

# MEDICINAL PLANTS IN CHHATTISGARH STATE

Sanyogita Shahi<sup>1\*</sup>, Shirish Kumar Singh<sup>2</sup>

<sup>1</sup>Kalinga University, Raipur, Chhattisgarh

<sup>2</sup>Regional Science Centre, Saddu, Raipur, Chhattisgarh

\*corresponding author- Sanyogita Shahi

<sup>1</sup>Kalinga University, Raipur, Chhattisgarh, Email: - drsanyogitashahi@gmail.com

DOI: 10.47750/pnr.2022.13.S05.102

## Abstract

The look at changed into carried out for Traditional Knowledge of Medicinal Plants, Part use and their Uses in Tribal Region in Chhattisgarh. tribe is aware of overall forty one Medicinal Plant species. As in keeping with the expertise of respondents approximately Medicinal tree species Arjun (*Terminaliaarjuna*), Baheda (*Terminaliabellirica*), Harra (*Terminaliachebula*), Karanj (*Pongamiapinnata*), Neem (*Azadiractaindica*), Char(*Buchananialanzan*) Mahua (*Madhucaindica*) etc. are normally the use of as medicinal motive observed through Bhuineem (*Andrographispaniculata*), Chirchita (*Achyranthesaspera*) Bariyari (*Sidaacuta*), Satavar (*Asparagus racemosus*), Sher datum(*Smilax macrophylla*), Genda (*Tegeteserecta*), Hadsanghar (*Nyctanthesarbortristis*), Hathhjud (*Cissusquadrangularis*) and Kewach (*Mucunapruriens*) etc. are shrub and climber Species use through the tribal people. Therefore, it's miles the requisite element of holding those organic assets for a sustainable ecosystem. This statistics given through tribal's suggests the very numerous nature of Medicinal plant life they use in recovery motive & dwelling general upliftment.

**Keywords**— Tribe, Traditional, Medicinal plants, Ailment, Knowledge

## INTRODUCTION

Medicinal vegetation play an vital function in assisting the fitness care device in India. This numerous composition with know-how approximately their medicinal residences may be very important for the survival of tribes, nevertheless stay with plenty dependence on vegetation. According to WHO global fitness corporation planning, 80% of the populace in growing nations is based on conventional medication (Bhandary and Chandrashekhar, 2002). In India extra than 75% populace belongs to rural regions and deepened to the herbal assets (Anonymous, 1991). India is one of the wealthy and numerous facilities of various medicinal vegetation. Around 45,000 plant species located in India almost 15,000 plant species are used for his or her unique medicinal price that indicates the top notch numerous nature of plant species and Chhattisgarh having wealthy conventional know-how on medicinal vegetation round 2500 species of vegetation are used as a supply of Herbal medication (Pei, 2001). Medicinal vegetation utilizatization withinside the remedy of various illnesses studied with the aid of using Ambasta( 1986). Documentation is a considered necessary issue of sustainable usage and conservation of medicinal vegetation (Patel, 2012). It is predicted that 40% of the sector populace relies upon at once on plant-primarily based totally medication for his or her fitness care (WHO, 2003). Chhattisgarh is wealthy in wooded area assets approximately 44% region of the country is beneathneath wooded area cover. Tribal location of Bagicha Block, Jashpur district and Sitapur block Surguja District are such regions in Chhattisgarh, wherein tribal human beings stay with nature. The observe changed into carried out to file the Medicinal Plants with their know-how makes use of many of the specific tribal groups of Chhattisgarh Arjun(*Terminaliaarjuna*), Baheda(*Terminaliabellirica*), Harra(*Terminaliachebula*), Karanj (*Pongamiapinnata*), Neem (*Azadiractaindica*), Char(*Buchananialanzan*) and Mahua (*Madhucaindica*) etc. are most important woody tree species located in a massive wide variety and Bhuineem (*Andrographispaniculata*), Chirchita (*Achyranthesaspera*), Nirgundi(*Vitexnegundo*), Bariyari (*Sidaacuta*), Satavar (*Asparagus racemosus*), Bantulsi(*Eranthemumpullchellum*), Sher datum(*Smilax macrophylla*), Genda(*Tegeteserecta*), Hadsanghar (*Nyctanthesarbortristis*), Hathhjud (*Cissusquadrangularis*) and Kewach (*Mucunapruriens*) etc. are shrub and Climber species located withinside the observe site. Among those woody tree species, shrub and climber vegetation are provided in diversity. They realize the significance of vegetation and forests, subsequently practising sustainable use of plant assets. This observe changed into carried out to file the medicinal vegetation with their know-how makes use of many of the specific tribal groups of Tribal location of different district of Chhattisgarh.

