RESEARCH PAPER

Evaluation of the Chemical Composition, Antioxidant Potential and Anti-Inflammatory Activities Variety of Abrus Precatorius L. Seeds Extract

[1*] J. B. Randhawane, [2*] S. S. Borhade, [1] G.R. Pandhre, [1] B.K. Uphade, [3] D. N. Raut, [4] P.H. Naikwadi

[1*]Padmashri Vikhe Patil College of Arts, Science and Commerce, Pravaranagar, Maharashtra, India

[2*]S.M.B.S.T. College of Arts, Science and Commerce, Sangamner, Maharashtra, India

[3]Amrutvahini College of Pharmacy, Sangamner, Maharashtra, India

[4]Agasti Arts, Commerce and Dadasaheb Rupwate Science College, Akole, Maharashtra, India

Savitribai Phule Pune University, Pune, Maharashtra, India

Corresponding Author: Jyoti B. Randhawane

Email ID: randhawanejyoti@gmail.com

Abstract

The utilization of compounds derived from natural sources represents a pivotal strategy in the development of effective and safe therapeutic interventions in human healthcare. Phytochemicals present in plants are increasingly acknowledged for their potential in the prevention of various human diseases. Abrus precatorius, commonly found in the tropical regions of the Western Ghats, exhibits several therapeutic properties. In this study, we systematically evaluated the chemical composition, antioxidant potential, and anti-inflammatory activity of the seeds from the black and white-yellow varieties of Abrus precatorius L. using an in vitro approach. This was achieved through successive extraction with n-hexane, ethanol, and aqueous Soxhlet. Phytochemical analysis via LC-MS revealed the presence of diverse secondary metabolites known for their biological activity. The concentration-dependent reduction of DPPH radicals was extensively investigated using in vitro biochemical methods, indicating the presence of effective free-radical neutralizing compounds. Mass spectroscopic analysis (LC-MS) demonstrated the presence of compounds such as Cortisone, 2-dimethylaminoethyl cinnamate, Ellipticine, Peonidin-3-O-glucoside, Diosmetin-7-O-rutinoside, Glabranin, 20-Hydroxyecdysone 20,22-acetonide, and Roemerine, which exhibited good binding scores and appreciable anti-inflammatory potential. The results indicate that A. precatorius seeds contain valuable natural antioxidants and anti-inflammatory compounds. The pharmacokinetic profiles of the active molecules were determined. The anti-inflammatory activity of the extracts was assessed using the bovine serum albumin (BSA) denaturation assay and the red blood cell membrane stabilization method. The black and white-yellow variety seeds of Abrus precatorius demonstrated notable inhibition of protein denaturation and effectiveness in stabilizing blood cell membranes, reflecting their ability to modulate inflammatory responses. Overall, our study reveals that the results support the therapeutic promise of Abrus precatorius seed extracts as a promising candidate for alleviating many health complaints associated with oxidative stress and inflammation. Further investigations are required to isolate the active constituents and establish their clinical relevance and safety.

Keywords:- LCMS, DPPH, *Abrus precatorius,* Antioxidant , Antiinflammtory

How to cite this article: Randhawane JB, Borhade SS, Pandhre GR, Uphade BK, Raut DN, Naikwadi PH. Evaluation of the Chemical Composition, Antioxidant Potential and Anti-Inflammatory Activities Variety of Abrus Precatorius L. Seeds Extract. Int J Drug Deliv Technol. 2026;16(8s): 930-936; DOI: 10.25258/ijddt.16.8s.103

