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A Review on the phytochemical characterization of *Araucaria columnaris*

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Running title: Phytochemical characterization of *Araucaria columnaris*

Abstract:

This review focused on studies concentrated on identifying phytochemicals in *Araucaria columnaris*. This species is popular as an ornamental plant and its pharmacological activities and therapeutic uses are not commonly known. We screened various bibliographic databases and retrieved 13 relevant studies, which explored *Araucaria columnaris* chemical constitution. Phytochemical screening of its root, bark, resin, leaves, and essential oils was noted rich in flavonoids, phytosterols, tannins, and phenolic compounds. We identified 13 major compounds in the *Araucaria columnaris* which are well-known for their pharmacological activities. The pharmacological importance of those 13 major chemical compounds is also reviewed in this paper. These compounds are known as important for anti-inflammatory, antimicrobial, and many other pharmacological activities. The presence of the compound diosgenin makes it suitable for entry into pharmaceutical companies as a precursor to making many steroid hormones. We conclude that *A. columnaris* is a budding candidate for the pharmaceutical industry so, additional clinical research is still required to identify the mechanisms of action of these chemicals, which might confirm their potential to be used as an anti-inflammatory, and antimicrobial agent.

Keywords: Stigmasterol, Pinocarveol, Diosgenin, Manool,

Introduction:

Araucaria columnaris (J.R.Forst.) Hook., synonym Araucaria excelsa (Lamb.) is a tall, columnar, narrow and evergreen conifer species. It is commonly known as Cook Pine, New Caledonia Pine, and Cook's Araucaria. It is used as substitution of Christmas tree in tropical

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regions. The *Araucaria columnaris* belongs to family *Araucariaceae*, which having 20 evergreen species. This species is distributed in Southern Hemisphere majorly in Australia, New Guinea, New Caledonia, Norfolk Island and South America. According to Kanak tradition in New Caledonia, *A. columnaris* is a crucial tree. It is a potent representation of masculinity and the clan leader. Kanak settlements featured a huge meeting house in the middle, which frequently had a row of *A. columnaris* and coconut palms in front of it. The Cook pine is known by numerous names in New Caledonia, where 28 Kanak languages are spoken. The Cook pine is famous as xéxé in the southern province of Grande Terre [1].

New pharmaceuticals can be derived from medicinal plants, and many current medications are indirectly derived from plants. Because of safety concerns, particularly with regard to oxidative stress, interest in medicinal plants as an alternative to synthetic pharmaceuticals has grown over the past few years. Traditionally, *Araucaria columnaris* species have been used for medicinal purposes other than its major use as ornamental plant [2]. The species has noted rich in various bioactive compounds which are derivatives of flavonoids, phenolics, terpenoids, steroids, and tannins [3, 4]. Presence of these compounds make *A. columnaris* to be a best candidate to explore for several therapeutic activities, such as antifungal, antidepressant, antihypertensive, anticancer, healing against respiratory infection, anti-inflammatory and anticoagulant [5,6].

This review on the *A. columnaris* covers phytochemistry of compounds found by different researchers of the world. Various retrieval systems such as Pubmed, Elsevier, and Springer were accessed for the compilation of the literature presented here. We included 12 studies that were focused on the identification of phytochemicals in *A. columnaris*. Researchers collected samples of plant leaves, roots, bark or whole plant parts for the isolation of phytochemicals.

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They Pulverize and dried the samples. Dried powder and various solvents such as ethanol, methanol, chloroform, dichloromethane, hexene etc were used to make the extract. Various techniques such as GC–MS, DAD, DFT, NMF, chromatography, and spectroscopic were used to analyze different extracts resulting in showing the presence of a bioactive chemical (Fig 1, Table 1).