## STUDY AREA:

Chhattisgarh are hilly motive dense Forest area. District within side the Indian State of Chhattisgarh. The examine become carried out at some stage in 2018-2021 in Chhattisgarh State. Which is set 1200 m above sea degree and is blanketed with the dense forest. Key informants have been recognized after initial dialogue with the people. Medicinal vegetation facts become amassed through interviewing key informants of the network the use of a questionnaire having questions associated with socio-profile viz., call of village, call of informants, age of informants, cast, schooling and questions on medicinal vegetation viz. nearby call, habit, use of plant, element used etc. The species have been found

and recognized with the assist of nearby of villages and tribal people. The affirmation of the species is performed with the assist of vegetation of Chhattisgarh and Madhya Pradesh and different associated literature (Hooker's, 1875; Sharma, 2003; De, 2005; Pullaiah, 2006; Trivedi, 2006). Finally, vegetation have been documented through following their botanical call, habits, nearby call, components use and makes use of of the man or woman vegetation.



**Figure -** Location of Chhattisgarh in India

### III. RESULTS AND DISCUSSION

During the survey the Knowledge of Tribal human beings approximately Medicinal Plants is to the nearby flowers of a complete of fifty two Species are recorded with the aid of using the take a look at area. Indigenous and Traditional information and their Medicinal utilization comprising one of a kind Medicinal Plant Species. The information about the use of medicinal flora with the aid of using Tribes with their Ailment, Common call of plant Botanical call, elements use of plant are given beneath in Tables 1. As according to the evaluation floral species as medicinal reason accompanied with the aid of using (34). Similar take a look at Painkra et al., (2015) as according to evaluation most wide variety of floral species as medicinal reason accompanied with the aid of using(41). Apart from fitness care, medicinal flora is specially the exchange profits producing supply of underprivileged groups (Myers, 1991; Lacuna-Richman, 2002). Similar take a look at Choudhary et al. (2011) Haldi and Bhui-neem is frequently utilized by those as medicinal reason. Has labored on ethno botany focussing on groups i.e., Bhil, Bhilala, Gond and Korku and stated a complete of 29 species have been utilized by them for treatments in M.P. A overall of 89 species and fifty six households have been stated with the aid of using Thakur et al. (2013).

**Table 1** Detail about available medicinal plants at Chhattisgarh State

S.N	Ailment	Common name of plant	Botanical name	Useful parts of plant
1	Weight loss, controlling blood sugar level, imrove eye sight, treatment of dandruff &lice	Bhindi	<i>Abalomoscus esculantus L. Moench</i>	Fruit
2	Urine-genital disease, mouth ulcers	Babul	<i>Acacia nilotica L Delile</i>	Bark, fruit
3	Leprosy	Korinda	<i>Acacia tora (L.) Roxb.</i>	Whole plant
4	wounds, injury.	Katapatha	<i>Achyranthes aspera Linn</i>	Leaf, stem
5	Stomach troubles, intermittent fever, diarrhea, blood dysentery	Bel	<i>Aegle marmelos Linn</i>	Leaf, Root, fruit
6	Oral afflictions like bleeding gums	Hollyhock	<i>Alcea rosea L.</i>	Whole plant
7	Heart disease, cancer, ulcer, osteoarthritis	pyaj	<i>Allium cepa L.</i>	bulb
8	Heart disease, cancer, ulcer, osteoarthritis	Lahsun	<i>Allium sativum L.</i>	bulb
9	Stomach ache, anemia, haemorrhage, constipation	Chaulai	<i>Amaranthus dubius Mart.e x Thell</i>	Whole plant