1. Introduction: Secondary metabolites especially phenolic and flavonoids derived from the Plant [1]. The ability to scavenge free radicals and inflammatory intermediary with fewer adverse effects they have gained the attention of researcher [2]. *Abrus precatorius* L. (Fabaceae) is a medicinally important plant widely distributed in tropical and subtropical regions of the western ghat of Sahyadri. Traditionally, different parts of the plant have been used for the treatment of pain-related disorders, various type of infections and inflammatory conditions [3]. Inflammation and Oxidative stress are closely related to the pathogenesis of several chronic disorders which includes metabolic, neurodegenerative and cardiovascular diseases [4]. Anti-inflammatory activity refers to the ability of a substance or medication to reduce inflammation in the body. Inflammation is a natural response of the immune system to injury, infection, or irritation, but chronic or excessive inflammation can lead to various health problems, including autoimmune disorders, allergies, and cancer [5]. Disruption of cellular homeostasis and activates inflammatory cascades takes place due to the excessive generation of reactive oxygen species (ROS), it highlight the needs of effective antioxidant and anti-inflammatory agents Phytochemical studies shows that *A. precatorius* contains broad spectrum of bioactive constituents which includes phenolic compounds, alkaloids, flavonoids, triterpenoids, glycosides etc. which are responsible for the pharmacological activities. *A. precatorius* exhibit variations in the color of the seeds like, it is primarily categorized as black and white–yellow types [6]. Due to this it shows the variations in the qualitative and quantitative secondary metabolites composition which influence the potential biological activity [7]. The comparative evaluations of chemical composition and biological activity of the seed variety remains limited, especially in relation to anti-inflammatory and antioxidant potential [8]. In the Antioxidant activity assays, like DPPH radical scavenging method plant extracts has valuable insight into the capacity to neutralize ROS, where as in vitro anti-inflammatory models assist Demonstrating their therapeutic relevance [9]. To establish the relationship between biological activity and phytochemical constituents, it is important to validate their traditional use and identify the natural compound for their pharmaceutical development [10]. Therefore, the present study aims to investigate the chemical composition, antioxidant potential, and anti-inflammatory activities of black and white–yellow varieties of *Abrus precatorius* L. seed extracts [11]. The findings obtained from the results are expected to contribute to understand the variation differences and applications of *A. precatorius* seeds as a natural source of antioxidant and anti-inflammatory agent [12-15].

2. Materials and method

2.1 Chemicals: Chemicals like DMSO (Merac) 10 ml, Ascorbic Acid (Vit C) - 5 mg, Deionized water (Milipore) 10 ml, DPPH 5 mg, methanol 5ml used. All other drugs and chemicals used in the study were of analytical grade obtained from were obtained from LOBA CHEMIE PVT.LTD India. Disprine: 500 mg, BSA: 5 gm., DMSO: 10 ml per 10mg extract, Sodium phosphate buffer: i) 0.02 gm. NaH_2PO_4, ii) 0.115 gm. Na_2HPO_4, iii) 0.9 gm. NaCl, 0.9% NaCl Solution and blood from the healthy volunteer [16-18].

2.2 Plant material: Dry seeds of Black and white-yellow varieties of *Abrus precatorius* were used for the investigation of antioxidant and anti-inflammatory activity authenticated by the botanical survey of India, Pune [19].

2.3 Preparation of extracts: The collected air-dried seeds of plant Abrus precatorius were powdered with a mechanical blender to obtain a coarse powder,which is subjected for successive extraction by using a soxhlet apparatus by using the solvents like hexane , ethanol and water.every time before the extraction with next solvents the marc were firstly dried in air and then hot air oven up to 40- 45^0C.after complete extraction each extract were filtered through the Whatman No.1 filter paper and dried by using rotary evaporator [19-23]. Yield of each dried exract were measured and then stored in glass tubes for further investigation. The different extract obtained werw designated as BHE (Hexane extract of black variety), BEE (Ethanol extract of black variety), BWE (Water extract of black variety), WYHE (Hexane extract of white yellow variety), WYEE (Ethanol extract of white yellow variety), and WYWE (Water extract of white yellow variety). The dried extracts were dissolve in 10 ml dimethyl sulfoxide (DMSO) to make a clear solution of pH 7.4 and then used for the preparation of different final concentrations [20-26].

3. Methods:

3.1 DPPH• radical scavenging activity

The dried extract of the plant varieties were use solubilized in DMSO in the concentration of 1000 µg/mL. The stalk solution of Ascorbic acid was formed in concentration of 1000 µg/mL. Different serial dilutions concentrations of 3.12 µg/mL, 6.25 µg/mL, 12.5 µg/mL, 25 µg/mL, 50 µg/mL. 100 µg/mL were added in well of micro plate along with the 100 µg/mL DPPH solution and measure absorbance at 630 nm wave length. All procedure was repeated thrice. The percentage of inhibition of different extracts was calculated by using formula.

$$\%\ \text{Inhibition} = \frac{\text{Abs control} - \text{Abs Sample}}{\text{Abs Contorl}}\ X\ 100$$