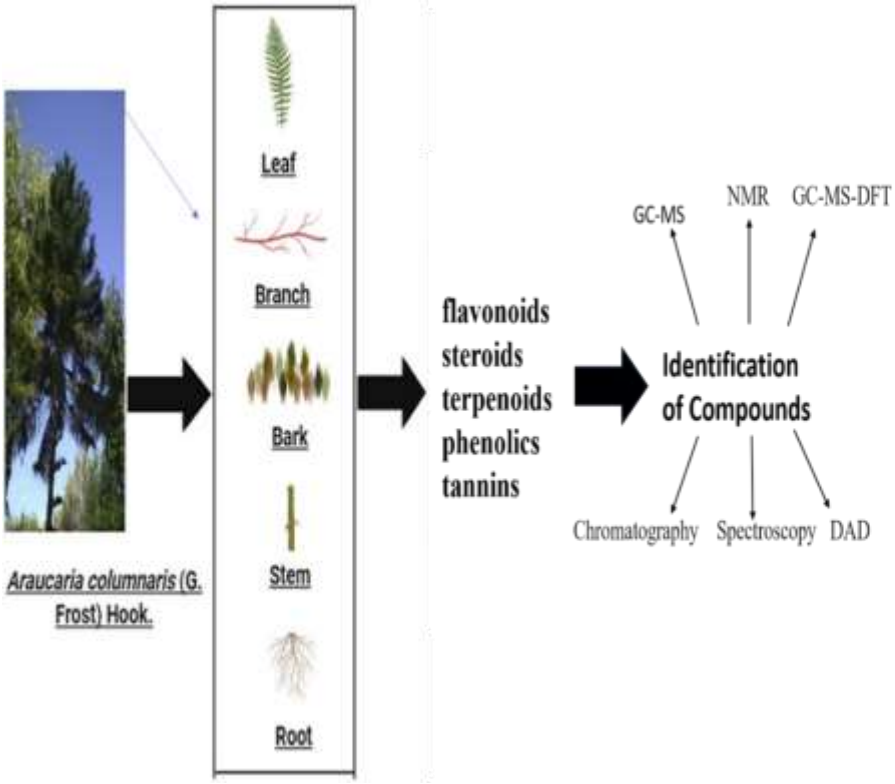

Figure 1: Process of Phytochemical extraction from *A. columnaris*

Phytochemical constituents were majorly distributed into flavonoids, tannins, Phytosteroids, and phenolic compounds as shown in Table 1. Therapeutically important chemicals are described below

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1. **Stigmasterol**: It is an unsaturated phytosterol, which was identified by Patial and Sud, (2022) in *A. columnaris* [7]. It is commonly used as a food supplement to reduce the risk of cardiovascular diseases. Its potent pharmaceutical properties are antifungal, antiparasitic, anti-osteoarthritis, anti-diabetic, immunomodulatory, antibacterial, antioxidant, anti-inflammatory, and neuroprotective properties [8].

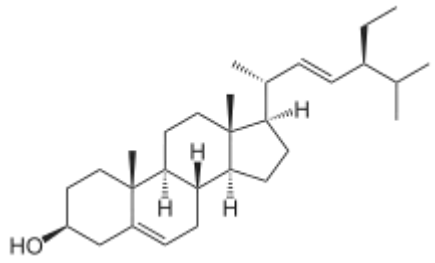

Figure 2: Stigmasterol**:** Stigmasta-5,22-dien-3β-ol

2. Diosgenin: Diosgenin, a phytosteroid sapogenin was noted in detectable amount by Patial and Sud, (2022) in *A. columnaris*[7]. It is used as precursor for the preparation of several steroidal drugs in the pharmaceutical industry. It has shown high potential in the treatment of diabetes, asthma, cancer, arthritis, and cardiovascular disease using its anti-inflammatory property [9].

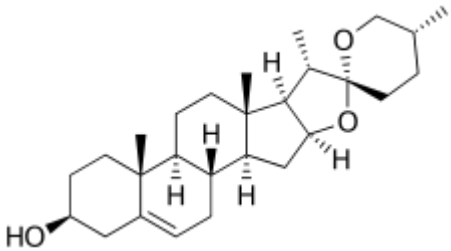

Figure 3: Diosgenin: (25R)-Spirost-5-en-3β-ol

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3. β-Pinene: It is a monoterpene found in essential oil of many plants. Its wide range of pharmacological activities include antitumor, antibiotic resistance modulation, antimicrobial, antimalarial, anticoagulant, anti-*Leishmania,* antioxidant, anti-inflammatory, and analgesic effects [10].