	& kidney complain			
10	Astringent, diaphoretic, diuretic, febrifuge	Kanta Chaulai	<i>Amaranthus spinosus</i> L.	Whole plant
11	Tonic	Kadamb	<i>Anthocephalus chinensis</i> Wall	Bark
12	Asthma, bronchitis, antihelmithic, stomachic, malaria	Kalmegh, Bhui neem	<i>Andrographis paniculata</i> (Burm.f.)Wall. Ex Nees	Leaf
13	Pneumonia, diarrhea, skin & eye disorder	Sitafal	<i>Annona senegalensis</i> Pers.	Whole plant
14	Jaundice, expectorant, demulcent	Siyal kanta	<i>Argemone mexicama</i> Linn	Leaf, seeds
15	Diarrhea, glandular swelling.	Kathal	<i>Artocarpus heterophyllous</i> Roxb.	Fruit, root, latex, rachis.
16	Joint pain, weakness	Sa Liliaceae tawar	<i>Asparagus racemosus</i> Willd	Tuber
17	Nerve tonic, asthma, snake bite	Brahmisak	<i>Bacopa monnieri</i> Linn	
18	Leucorrhoea, carminative	Raktakanchan	<i>Bauhinia variegata</i> Linn	Leaf, stem
19	Gastrointestinal disorders	Semul	<i>Bombax ceiba</i> Linn	Whole plant
20	Anti-diabetic, anti-cancer, anti-inflammatory, anti-oxidant properties, kidney stone	Pathribaji, punarnava	<i>Boerhavia diffusa</i> L.	Bark, root
21	Kidney stone, headache.	Patherkuchi	<i>Bryophyllum pinnatum</i> Roxb	Bark
22	Jaundice, stomach disorder Chest pain, eye troubles, skin diseases.	Arhar	<i>Cajanus cajan</i> Linn	Root, leaves
23	Chest pain, eye troubles, skin diseases.	Akanda	<i>Calotropis gigantea</i> Linn	Leaf
24	Diarrhea, dysentery, narcotic	Ganja	<i>Cannabis sativa</i> Linn	Leaf, bark, seed, latex, flower
25	Carminative, lumbago, rheumatism.	Mirchi	<i>Capsicum annum</i> Linn	Leaf, seed
26	Antihelminthic, dog bites, stomachic, diuretic.	Papita	<i>Carica papaya</i> Linn	Leaf, stem, latex
27	Chornic fever, ringworms, rheumatism.	Amaltas	<i>Cassia fistula</i> Linn	Leaf, flower
28	Stomachic, constipations, liver tonic.	Bharmi	<i>Centella asiatica</i> Linn	Fruit, leaf
29	Leucoderma, antihelminthic	Bathuasag	<i>Chenopodium albrun</i> Linn	Latex, fruit, root
30	Cough and cold, toothache.	Tejpatha	<i>Cinnamonaum bejolohota</i> Linn	Bark, fruit, root
31	Stomach problem, antibacterial	Nimbu	<i>Citrus lamon</i> (L.)Burm	Leaf
32	Blood purifier, diarrhea	Santara	<i>Citrus reticulate</i> blanco	Leaf
33	Swellings, stomachic, malaria	Bhati	<i>Clerodendron viscosum</i> Vant	Leaf, bark
34	Wound and ulcer	Asian sider flower	<i>Cleome viscosa</i> L.	
35	Digestive, liver Tonic, check vomiting	Dhania	<i>Coriander sativum</i> Linn	Fruit
36	Tonic, cooling, demulcent, diuretic.	Khira	<i>Cucumis sativus</i> Linn	Fruit
37	Antihelminthic burns.	Kumra	<i>Cucurbita pepo</i> Linn	Leaf, root
38	Stimulant, tonic, carminative, sprains, conjunctivitis.	Haldi	<i>Curcuma domestica</i> Valetton	Leaves
39	Piles, chronic, dysentery, wounds, blood in urine	Doob grass	<i>Cynodon dactylon</i> L. Pers.	Leaf, Seed
40	Ulcer, cancer.	Sada suhagi	<i>Catharanthus roseus</i> (L.) G. don	Fruit, seed
41	Astringent	Shisham	<i>Dalbergia sisso</i> Roxb	Leaf, seed
42	Fever, asthma, skin diseases	Datura	<i>Datura alba</i> Linn	Rhizomes