3.2 Anti-inflammatory activity:

The stalk solution of 1000 µg/ml concentration was prepared by dissolving 308 mg of Disprine tablet in 20 ml deionized water. From stalk solution of 1000 µg/ml various concentrations like 100 µg/ml, 200 µg/ml, 300 µg/ml, 400 µg/ml, and 500 µg/ml were prepared. The 10 mg of crude dried extract of plant varieties were [BHE, BEE, BWE, WHE, WEE, WWE] dissolve in 10 ml DMSO to make a clear solution. The BSA solution and extract incubate at

70^0c further allowed to cooled and record the absorbance at 660 nm. The 5 ml of human blood from healthy volunteer were Centrifuge it at 3000 rpm for 5 min so that clear plasma were separate out. All plasma was removed and centrifuged were washed by using 0.9% NaCl solution. All procedure were repeated the thrice times so that the blood sample were ready for testing. Blood sample 100µg/ml, crude extract of *Abrus precatorius* 100µg/ml and sodium phosphate buffer solution 2.8 ml taken in to a test tube incubate at 54°c for 20 min. centrifuge again at 3000 rpm for 5 min. Measure the absorbance of sample and standard at 630 nm.

4. Result and Discussion:

4.1 Result

The DPPH assay was employed to measure the scavenging activity of *Abrus precatorius* extracts against the stable DPPH radicals. The percentage of DPPH radial scavenging was determined at various concentration of the extract. The results are summarized in table and graphically represented.

Table: 1 DPPH Radical Scavenging antioxidant Activity of *Abrus precatorius*

Sr. No	Sample	Concentration	Absorbance	Standard Deviation	Percent Inhibition
1	BHE	100 µg/mL	0.972666667	0.078	40.76329679
2	BEE	100 µg/mL	1.041333333	0.057744	36.58140479
3	BWE	100 µg/mL	0.855333333	0.025239	47.909054
4	WHE	100 µg/mL	1.204666667	0.037287	26.63418595
5	WEE	100 µg/mL	0.962	0.005568	41.41291108
6	WWE	100 µg/mL	0.998666667	0.030501	39.17986196
7	STD 1	3.12 µg/mL	1.416666667	0.11012	13.72310191
8	STD 2	6.25 µg/mL	1.268	0.048645	22.7771011
9	STD 3	12.5 µg/mL	1.028	0.066078	37.39342266
10	STD 4	25 µg/mL	0.837333333	0.047004	49.00527812
11	STD 5	50 µg/mL	0.406	0.04236	75.27405603
12	DPPH	100 µg/mL	1.642	0.03214	0

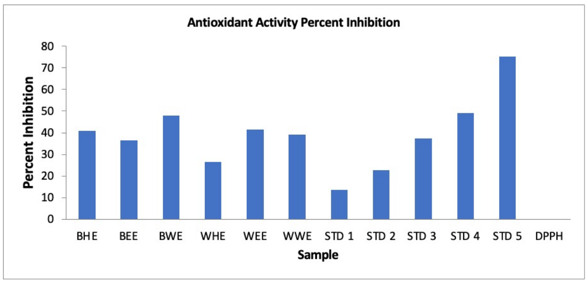

Figure: 1Antioxidant Activity Percent Inhibition of Sample and standard

Table: 2 Anti-Inflammatory Activities BSA

Sr. No	Sample Code	Absorbance	Formula	Percentage Inhibition
1	BHE	0.568333	1.069	52.21411217
2	BEE	0.625667	1.090583	47.39348301
3	BWE	0.664333	1.051917	44.14236103
4	WHE	0.797	0.91925	32.98764938
5	WEE	0.739333	0.976917	37.83630545
6	WWE	0.769667	0.946583	35.2858563
7	STD 1 100 µg/mL	0.771333	1.064917	35.14572173
8	STD 2 200 µg/mL	0.676333	1.039917	43.13339213
9	STD3 300 µg/mL	0.570333	1.08925	52.04595069
10	STD 4 400 µg/mL	0.351333	1.025917	70.45963298
11	STD 5 500 µg/mL	0.236333	1.072917	80.1289182
12	Blank	1.189333	1.14325	0