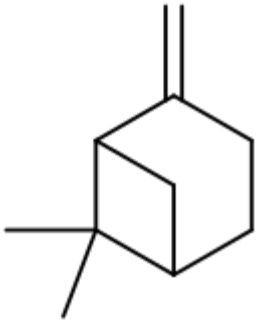

Figure 4: β-Pinene: 6,6-Dimethyl-2-methylidenebicyclo[3.1.1]heptane Pin-2(10)-ene

4. Terpinolene: Isomeric δ-terpinene are known as terpinolene. It has been noted associated with antinociceptive, wound healing and anti-inflammatory potential [11]**.**

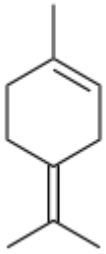

Figure 5: Terpinolene: δ: 1-Methyl-4-(propan-2-ylidene)cyclohex-1-ene

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5. Pinocarveol: Patial and Cannoo, (2020) isolated Pinocarveol**,** a bicyclic monoterpenoid. A Korean study found it responsible for weight loss, improving blood kidney function index, inhibits a metabolic inflammation and reducing blood sugar [12].

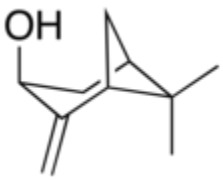

Figure 6: 6,6-dimethyl-2-methylidenebicyclo[3.1.1]heptan-3-ol

6. 2-propenoic acid, 3-(4-methoxyphenyl): Devi et al., 2015 isolated it from *A. columnaris* bark. It is reported to have anti-inflammatory, antibacterial, herbicide, anesthetic, antispasmodic, dermatitigenic, antimutagenic, fungicide, laxative, cancer preventive and pesticide activities [13].

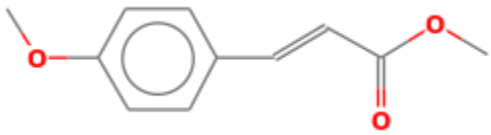

Figure 7: 2-propenoic acid, 3-(4-methoxyphenyl)

7. 1H-N Hydrxynaphth (2,3) imidazole 6,7 dicarboximide: It have various antifungal, antiprotozoal, antihypertensive and anticancer activity, medications in inflammation, neurodegenerative diseases and also have antioxidant property [14, 15].

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8. 2-[2-Hydroxy-2-(p-chlorophenyl)ethyl]-3,5,6-trimethylpyrazine: Devi et al in 2013 identified this compound in *A. columnaris,* which is proven to have Antimicrobial activity [5].

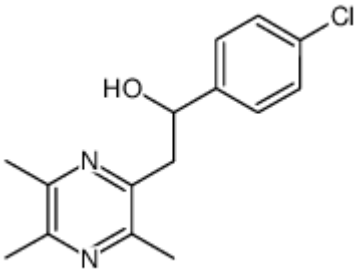

Figure 8: 2-[2-Hydroxy-2-(p-chlorophenyl)ethyl]-3,5,6-trimethylpyrazine

9. 1,2-Benzenedicarboxylic acid, bis(2-ethylhexyl) ester: It is a phthalate ester which is known for Antimicrobial and Anti-inflammatory activity, an inhibitor of apoptosis and an agonist of androstane receptor as well as a plasticiser [5].

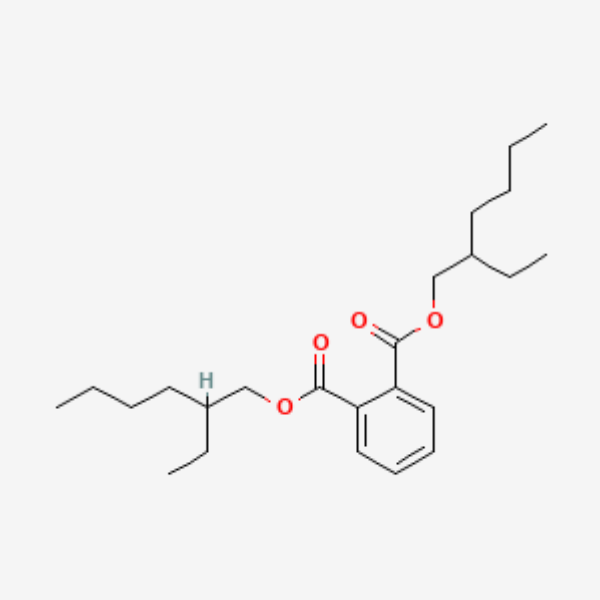

Figure 9: 1,2-Benzenedicarboxylic acid, bis(2-ethylhexyl) ester:

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10. Diisooctyl-phthalate: Diisooctyl-phthalate has shown antimicrobial and Cytotoxic Activity in Habib and Karim (2009) study [16].