43	Stimulant, diuretic, carminative	Gagger	<i>Daucus carota</i> Linn	Whole plant
44	Piles.	Kamalu	<i>Dioscorea alata</i> Linn	Leaf
45	Dysentery, stomachic, boil, sores.	Sialmutra	<i>Digitalis</i> sp	Leaf, root
46	Hypertension, constipation.	Karaiya	<i>Eclipta prostrata</i> Linn	Leaf, root
47	Diarrhea, dysentery, stomachic, arrest vomiting.	Gugialata	<i>Elephantopus scaber</i> Linn	Root
48	Skin disease	Lalpatta	<i>Euphorbia pulcherrima</i> Wild	Tuber
49	Dysentery, diabetes, boils	But	<i>Ficus bengalensis</i> Linn	Leaf
50	Ringworm, purgative, boils	kakadumur	<i>Ficus hispida</i> Linn	Leaf
51	Kidney stone, diabetes, small pox	Jaggadumur	<i>Ficus carica</i> Linn	Leaf, root
52	Hair care lotion, gonorrhoea, aphrodisiac, amenorrhoea	Gurhal	<i>Hibiscus rosasinesis</i> Linn	Leaf, bark, fruit
53	Kidney stone, malarial fever, cough and cold	Surajmukhi	<i>Helianthus annuus</i> Linn	Latex
54	Rheumatism	Candytuft	<i>Iberis amara</i>	Root, fruit, latex
55	Headache, hypertension	Mitha aloo	<i>Ipomea batatas</i> Lamk	Leaf, bark, fruit, latex
56	Stomachic, ulcers	Lalbarenda	<i>Jatropha gossypifolia</i> Linn	Seed, leaf
57	Antiseptic, antihemorrhagic	Barenda	<i>Jatropha curcas</i> Linn	Leaf, flower, root
58	Ear infection	Jivanti	<i>Leptidenea reticulata</i> L.	Leaf, flower, seed,
59	Tonic, diuretic, rheumatism, burus, diabetes	Aam	<i>Mangifera indica</i> Linn	Root and seed
60	Antihelminthic, Irregular menstruation, Rheumatism, diuretic	Pudina	<i>Mentha arvensis</i> Linn	Leaf
61	Gonorrhoea, stomachic, purgative, eradicating lice.	Champa	<i>Michelia champaca</i> Linn	Leaf, latex, bark
62	Piles, boils, sores, aphrodisiac.	Lajwanti	<i>Mimosa pudica</i> Linn	Leaf
63	Stomachic, carminative, rheumatism.	Kerala	<i>Momordica charantia</i> L	Whole plant
64	Joint pain	Ka Legumin ranja	<i>Pongamia pinnata</i> (Linn.)	Leaf, Flower, Fruit
65	Diabetes, ulcer pain relief, lung diseases	Jam	<i>Psidium guajava</i> L.	Leaf
66	<i>Leucorrhoea</i>	<i>Alnyatbracea</i>	<i>Punica granatum</i> Linn	Leaf, root, flower
67	Lowering the risk of cancer & blood pressure, improving bone health	Palak	<i>Spinacea oleracea</i> L.	Whole plant
68	Hart disease, asthma, scorpion stings & poisoning	Kahua, Arjuna	<i>Terminalia arjuna</i> (Roxb.) Wight & Arn.	Fruit, leaf
69	Stomach disorder, antispasmodic & carminative properties	Ajwain	<i>Trachyspermum ammi</i> Sprague	Leaves
70	Cough, cold, hoarseness of voice, & asthmas, diarrhea, HIV infection	Bahera	<i>Terminalia bellirica</i> (Gaertn.) Roxb. (Health harmonizer in combination with <i>T. chebulla</i> & <i>Emblica officinalis</i> )	Fruit, leaves, seed, bark