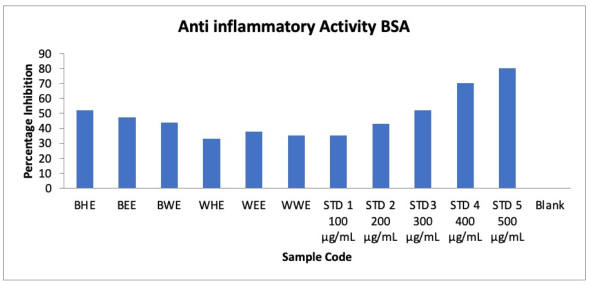

Figure: 2 Anti-Inflammatory Activities BSA

Table: 3 Anti-inflammatory Activity of sample Blood Cell Stabilization Assay

Sample No.	Samples Code	Absorbance	Formula	Percent inhibition
A1	BHE	1.069	0.71225	60.96
A2	BEE	1.146	0.63525	53.26
A3	BWE	1.336	0.44525	34.26
A4	WHE	1.082	0.69925	59.66
A5	WEE	1.073	0.70825	60.56
A6	WWE	1.307	0.47425	37.16
F1	STD1[31.75μg/mL]	1.103	0.67825	57.56
F2	STD 2 [62.5μg/mL]	0.99	0.79125	68.86
F3	STD 3 [125μg/mL]	0.863	0.91825	81.56
F4	STD 4[250μg/mL]	0.789	0.99225	88.96
F5	STD 5 [500μg/ml]	0.625	1.15625	105.36
G1	OD1	1.453	NA	
G2	OD1	1.38	NA	
G3	OD1	1.429	NA	
	AVG OD1	1.920666667	NA	

% Inhibition = 100 * 1-(OD2-OD1/OD3-OD1)
OD1- Test without heating
OD2-Test with heating

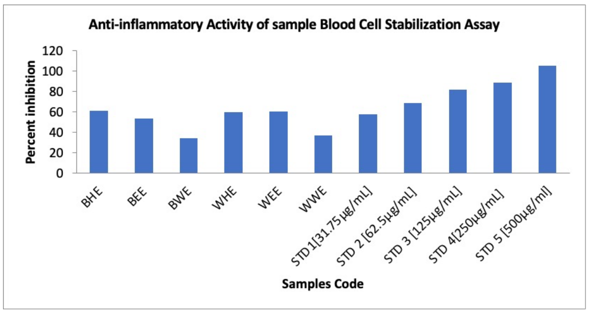

Figure: 3 Anti-inflammatory Activity of sample Blood Cell Stabilization Assay

Table: 4 Phytochemical constituents of *Abrus precatorius*

Sr.No.	Retention Time	PeakArea (%)	Mass of the Compound	Molecular formula	Compound Name	Activity
1	1.17	5.26	360.45	$C_{21}H_{28}O_5$	Cortisone	Anti-inflammatory
2	2.54	10.29	219.2859	$C_{13}H_{17}NO_2$	2-dimethylaminoethyl cinnamate	cytotoxic activities
3	3.63	12.16	246.313	$C_{17}H_{14}N_2$	Ellipticine	Alkaloid compound shows anti-cancer
4	6.83	1.40	463.415	$C_{22}H_{23}O_{11}$	Peonidin-3-O-glucoside	Antioxidant
5	8.02	23.40	608.549	$C_{28}H_{32}O_{15}$	Diosmetin-7-O-rutinoside	antioxidant, anti-inflammatory
6	14.25	8.42	324.38	$C_{20}H_{20}O_4$	glabranin	antioxidant, anti-inflammatory, anti-cancer
7	18.19	12.35	520.712	$C_{30}H_{48}O_7$	20-Hydroxyecdysone 20,22-acetonide	anabolic, anti-inflammatory
8	20.68	7.41	279.3	$C_{18}H_{17}NO$	Roemerine	antibacterial, anticancer,