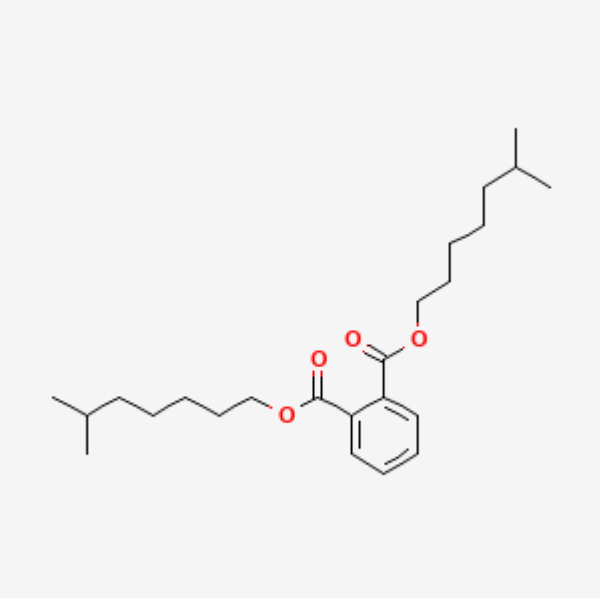

Figure 10: Diisooctyl-phthalate

11. 4-(3-Benzyl-2,4-dioxo-1- phenethyl-1,2,3,4-tetrahydro-5- pyrimidinylmethyl) benzamide: It is noted to show antimicrobial activity, Anti-oxidant, anti-inflammatory and analgesic activities in studies by Devi et al., (2013) and Sakr et al., (2019) [5, 17].

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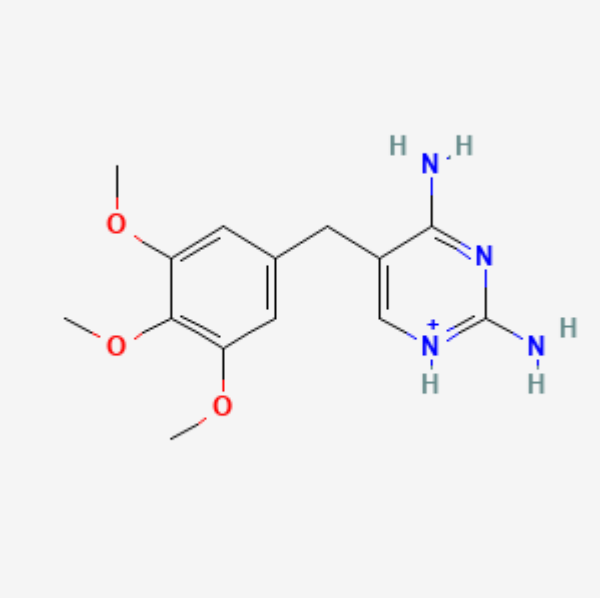

Figure 11: 4-(3-Benzyl-2,4-dioxo-1- phenethyl-1,2,3,4-tetrahydro-5-pyrimidinylmethyl)benzamide

12. Manool: It is a diterpene which shows anti-malenoma, antigenotoxic and antitumor biological activity. It was noted abundantly in *A. columnaris* by Patial and Cannoo in 2021 [18].

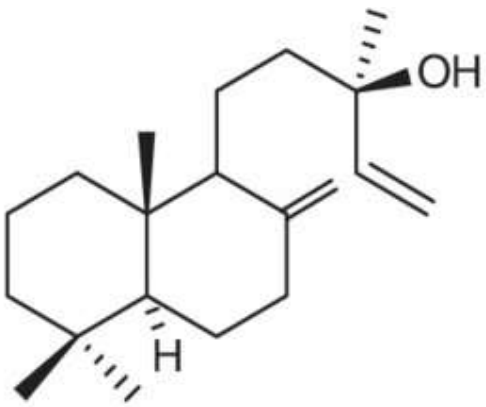

Figure 12: Manool

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13. Agathisflavone: It is a known plant-derived Biflavonoid. It was found effective in the treatment of inflammatory diseases, hepatic disorders, oxidative stress, microbial infection, and neurological diseases, and cancer [19].