71	Digestive disorder, high cholesterol, mouth wash and gargle	Harad	<i>Terminalia chebulla</i> Retz.	Leaves & fruit
72	Dengue Diabetes, leprosy, swine flu, cancer	Giloy	<i>Tinospora cardifolia</i> (Thunb.) Miers	Flower
73	Reduce blood cholesterol, control blood sugar level	Methi	<i>Trigonella foenum graecum</i> L.	fruit
74	Constipation jaundice, ulcerative colitis	Ganhu	<i>Triticum aestivum</i> L.	Leaves
75				Leaves, bark, fruit, seeds
76	Cough and Cold	Baheda	<i>Terminalia bellirica</i>	Bark
77	Cough and Cold	Pilikateri	<i>Argemone exicana</i>	Fruit
78	Body ache	Bis tendu	<i>Diospyros ontana</i>	Fruit
79	Chest pain	Kahua	<i>Terminalia arjuna</i>	Fruit
80	Joint Pain, Kidney Stone	Shatavari	<i>Asparagus racemosus</i>	Leaves, stem
81	Fracture , Cuts & wounds	Ghritkumari	<i>Aloe vera</i>	Stem, Leaves, fruit
82	Diabetes	Dhawra	<i>Anogeissus latifolia</i>	Leaves, seed
83	Diabetes	Jamun	<i>Syzygium cuminii</i>	Seeds
84	Dysentery	Bhuiamla	<i>Phyllanthus niruri</i>	Whole plant
85		Kudai	<i>Holarrhaena antidysenterica</i>	Stem bark
86		Aithi	<i>Helicteres isora</i>	Seeds
87		Amla	<i>Emblica officinalis</i>	Fruits
88	Epilepsy	Beal	<i>Aegle marmelos</i>	Fruit
89	Eye problems	Brahmi	<i>Bacopa monnieri</i>	Leaves
90	Eczema	Bantulsi	<i>Eranthemum pullchellum</i>	Leaves
91	Eczema	Satawar	<i>Asparagus racemosus</i>	Roots
92	Heart diseases	Arjun	<i>Terminalia arjuna</i>	Bark
93	Fracture , Head-ache, Fracture	Harsingar	<i>Nyctanthes arbortristis</i>	Leaves and fruits
94	Giddiness , Hydrocel , Giddiness	Tulsi	<i>Ocimum basilicum</i>	Entire plant
95	Hydrocel	Bhelava	<i>Semicarpus anacardium</i>	Seeds
96		Arandi	<i>Ricinus communis</i>	Leaves
97	Irregular Menses	Dhawai	<i>Woodfordia fruticosa</i>	Dhawai Corolla
98	Jaundice	Bhui Amla	<i>Phyllanthus nirurai</i>	Whole plant
99		Char	<i>Buchanania lanzan</i>	Bark
100	Kidney Stone	Kulthi	<i>Mycrotyloma uniflorum</i>	Seeds
101	Leucorrhoea	Palas	<i>Butea monosperma</i>	Flowers
102	Milk secretion	Satawri	<i>Asparagus racemosus</i>	Fibre
103	Snake bite, Malaria	Bhuileem	<i>Andrographis paniculata</i>	Entire plants
104	Tooth ache and	Ramdaton	<i>Smilax macrophyla</i>	Whole plant
105	Normal Pain	Rohina	<i>Soymida febrifuge</i>	Bark
106	Fever	Imli	<i>Tamaridus indica</i>	Root
107		Ber	<i>Zizyphus numularia</i>	Bark
108	Heart diseases, Eye problems	Choulai bhaji	<i>Amaranthus viridis</i>	Leaves