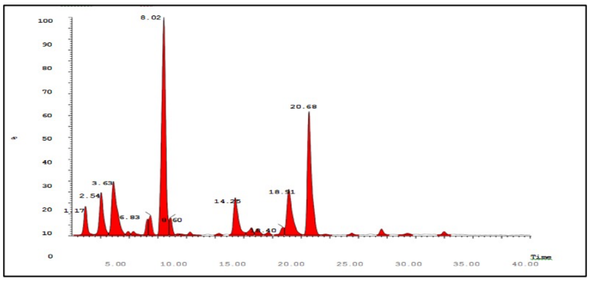

Figure:4 LC-MS analysis of *Abrus precatorius*

4.2 Discussion:

The seeds of *Abrus precatorius*, commonly known as rosary pea, serve as potent natural anti-inflammatory and antioxidant agents, underscoring their pharmacological potential. This study evaluates the chemical composition, antioxidant, and anti-inflammatory activities of *Abrus precatorius* L. seed extracts. LC-MS analysis was employed to identify a diverse range of bioactive phytochemicals, including phenolics, flavonoids, abrine, cortisone, glabranin, and peonidin-3-O-glucoside, which play crucial roles in biological membrane stabilization and free-radical scavenging, thereby regulating oxidative stress in vitro. Given the close relationship between oxidative stress and inflammatory signaling, these compounds may contribute to the plant's anti-inflammatory effects. Notably, the plant contains a specific chemical constituent, abrine, which, due to its favorable pharmacokinetic profile, is utilized in arthritis management. Additionally, the plant's secondary metabolites offer a therapeutic roadmap for managing oxidative stress-related diseases and various cancers, such as breast and cervical cancer. The seed extracts demonstrated significant antioxidant and anti-inflammatory activity, with the black variety exhibiting greater inhibition. The raw seeds contain protein synthesis inhibitors, which are crucial in specialized detoxification processes in pharmaceutical applications. Overall, further isolation and mechanistic investigations are warranted to validate their potential as natural antioxidant and anti-inflammatory agents.

5. Conclusion: The DPPH radical scavenging assay revealed a concentration- dependent increase in the inhibition of DPPH radicals by the extract. This suggests that the extract contains bioactive compounds capable of neutralizing free radicals. These findings suggest that *Abrus precatorius* could serve as a potential source of natural antioxidants. Further studies are warranted to identify and characterize the specific antioxidant compounds present in the extract. Studies on the anti-inflammatory activity of *Abrus precatorius* using the BSA assay and blood cell stabilization assay have highlighted its potential in inhibiting inflammatory responses and stabilizing blood cells. Result suggests that the plants extracts can effectively mitigate inflammation by reducing the levels of inflammatory markers and stabilizing blood cells. These findings indicates a promising direction for the development of based treatments for inflammatory conditions, but further research is *Abrus precatorius* necessary to establish its full therapeutic potential and ensure its safety for clinical use.

6. References:

1. Alsawaf, S., Alnuaimi, F., Afzal, S., Thomas, R. M., Chelakkot, A. L., Ramadan, W. S., Hodeify, R., Matar, R., Merheb, M., Siddiqui, S. S., & Vazhappilly, C. G. (2022). Plant Flavonoids on Oxidative Stress-Mediated Kidney Inflammation. Biology, 11(12), 1717. https://doi.org/10.3390/biology11121717

2. Yang, H., Leng, J., Liu, N., & Huang, L. (2024). Editorial: Free radicals and antioxidants in diseases associated with immune dysfunction, inflammatory process, and aberrant metabolism. Frontiers in Endocrinology, 15. https://doi.org/10.3389/fendo.2024.1363854

3. Ali, S., Sudha, K. G., Thirumalaivasan, N., Ahamed, M., Pandiaraj, S., Rajeswari, V. D., Vinayagam, Y., Thiruvengadam, M., & Govindasamy, R. (2023). Green Synthesis of Magnesium Oxide Nanoparticles by Using Abrus precatorius Bark Extract and Their Photocatalytic, Antioxidant, Antibacterial, and Cytotoxicity Activities. Bioengineering, 10(3), 302. https://doi.org/10.3390/bioengineering10030302 .

4. Silva, D. F., Empadinhas, N., Esteves, A. R., & Cardoso, S. M. (2022). Neurodegenerative Microbially-Shaped Diseases: Oxidative Stress Meets Neuroinflammation. Antioxidants, 11(11), 2141. https://doi.org/10.3390/antiox11112141

5. Rogovskii, V. (2024). Cancer and Autoimmune Diseases as Two Sides of Chronic Inflammation - and the Method of Therapy. Current Cancer Drug Targets, 24(11), 1089–1103. https://doi.org/10.2174/0115680096282480240105071638

6. Xu, B., Du, A.-N., Liu, T.-Z., Wei, P.-H., Zhu, B.-R., Chen, K., & Shi, L. (2025). Chemical Constituents and Pharmacological Effects of Camellia oleifera

Fruits: A Review. Molecules, 30(19), 3965. https://doi.org/10.3390/molecules30193965

7. Wu, W., Wu, H., Liang, R., Huang, S., Meng, L., Zhang, M., Xie, F., & Zhu, H. (2025). Light regulates the synthesis and accumulation of plant secondary metabolites. Frontiers in Plant Science, 16. https://doi.org/10.3389/fpls.2025.1644472