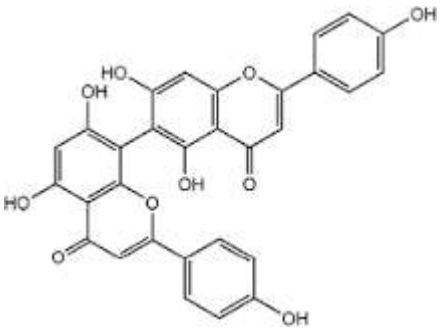

Figure 13: Agathisflavone [8-[5,7-dihydroxy-2-(4-hydroxyphenyl)chromen-6-yl-4-oxo]-5,7-di-hydroxy-2-(4-hydroxyphenyl) chromen-4-one]

Table 1: Details of studies on identification of phytochemicals

	Plant part	Extract	Phytochemicals	Analysis Method	Authors
1.	Branch	Ethanol and dichlorome -thane	Flavonoids, tannins and phenolic compounds	Phytochemical screening	Patial and Cannoo, 2021 [18]
2.	Bark	Methanol and water	Flavonoids, tannins and phenolic compounds	Phytochemical screening	Jadav and Gowda, 2017 [20]

3.	Bark	Ethanol	Phytosteroids i.e., stigmasterol and diosgenin	Phytochemical screening	Patial and Sud, 2022 [21]
4.	Plant	Essential oil	β-pinene, terpinolene, 2-nonanone, pinocarveol, *trans*-verbenol, dihydrocarvone, dodecane, thymol, isolongifolene, α-copaene, α-gurjunene, β-caryophyllene, isoledene, γ-muurolene, γ-cadinene,	RP-HPLC-DAD, GC-MS	Patial and Cannoo, 2020 [22]
5.	Aerial parts	Dichloromethane and methanol	Tannins and cardiac glycosides	Phytochemical screening	Aslam et al., 2014 [2]
6.		Hexane, Chloroform, methanol	11 polyphenolic compounds, 48 bioactive terpenes, Phytosteroid, Vitamin, Carotenoids or their derivatives	GC-MS-DFT	Patial and Cannoo, 2021 [18]
7.	Leaves	Alcoholic	15-agathic acid methyl ester, 7,4′,7″,4‴-tetra-*O*-methyl-robustaflavone, 4-*O*-*trans*-*p*-coumaroyl-quinic acid, 3-*O*-*trans*-*p*-coumaroyl-quinic acid,	Column chromatography together with NMR spectroscopy	Frezza et al., 2022 [23]

			ladanein, shikimic acid, 5-*O*-*trans*-*p*-coumaroyl-quinic acid		
8.	Bark	methanol, ethyl acetate, benzene and water	Benzoic acid, 1H-N-Hydroxynaphth (2,3-d) imidazole-6,7-dicarboximide, 2-Propenoic acid, 3-(4-methoxyphenyl), 1H-N-Hydroxynaphth (2,3) imidazole-6,7-dicarboximide	TLC and GC-MS	Devi et al., 2015 [24]
9.	Leaves	Acetone	flavonoids, steroids, terpenoids, phenolics, and tannins	Phytochemical screening	Kurniawanti et al., 2021 [25]
10.	Whole plant		saponins, antraquinones, terpenes, flavonoids, carbohydrates, proteins	Phytochemical screening	Pavani et al., 2014 [3]
11.	Leaves		saponins, tannins, phenols, flavonoids phytosteroids	Phytochemical screening	Verma et al., 2013 [4]
12.	Leaves		7,4′’’-di-*O*-methyl-agathisflavone, 7-*O*-methyl-agathisflavone, hinokiflavone, agathisflavone, amentoflavone, cupressuflavone, 7′’-*O*-methyl-amentoflavone, 7,7′’-di-*O*-methyl-amentoflavone, 7,7′’-di-*O*-methyl-agathisflavone, 7,7′’,4′’’-tri-*O*-methyl-	SE, CC, TLC, IR, UV, NMR, MS	Ilyas et al., 1978 [26]

			agathisflavone, 7,4′,7′′,4′′′-tetra-*O*-methyl-amentoflavone, 7,4′,7′′-tri-*O*-methyl-amentoflavone, 7,4′,7′′,4′′′-tetra-*O*-methyl-cupressuflavone,		
13	Resin	water, methanol, ethyl acetate and Benzene	2-[2-Hydroxy-2-(p-chlorophenyl)ethyl]-3,5,6-trimethylpyrazine, 2-propenoic acid, 3-(4-methoxyphenyl), Diisooctyl-phthalate, 4-(3-Benzyl-2,4-dioxo-1-phenethyl-1,2,3,4-tetrahydro-5-pyrimidinylmethyl) benzamide	Thin layer Chromatography, GC-MS	Devi et al., 2013 [5]