109	Itching	Gudahal	<i>Hibiscus rosa-sinensis</i>	Flower
110	Malaria	Karanji	<i>Pongamia pinnata</i>	Root, stem and leaves
111	Milk secretion , Fever	Neem	<i>Azadiracta indica</i>	Bark
112	Stomach Pain	Dudhi	<i>Euphorbia hirta</i>	Whole plant
113	Swelling	Bargad	<i>Ficus religiosa</i>	Leaves and fruits
114	Cuts & wounds, Ear ache	Bhelawa	<i>Semicarpus nacardium</i>	Bark
115		Dumar	<i>Ficus glomerata</i>	Fruit and bark
116	Delivery problem	Bach	<i>Acorus calamus</i>	Fresh milk
117	Ear ache	Bad	<i>Ficus bengolensis</i>	Leaves
118		Dhatura	<i>Datura alba</i>	Seeds
119	Head-ache	Genda	<i>Tegetes erecta</i>	Leaves
120	Itching	Chitrak	<i>Plumbago zeylanica</i>	Entire plants
121	Jaundice	Chirchita	<i>Achyranthes aspera</i>	Roots
122		Mehandi	<i>Lawsonia alba</i>	Leaves
123		Kahava	<i>Terminalia arjuna</i>	Bark
124	Milk secretion	Satavari	<i>Asparagus racemosus</i>	Fibre
125	Stomach Pain	Peepal	<i>Ficus religiosa</i>	Leaves and fruits
126		Sher datun	<i>Smilax macrophylla</i>	Root
127	Swelling, Leucorrhoea	Nirgundi	<i>Vitex negundo</i>	Entire plants
128		Baryari	<i>Sida acuta</i>	Leaf
129	Diarrhea	Saja	<i>Terminalia tomentosa</i>	Bark
130	Ear ache	Harra	<i>Terminalia chebula</i>	Fruits
131		Hadjod	<i>Cissus quadrangularis</i>	Stem
132	Head-ache	Keokand	<i>Costus speciosus</i>	Rhizomes
133	Snake bite	Bhalu Kakai	<i>Alysicarpus monilifer</i>	Root

## CONCLUSION

The information through respondents showed a very diverse nature of the medicinal plant and their usage in healing purposes with socio-economic/ living standard upliftment. Thus it is expected that this investigation will be helpful to conserve heritable knowledge in the field of herbal treatment and general uses of plants in village ecosystem and the conservation of these resources along with domestication, multiplication, sustainable harvesting is required for future generations and for ecological wellbeing.

## REFERENCES

- Patel, H. Fixed-bed column adsorption study: A comprehensive review. *Appl. Water. Sci.* 2019, 9, 45.
- Dabrowski, A. Adsorption—From theory to practice. *Adv. Colloid Interface Sci.* 2001, 93, 135–224.
- Selim, K.A.; Youssef, M.A.; Abd El-Rahiem, F.H.; Hassan, M.S. Dye removal using some surface modified silicate minerals. *Int. J. Min. Sci. Technol.* 2014, 24, 183–189.
- Kafshgari, F.; Keshtkar, A.R.; Mousavian, M.A. Study of Mo (VI) removal from aqueous solution: Application of different mathematical models to continuous biosorption data. *Iran. J. Environ. Health Sci. Eng.* 2013, 10, 14.
- Miralles, N.; Valderrama, C.; Casas, I.; Martnez, M.; Florido, A. Cadmium and Lead Removal from Aqueous Solution by Grape Stalk Wastes: Modeling of a Fixed-Bed Column. *J. Chem. Eng. Data* 2010, 55, 3548–3554.
- Ramesh, A.; Hasegawa, H.; Sugimoto, W.; Maki, T.; Ueda, K. Adsorption of gold(III), platinum(IV) and palladium(II) onto glycine modified crosslinked chitosan resin. *Bioresour. Technol.* 2008, 99, 3801–3809.
- Spitzer, M.; Rodnei, B. Selective electrochemical recovery of gold and silver from cyanide aqueous effluents using titanium and vitreous carbon cathodes. *Hydrometallurgy* 2004, 74, 233–242.
- Syed, S. Recovery of gold from secondary sources—A review. *Hydrometallurgy* 2012, 115–116, 30–51.
- Cui, J.; Zhang, L. Metallurgical recovery of metals from electronic waste: A review. *J. Hazard. Mater.* 2008, 158, 228–256.
- Fleming, C.A. Hydrometallurgy of precious metals recovery. *Hydrometallurgy* 1992, 30, 127–162.
- Rhee, K.I.; Lee, J.C.; Lee, C.K.; Joo, K.H.; Yoon, J.K.; Kang, H.R.; Kim, Y.S.; Sohn, H.J. A Recovery of Gold from Electronic Scrap by Mechanical Separation, Acid Leaching and Electrowinning. In *Recycling Metals and Engineered Materials*; Queneau, P.B., Peterson, R.D., Eds.; TMS Publication: Pittsburgh, PA, USA, 1995; pp. 469–478.
- Yap, C.Y.; Mohamed, N. An electro-generative process for the recovery of gold from cyanide solutions. *Chemosphere* 2007, 67, 1502–1510.
- Hoffmann, J.E. Recovering precious metals from electronic scrap. *J. Miner. Metall. Mater. Soc.* 1992, 44, 43–48.
- Lee, J.C.; Song, H.T.; Yoo, J.M. Present status of the recycling of waste electrical and electronic equipment in Korea. *Resour. Conserv. Recycl.* 2007, 50, 380–397.

