+++
Oils and Fat	---	---	----	---
Anthrocyanins	---	---	---	---
Carboxylic acid	---	+++	+++	+++
Coumarins	+++	+++	+++	---
Tannins, Phenols	---	+++	+++	+++
Quinones	---	+--	+--	---
Anthraquinones	---	---	---	---

"+++" = Highly Present, "++" =Moderately Present, "+" =Present, "-" = Absent

IV. CONCLUSION

The ecological problems caused by the invasive plants worldwide cannot be ignored, efficient policies are necessary to tackle the damage caused by the IP's. They are the rich source of different phytochemicals such as alkaloids, carbohydrates, amino acids/ proteins, glycosides, flavonoids, reducing sugars, terpenoids, oils and fat, anthrocyanins, carboxylic acid, coumarins, tannins, phenol, quinones, and anthraquinones which has enabled them to use as a universal reservoir for pharmaceutical industries. A comprehensive up to date data about the phytochemicals of

IP's is unavailable There are various parts of this to work and yet to identify. Therefore, it is necessary to create the awareness of IP's among researchers and pharmacologist for providing the better therapeutic wellness to the society. In this article scientific phytochemicals identifications have been summarized and critical discussion have been reported to help researchers.

REFERENCES

[1]. Aerts R, Honnay O, Van Nieuwenhuyse A. Biodiversity and human health: mechanisms and evidence of the positive health effects of diversity in nature and green spaces. Br Med Bull. ***2018,*** 127(1):5-22. DOI: 10.1093/bmb/ldy021.

[2]. Allen, W. J.; Wainer, R.; Tylianakis, J. M.; Barratt, B. I.; Shadbolt, M. R.; Waller, L. P.; Dickie, I. A. Community-level direct and indirect impacts of an invasive plant favour exotic over native species. J. Ecol. ***2020***, 108, 2499– 2510. DOI: 10.1111/1365-2745.13433.

[3]. Burge, O. R., Bodmin, K. A., Clarkson, B. R., Bartlam, S., Watts, C. H., & Tanner, C. C.. Glyphosate redirects wetland vegetation trajectory following willow invasion. Applied Vegetation Science, ***2017***, 20(4), 620–630. DOI: 10.1111/avsc.12320

[4]. Clewley, G. D., Eschen, R., Shaw, R. H., & Wright, D. J.. The effectiveness of classical biological control of invasive plants. Journal of Applied Ecology, ***2012***, 49(6), 1287–1295. DOI: 10.1111/j.1365-2664.2012.02209.x

[5]. Dechoum, M. D. S., Giehl, E. L. H., Sühs, R. B., Silveira, T. C. L., & Ziller, S. . Citizen engagement in the management of non-native invasive pines: Does it make a difference? Biological Invasions, ***2019,*** 21(1), 175–188. DOI: 10.1007/s10530-018-1814-0.

[6]. El-Mergawi, R.A.; Al-Humaid, A.I. Searching for natural herbicides in methanol extracts of eight plant species. Bull. Natl. Res. Cent. ***2019***, 43, 22. DOI: 10.1186/s42269-019-0063-4.

[7]. Erckie, L.; Adedoja, O.; Geerts, S.; van Wyk, E.; Boatwright, J. S. Impacts of an invasive alien Proteaceae on native plant species richness and vegetation structure. S. Afr. J. Bot. ***2022***, 144, 332–338. DOI: 10.1016/j.sajb.2021.09.017.

[8]. Hameed A., Al-Rashida M., Uroos M., et al. A patent update on therapeutic applications of urease inhibitors (2012–2018) Expert Opinion on Therapeutic Patents. ***2019***, 29(3):181–189. DOI: 10.1080/13543776.2019.1584612

[9]. Hess, M. C. M.; Mesléard, F.; Buisson, E. Priority effects: Emerging principles for invasive plant species management. Ecol. Eng***. 2019***, 127, 48– 57, DOI: 10.1016/j.ecoleng.2018.11.011.

[10]. Islam, A. M.; Hasan, M.; Musha, M.H.; Uddin, K.; Juraimi, A.S.; Anwar, P. Exploring 55 tropical medicinal plant species available in Bangladesh for their possible allelopathic potentiality. *Ann. Agric. Sci*. ***2018***, 63, 99–107. DOI: 10.1016/j.aoas.2018.05.005.