Conclusion: This review declares *A. columnaris* has huge potential to be used and anti-inflammatory and antimicrobial agent because of the present of above discussed phytochemicals. Presence of Diosgenin makes it suitable for entry into pharmaceutical companies as a precursor to make many steroid hormones.

Acknowledgement:

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 UGC CARE Listed (Group -I) Journal Volume 12, Iss 1, 2023

References

1. Bramwell David. "Biogeography and conservation of the flora of New Caledonia." The Biology of Island Floras. Ed. David Bramwell and Juli Caujape-Castells. Cambridge UP: Cambridge 2011. 226-238.

2. Aslam MS, Choudhary BA, Uzair M, Ijaz AS. Phytochemistry of aerial parts of Araucaria columnaris. J. Appl. Pharmacol 2014;6:114-20.
3. Pavani PS, Raj KP, Sarany A, Kumar AR. Phytochemical profile of three selected plants of Araucaria columnaris, Araucaria heterophylla, Ocimum tenuiflorum. International Research Journal of Pharmaceutical and Applied Sciences 2014;4(5):18-20.
4. Verma, S.; Mohanta, T.; Revathy, T.; Suthindhiran, K.; Jayasri, M.A. Phytochemical and pharmacological evaluation of selected plants. Am. J. Biochem. Biotechnol 2013, 9, 291–299.
5. Devi K Saranya, Sruthy P B, Anjana J C, Rathinamala J, Jayashree S. GC-MS analysis of phytocomponents in resin of Araucaria Columnaris (Cook Pine) and its medicinal uses. International Journal of Applied Biology and Pharmaceutical Technology 2013 Jul-Sept; 4(3): 272-276.
6. Devi KS, Sruthy PB, Anjana JC, Rathinamala J. Identification of bioactive compounds and toxicity study of Araucaria columnaris bark extract on human embryonic kidney cell line. Asian J Biotechnol 2015;7(3):129-36.
7. Patial PK, Sud D. Bioactive phytosteroids from Araucaria columnaris (G. Forst.) Hook.: RP-HPLC-DAD analysis, in-vitro antioxidant potential, in-silico computational study and molecular docking against 3MNG and 1N3U. Steroids 2022 Dec 1;188:109116.

8. Bakrim S, Benkhaira N, Bourais I, Benali T, Lee LH, El Omari N, Sheikh RA, Goh KW, Ming LC, Bouyahya A. Health Benefits and Pharmacological Properties of Stigmasterol. Antioxidants (Basel) 2022 Sep 27;11(10):1912.
9. Semwal P, Painuli S, Abu-Izneid T, Rauf A, Sharma A, Daştan SD, Kumar M, Alshehri MM, Taheri Y, Das R, Mitra S, Emran TB, Sharifi-Rad J, Calina D, Cho WC. Diosgenin: An Updated Pharmacological Review and Therapeutic Perspectives. Oxid Med Cell Longev 2022 May 29;2022:1035441.
10. Salehi B, Upadhyay S, Erdogan Orhan I, Kumar Jugran A, L D Jayaweera S, A Dias D, Sharopov F, Taheri Y, Martins N, Baghalpour N, Cho WC, Sharifi-Rad J. Therapeutic Potential of α- and β-Pinene: A Miracle Gift of Nature. Biomolecules 2019 Nov 14;9(11):738.
11. Macedo EM, Santos WC, Sousa Neto BP, Lopes EM, Piauilino CA, Cunha FV, Sousa DP, Oliveira FA, Almeida FR. Association of terpinolene and diclofenac presents antinociceptive and anti-inflammatory synergistic effects in a model of chronic inflammation. Brazilian Journal of Medical and Biological Research 2016 Jun 20;49.
12. Patial PK, Cannoo DS. Evaluation of volatile compounds, phenolic acids, antioxidant potential and DFT study of essential oils from different parts of Araucaria columnaris (G. Forst.) Hook. from India. Food and Chemical Toxicology 2020 Jul 1;141:111376.
13. Ponnamma SU, Manjunath K. GC- MS analysis of phytocomponents in the methanolic extract of Justicia wynaadensis (Nees) T. anders. International Journal of pharma and bio sciences 2012;3(3):570-6.
14. Khalid MH, Tokunaga Y, Caputy AJ, Walters E. Inhibition of tumor growth and prolonged survival of rats with intracranial gliomas following administration of clotrimazole. Journal of neurosurgery 2005 Jul 1;103(1):79-86.