15. Mack, C.; Wilhelmi, B.; Duncan, J.R.; Burgess, J.E. Biosorption of precious metals. *Biotechnol. Adv.* 2007, 25, 264–271.
16. Safarzadeh, M.S.; Bafghi, M.S.; Moradkhani, D.; Ilkhchi, M.O. A review on hydrometallurgical extraction and recovery of cadmium from various resources. *Miner. Eng.* 2007, 20, 211–220.
17. Sum, E.Y.L. The Recovery of Metals from Electronic Scrap. *J. Miner. Metall. Mater. Soc.* 1991, 43, 53–61.
18. Jafari, S.; Wilson, B.P.; Hakalahti, M.; Tammelin, T.; Kontturi, E.; Lundstrom, M.; Sillanpaa, M. Recovery of Gold from Chloride Solution by TEMPO-Oxidized Cellulose Nanofiber Adsorbent. *Sustainability* 2019, 11, 1406.
19. Li, Y.; Zhou, Y.; Zhou, Y.; Lei, J.; Pu, S. Cyclodextrin modified filter paper for removal of cationic dyes/Cu ions from aqueous solutions. *Water Sci. Technol.* 2018, 78, 2553–2563.
20. Liu, Q.; Zhou, Y.; Lu, J.; Zhou, Y. Novel cyclodextrin-based adsorbents for removing pollutants from wastewater: A critical review. *Chemosphere* 2020, 241, 125043.
21. Syed, S. A green technology for recovery of gold from non-metallic secondary sources. *Hydrometallurgy* 2006, 82, 48–53.
22. Vences-Alvarez, E.; Razo-Flores, E.; Lazaro, I.; Briones-Gallardo, R.; Velasco-Martinez, G.; Rangel-Mendez, R. Gold recovery from very dilute solutions from a mine in closing process: Adsorption-desorption onto carbon materials. *J. Mol. Liq.* 2017, 240, 549–555.
23. Bui, T.H.; Lee, W.; Jeon, S.B.; Kim, K.W.; Lee, Y. Enhanced Gold(III) adsorption using glutaraldehyde-crosslinked chitosan beads: Effect of crosslinking degree on adsorption selectivity, capacity, and mechanism. *Sep. Purif. Technol.* 2020, 248, 116989.
24. Yi, Q.; Fan, R.; Xie, F.; Min, H.; Zhang, Q.; Luo, Z. Selective Recovery of Au(III) and Pd(II) from Waste PCBs Using Ethylenediamine Modified Persimmon Tannin Adsorbent. *Procedia Environ. Sci.* 2016, 31, 185–194.
25. Cortina, J.L.; Warshawsky, A. Developments in Solid-Liquid Extraction by Solvent-Impregnated Resins. In *Ion Exchange and Solvent Extraction*; Marinsky, J.A., Marcus, Y., Eds.; Marcel Dekker Inc.: New York, NY, USA, 1997; pp. 195–293.
26. Mihailescu, M.; Negrea, A.; Ciopec, M.; Davidescu, C.M.; Negrea, P.; Duteanu, N.; Rusu, G. Gold (III) adsorption from dilute waste solutions onto Amberlite XAD7 resin modified with L-glutamic acid. *Sci. Rep.* 2019, 9, 8757.
27. Vasanth Kumar, K.; Subanandam, K.; Bhagavanulu, D.V.S. Making GAC sorption economy. *Pollut. Res.* 2004, 23, 439–444.
28. Gupta, V.K.; Ali, I. *Environmental Water: Advances in Treatment, Remediation and Recycling*; Elsevier: Amsterdam, The Netherlands, 2013.
29. Crittenden, B.; Thomas, W.J. *Adsorption Technology and Design*; Butterworth-Heinemann: Oxford, UK, 1998.
30. Chowdhury, Z.Z.; Zain, S.M.; Rashid, A.K.; Rafique, R.F.; Khalid, K. Breakthrough Curve Analysis for Column Dynamics Sorption of Mn(II) Ions from Wastewater by Using Mangostanagarcinia Peel-Based Granular-Activated Carbon. *J. Chem.* 2013, 2013, 959761.