8. Fratianni, F., D'Acierno, A., Ombra, M. N., Amato, G., De Feo, V., Ayala-Zavala, J. F., Coppola, R., & Nazzaro, F. (2021). Fatty Acid Composition, Antioxidant, and in vitro Anti-inflammatory Activity of Five Cold-Pressed Prunus Seed Oils, and Their Anti-biofilm Effect Against Pathogenic Bacteria. *Frontiers in Nutrition*, *8*. https://doi.org/10.3389/fnut.2021.775751

9. Chirumamilla, P., & Taduri, S. (2022). Assessment of in vitro anti-inflammatory, antioxidant and antidiabetic activities of Solanum khasianum Clarke. *Vegetos*, *36*(2), 575–582. https://doi.org/10.1007/s42535-022-00410-6

10. Eljounaidi, K., & Lichman, B. R. (2020). Nature's Chemists: The Discovery and Engineering of Phytochemical Biosynthesis. *Frontiers in Chemistry*, *8*. https://doi.org/10.3389/fchem.2020.596479

11. Bourhia, M., Khalil Alyahya, H., Albadr, N. A., Laglaoui, A., Bakrim, H., Benbacer, L., Bouothmany, K., Gmouh, S., Salamatullah, A. M., El Mzibri, M., Alzahrani, A., & Hadrach, S. (2021). Chemical Profiling, Antioxidant, Antiproliferative, and Antibacterial Potentials of Chemically Characterized Extract of Citrullus colocynthis L. Seeds. *Separations*, *8*(8), 114. https://doi.org/10.3390/separations8080114

12. Agrawal, M., Chopra, K., & Bansal, S. (2021). Evaluation of the in vitro and in vivo antioxidant potentials of food grade Phycocyanin. *Journal of Food Science and Technology*, *58*(11), 4382–4390. https://doi.org/10.1007/s13197-020-04922-4

13. D'Angelo, G., Chimenz, R., Reiter, R. J., & Gitto, E. (2020). Use of Melatonin in Oxidative Stress Related Neonatal Diseases. *Antioxidants*, *9*(6), 477. https://doi.org/10.3390/antiox9060477

14.Minh Nguyen, H., Nguyen, K. P., Nguyen, K. P., Le, A. T. P., Vu-Huynh, L. K., Le, C. K. T., Delpe Acharige, A., Hull, K., & Romo, D. (2024). Antioxidant, anti-tyrosinase, hepatoprotective, and anti-inflammatory potential in flowers and seeds of Ochna integerrima (Lour.) Merr. *Natural Product Research*, *ahead-of-print*(ahead-of-print), 1–11. https://doi.org/10.1080/14786419.2024.2378195

15.Yeo, J., Lee, J., Kim, W. J., & Yoon, S. (2020). Tannic acid-based nanogel as an efficient anti-inflammatory agent. *Biomaterials Science*, *8*(4), 1148–1159. https://doi.org/10.1039/c9bm01384a

16. Al-Huqail, A. A., Aref, N. M. A., Khan, F., Sobhy, S. E., Hafez, E. E., Khalifa, A. M., & Saad-Allah, K. M. (2024). Azolla filiculoides extract improved salt tolerance in wheat (Triticum aestivum L.) is associated with prompting osmostasis, antioxidant potential and stress-interrelated genes. Scientific Reports, 14(1). https://doi.org/10.1038/s41598-024-61155-7

17. Popov, K., Silaev, G., Butakova, M., Trokhin, V., Oshchepkov, A., Vainer, Y., Trukhina, M., Oshchepkov, M., Kuryakov, V., & Koltinova, E. (2024). Potential Nano/Microcenters of Crystal Nucleation in Reagent-Grade Purity Solvents and Their Differentiation by Fluorescent-Tagged Antiscalant. Crystals, 14(7), 650. https://doi.org/10.3390/cryst14070650

18. Zaib, Q., Park, H. S., & Kyung, D. (2021). Experimental modeling and optimization for the reduction of hexavalent chromium in aqueous solutions using ascorbic acid. Scientific Reports, 11(1). https://doi.org/10.1038/s41598-021-92535-y