15. Almasirad A, Mousavi Z, Tajik M, Assarzadeh MJ, Shafiee A. Synthesis, analgesic and anti-inflammatory activities of new methyl-imidazolyl-1, 3, 4-oxadiazoles and 1, 2, 4-triazoles. Daru journal of pharmaceutical sciences 2014 Dec;22:1-8.
16. Habib MR, Karim MR. Antimicrobial and Cytotoxic Activity of Di-(2-ethylhexyl) Phthalate and Anhydrosophoradiol-3-acetate Isolated from Calotropis gigantea (Linn.) Flower. Mycobiology 2009 Mar;37(1):31-6.
17. Sakr A, Kothayer H, Ibrahim SM, Baraka MM, Rezq S. 1,4-Dihydroquinazolin-3(2H)-yl benzamide derivatives as anti-inflammatory and analgesic agents with an improved gastric profile: Design, synthesis, COX-1/2 inhibitory activity and molecular docking study. Bioorg Chem 2019 Mar;84:76-86.
18. Patial PK, Cannoo DS. Phytochemical profile, antioxidant potential and DFT study of Araucaria columnaris (G. Forst.) Hook. Branch extracts. Natural Product Research 2021 Nov 18;35(22):4611-5.
19. Islam, M.T., Zihad, S.N.K., Rahman, M.S., Sifat, N., Khan, M.R., Uddin, S.J. and Rouf, R., 2019. Agathisflavone: Botanical sources, therapeutic promises, and molecular docking study. IUBMB life 71(9), pp.1192-1200.
20. Jadav KM, Gowda KN. Preliminary phytochemical analysis and in vitro antioxidant activity of Araucaria columnaris bark peel and Cosmos sulphureus flowers. world 2017;12:13.
21. Patial PK, Sud D. Bioactive phytosteroids from Araucaria columnaris (G. Forst.) Hook.: RP-HPLC-DAD analysis, in-vitro antioxidant potential, in-silico computational study and molecular docking against 3MNG and 1N3U. Steroids 2022 Dec 1;188:109116.
22. Patial PK, Cannoo DS. First-time comparative investigation on Araucaria columnaris (G. Forst.) Hook. leaves: Extraction techniques, phytochemicals, medicinal activities, and DFT study. Medicinal Chemistry Research 2021 Jan;30:196-214.

ISSN PRINT 2319 1775 Online 2320 7876
 UGC CARE Listed (Group -I) Journal Volume 12, Iss 1, 2023

23. Frezza C, Sciubba F, De Vita D, Toniolo C, Foddai S, Tomassini L, Petrucci R, Bianco A, Serafini M. Non-volatile compounds from Araucaria columnaris (G. Forst.) Hook leaves. Biochemical Systematics and Ecology 2022 Aug 1;103:104430.

24. Devi KS, Sruthy PB, Anjana JC, Rathinamala J. Identification of bioactive compounds and toxicity study of Araucaria columnaris bark extract on human embryonic kidney cell line. Asian J Biotechnol 2015;7(3):129-36.

25. Kurniawanti, Dhea Demitri Agusta, Hanhan Dianhar, Dyah Utami Cahyaning Rahayu, and Purwantiningsih Sugita. "Phytochemical screening and preliminary evaluation of antioxidant activity of three indonesian araucaria leaves extracts." Sci. Arch. 2021 250-254.

26. Ilyas, N.; Ilyas, M.; Rahman, W.; Okigawa, M.; Kawano, N. Biflavones from the leaves of Araucaria excelsa. Phytochemistry 1978; 17, 987–990