[11]. Javed, Q.; Sun, J.; Azeem, A.; Ullah, I.; Huang, P.; Kama, R.; Jabran, K.; Du, D. The enhanced tolerance of invasive Alternanthera philoxeroides over native species under salt-stress in china. *Appl. Ecol. Environ. Res.* ***2019***, 17, 14767– 14785. DOI: 10.15666/aeer/1706_1476714785.

[12]. Kama, R.; Javed, Q.; Bo, Y.; Muhammad A.; Imran, Filimban, F. Z.; Li, Z.; Nong, X.; Diatta, S.; Ren, G.; Eldin, S. M.; Iqbal, R.; Ali, I.; Iqbal, J.; and Sun, I. *ACS Omega*, ***2023***, 8 (20), 17983-17991. DOI:10.1021/acsomega.3c01139.

[13]. Kapun, T., Zule, J., Fabjan, E. et al. Engineered invasive plant cellulose fibers as resources for papermaking. *Eur. J. Wood Prod.* ***2022***, 80, 501–514. DOI: 10.1007/s00107-021-01779-y.

[14]. Karlovits, I., Kavčič, U. Flexo printability of agro and invasive papers. *Cellulose*, ***2022***, 29, 4613–4627. Doi: 10.1007/s10570-022-04571-0.

[15]. Kato-Noguchi, H. Involvement of Allelopathy in the Invasive Potential of Tithonia diversifolia. *Plants* ***2020***, 9, 766. DOI: 10.3390/plants9060766.

[16]. Kaur, L.; Malhi, D. S.; Cooper, R.; Kaur, M.; Sohal, S. H.; Mutreja, V.; Sharma, A. "Comperihensive review on ethnobotanical uses, phytochemistry, biological potential and toxicology of Parthenium hysterophorus L.: A journey fromnoxious weed to a therapeutic medicinal plants".*Journal of Ethnopharmacology*, ***2021,*** *281, 114525.* DOI: 10.1016/j.jep.2021.114525.

[17]. Kavčič, Urška and Karlovits, Igor. "The influence of process parameters of screen-printed invasive plant paper electrodes on cyclic voltammetry" *Nordic Pulp & Paper Research Journal*, ***2020***, 35 (2), 299-307. DOI: 10.1515/npprj-2019-0070

[18]. Keller, R. P.; Geist, J.; Jeschke, J. M. Invasive species in Europe: ecology, status, and policy. *Environ Sci Eur*, ***2011,*** 23, 2. DOI: 10.1186/2190-4715-23-23.

[19]. Koziol, L. I. Z.; Schultz, P. A.; House, G. L., Bauer, J. T.; Middleton, E. L.; & Bever, J. D. The plant microbiome and native plant restoration: The example of native mycorrhizal fungi. *Bio. Science*, ***2018,*** 68(12), 996–1006. DOI: 10.1093/biosci/biy125.

[20]. Li, S.; Peng, F.; Xiao, Y.; Gong, Q.; Bao, Z.; Li, Y.; Wu, X. Mechanisms of High Concentration Valine-Mediated Inhibition of Peach Tree Shoot Growth. *Front. Plant Sci.* ***2020***, 11, 603067. DOI: 10.3389/fpls.2020.603067.

[21]. Motmainna, M.; Juraimi, A.S.; Uddin, M.K.; Asib, N.B.; Islam, A.K.M.M.; Hasan, M. Bioherbicidal Properties of Parthenium hysterophorus, Cleome rutidosperma and Borreria alata Extracts on Selected Crop and Weed Species. *Agronomy* ***2021,*** 11, 643. DOI: 10.3390/agronomy11040643

[22]. Mousavi, S.S.; Karami, A.; Haghighi, T.M.; Alizadeh, S.; Maggi, F. Phytotoxic Potential and Phenolic Profile of Extracts from Scrophularia striata. *Plants* ***2021***, 10, 135. DOI: 10.3390/plants10010135.

[23]. Neugart, S.; Baldermann, S.; Hanschen, F. S.; Klopsch, R.; Wiesner-Reinhold, M.; Schreiner, M. The intrinsic quality of brassicaceous vegetables: How secondary plant metabolites are affected by genetic, environmental, and agronomic factors. *Sci. Hortic.* ***2018***, 233, 460– 478. DOI: 10.1016/j.scienta.2017.12.038.