19. Harbane, S., Ouelhadj, A., Escuredo, O., Nakib, R., Seijo, M. C., Saker, Y., Ghorab, A., & Rodríguez-Flores, M. S. (2024). The Contribution of Botanical Origin to the Physicochemical and Antioxidant Properties of Algerian Honeys. Foods, 13(4), 573. https://doi.org/10.3390/foods13040573

20. Borges, A., Simões, M., José, H., & Homem, V. (2020). Comparison of Techniques and Solvents on the Antimicrobial and Antioxidant Potential of Extracts from Acacia dealbata and Olea europaea. Antibiotics, 9(2), 48. https://doi.org/10.3390/antibiotics9020048

21. Haido, M. H., Taher, S. M., & Matti, A. H. (2024). Optimization of Extraction Conditions of Bioactive Compounds From Kurdistan Species Urtica dioica. Cureus, 16(5). https://doi.org/10.7759/cureus.61146

22. Lauberts, M., Shishkin, A., Latheef, M. A. A., Pals, M., & Mierina, I. (2022). Spent Coffee Grounds Valorization in Biorefinery Context to Obtain Valuable Products Using Different Extraction Approaches and Solvents. Plants, 12(1), 30. https://doi.org/10.3390/plants12010030

23.Páramos, P. R. S., Granjo, J. F. O., Corazza, M. L., & Matos, H. A. (2020). Extraction of high value products from avocado waste biomass. The Journal of Supercritical Fluids, 165, 104988. https://doi.org/10.1016/j.supflu.2020.104988

24. Kaczor-Kamińska, M., Kaszuba, K., Wróbel, M., Bilska-Wilkosz, A., Iciek, M., & Kamiński, K. (2024). Dimethyl Sulfoxide (DMSO) as a Potential Source of Interference in Research Related to Sulfur Metabolism-A Preliminary Study. Antioxidants, 13(5), 582. https://doi.org/10.3390/antiox13050582

25. Kundishora, A., Sithole, S., & Mukanganyama, S. (2020). Determination of the Cytotoxic Effect of Different Leaf Extracts from Parinari curatellifolia (Chrysobalanaceae). Journal of Toxicology, 2020(2), 1–11. https://doi.org/10.1155/2020/8831545

26. Nguyen, S. T., Nguyen, H. T.-L., & Truong, K. D. (2020). Comparative cytotoxic effects of methanol, ethanol and DMSO on human cancer cell lines. Biomedical Research and Therapy, 7(7), 3855–3859. https://doi.org/10.15419/bmrat.v7i7.614

27. Mahnashi, M. H., Ashraf, M., Alhasaniah, A. H., Ullah, H., Zeb, A., Ghufran, M., Fahad, S., Ayaz, M., & Daglia, M. (2023). Polyphenol-enriched Desmodium elegans DC. ameliorate scopolamine-induced amnesia in animal model of Alzheimer's disease: In Vitro, In Vivo and In Silico approaches. Biomedicine & Pharmacotherapy, 165, 115144. https://doi.org/10.1016/j.biopha.2023.115144

28. Piyasena, K. G. N. P., Napagoda, M. T., Kalinga, J., Abayarathne, A. A. B., Jayawardhane, P. A. M., Siriwardhane, K. D. P. U., Ranatunga, M. A. B., & Jayasinghe, L. (2024). Variation of elastase, collagenase, tyrosinase enzyme inhibitory and antioxidant potential of different tea cultivars. Discover Chemistry, 1(1). https://doi.org/10.1007/s44371-024-00041-7

29. Idm'Hand, E., Cherifi, K., & Msanda, F. (2020). Medicinal uses, phytochemistry and pharmacology of Ammodaucus leucotrichus. Clinical Phytoscience, 6(1). https://doi.org/10.1186/s40816-020-0154-7

30. Jiang, C., & Gates, P. J. (2024). Systematic Characterisation of the Fragmentation of Flavonoids Using High-Resolution Accurate Mass Electrospray Tandem Mass Spectrometry. Molecules (Basel, Switzerland), 29(22), 5246. https://doi.org/10.3390/molecules29225246

31. Worbs, S., Volland, H., Becher, F., Dorner, B. G., Dorner, M. B., Simon, S., Stern, D., Kampa, B., Skiba, M., & Hansbauer, E.-M. (2021). Differentiation, Quantification and Identification of Abrin and Abrus precatorius Agglutinin. In Toxins (Vol. 13, Issue 4, p. 284). Multidisciplinary Digital Publishing Institute (mdpi). https://doi.org/10.3390/toxins13040284

.