[24]. Pilon, N. A. L., Buisson, E., & Durigan, G. Restoring Brazilian savanna ground layer vegetation by topsoil and hay transfer. *Restoration Ecology*, ***2017,*** 26(1), 73–81. DOI: 10.1111/rec.12534.

[25]. Raj, T.; Dharela, R.; Vaid, P.; Chauhan, G. S. Novel method for extraction of lignin from Pinus roxburghii (pr) needles and its applications for antimicrobial lignin-silver composite synthesis. *Material Today: Proceedings*, **2022**, 09, 224. DOI:10.1016/j.matpr.2022.09.224

[26]. Raj, T.; Dharela, R.; Vaid, P.; Chauhan, G. S. Novel method for Extraction of lignin Cellulose & Hemicellulose from Pinus roxburghii needles. *AJISE*, ***2023,*** 2(1) 57-68. DOI: 10.54536/ajise.v2i1.1288.

[27]. Ren, G.-Q.; Li, Q.; Li, Y.; Li, J.; Opoku Adomako, M.; Dai, Z.-C.; Li, G.-L.; Wan, L.-Y.; Zhang, B.; Zou, C. B.; Ran, Q.; Du, D.-L. The enhancement of root biomass increases the competitiveness of an invasive plant against a co-occurring native plant under elevated nitrogen deposition. *Flora* ***2019,*** 261, 151486. DOI: 10.1016/j.flora.2019.151486.

[28]. Shaikh J. R., Patil M. Qualitative tests for preliminary phytochemical screening: an overview. International Journal of Chemical Studies. 2020;8(2):603–608. DOI: 10.22271/chemi.2020.v8.i2i.8834.

[29]. Stefanowicz, A. M.; Stanek, M.; Nobis, M.; Zubek, S. Species-specific effects of plant invasions on activity, biomass, and composition of soil microbial communities. *Biol. Fertil. Soil.* ***2016***, 52, 841– 852. DOI: 10.1007/s00374-016-1122-8

[30]. Sun, J.; Javed, Q.; Du, Y.; Azeem, A.; Abbas, A.; Iqbal, B.; He, Y.; Xiang, Y.; Du, D. Invasive Alternanthera philoxeroides has performance advantages over natives under flooding with high amount of nitrogen. *Aquat. Ecol.* ***2022,*** 56, 891– 903. DOI: 10.1007/s10452-022-09951-z.

[31]. Wang, C.; Wei, M.; Wang, S.; Wu, B.; Cheng, H. Erigeron annuus (L.) Pers. and Solidago canadensis L. antagonistically affect community stability and community invasibility under the co-invasion condition. *Sci. Total Environ.* ***2020***, 716, 137128. DOI: 10.1016/j.scitotenv.2020.137128

[32]. Wang, C.; Liu, J.; Xiao, H.; Zhou, J.; Du, D. Nitrogen Deposition Influences the Allelopathic Effect of an Invasive Plant on the Reproduction of a Native Plant: Solidago canadensis versus Pterocypsela laciniata. *Polish J. Ecol. Environ.* ***2017***, 65, 87– 96. DOI: 10.3161/15052249PJE2017.65.1.008.

[33]. Wang, C.; Zhou, J.; Liu, J.; Wang, L.; Xiao, H. Reproductive Allocation Strategy of Two Herbaceous Invasive Plants Across Different Cover Classes. *Polish J. Environ. Stud.* ***2017,*** 26, 355. DOI: 10.15244/pjoes/64240.

[34]. Wei, M.; Wang, S.; Xiao, H.; Wu, B.; Jiang, K.; Du, D.; Wang, C. Stand-alone or co-occurring invasive plant species do not modify the diversity of the soil N2-fixing bacterial community. *Plant Ecol. Divers.* ***2020***, 13, 277– 287. DOI: 10.1080/17550874.2020.1729887.

[35]. Weidlich, E. W.; Flórido, F. G.; Sorrini, T. B.; Brancalion, P. H. Controlling invasive plant species in ecological restoration: A global review. *J. Appl. Ecol.* ***2020***, 57, 1806– 1817, DOI: 10.1111/1365-2664.13656.