31. Hasanzadeh, M.; Ansari, R.; Ostovar, F. Synthesis and application of CeO<sub>2</sub>/sawdust nanocomposite for removal of As(III) ions from aqueous solutions using a fixed bed column system. *Glob. NEST J.* 2016, 19, 7–16.
32. Shafeeyan, M.S.; Daud, W.M.A.W.; Shamiri, A. A review of mathematical modeling of fixed-bed columns for carbon dioxide adsorption. *Chem. Eng. Res. Des.* 2014, 92, 961–988.
33. Yang, Q.; Zhong, Y.; Li, X.; Li, X.; Luo, K.; Wua, X.; Chen, H.; Liu, Y.; Zeng, G. Adsorption-coupled reduction of bromate by Fe(II)–Al(III) layered double hydroxide in fixed-bed column: Experimental and breakthrough curves analysis. *J. Ind. Eng. Chem.* 2015, 28, 54–59.
34. Han, R.; Wang, Y.; Zhao, X.; Wang, Y.; Xie, F.; Cheng, J. Adsorption of methylene blue by phoenix tree leaf powder in a fixed-bed column: Experiments and prediction of breakthrough curves. *Desalination* 2009, 245, 284–297.
35. Bohart, G.S.; Adams, E.Q. Some aspects of the behavior of charcoal with respect to chlorine. *J. Am. Chem. Soc.* 1920, 42, 523–544.
36. Woumfo, E.D.; Siewe, J.M.; Njopwouo, D. A fixed-bed column for phosphate removal from aqueous solutions using an andosol-bagasse mixture. *J. Environ. Manag.* 2015, 151, 450–460.
37. Vilvanathan, S.; Shanthakumar, S. Column adsorption studies on nickel and cobalt removal from aqueous solution using native and biochar form of *Tectonagrandis*. *Environ. Prog. Sustain.* 2017, 36, 1030–1038.
38. Thomas, H.C. Heterogeneous Ion Exchange in a Flowing System. *J. Am. Chem. Soc.* 1944, 66, 1664–1667.
39. Han, R.; Zhang, J.; Zou, W.; Xiao, H.; Shi, J.; Liu, H. Biosorption of copper(II) and lead(II) from aqueous solution by chaff in a fixed-bed column. *J. Hazard. Mater.* 2006, 133, 262–268.
40. Han, R.; Wang, Y.; Zou, W.; Wang, Y.; Shi, J. Comparison of linear and nonlinear analysis in estimating the Thomas model parameters for methylene blue adsorption onto natural zeolite in fixed-bed column. *J. Hazard. Mater.* 2007, 145, 331–335.
41. Mondal, S.; Aikat, K.; Halder, G. Ranitidine hydrochloride sorption onto superheated steam activated biochar derived from mung bean husk in fixed bed column. *J. Environ. Chem. Eng.* 2016, 4, 488–497.
42. Dlugosz, O.; Banach, M. Sorption of Ag<sup>+</sup> and Cu<sup>2+</sup> by Vermiculite in a Fixed-Bed Column: Design, Process Optimization and Dynamics Investigations. *Appl. Sci.* 2018, 8, 2221.
43. Madan, S.S.; De, B.S.; Wasewar, K.L. Adsorption performance of packed bed column for benzylformic acid removal using CaO<sub>2</sub> nanoparticles. *Chem. Data Collect.* 2019, 23, 100267.
44. Santos, N.T.; Landers, R.; da Silva, M.G.C.; Vieira, M.G.A. Adsorption of Gold Ions onto Sericin and Alginate Particles Chemically Crosslinked by Proanthocyanidins: A Complete Fixed-Bed Column Study. *Ind. Eng. Chem. Res.* 2020, 59, 318–328.
45. Wasikiewicz, J.M.; Nagasawa, N.; Tamada, M.; Mitomo, H.; Yoshii, F. Adsorption of metal ions by carboxymethylchitin and carboxymethylchitosan hydrogels. *Nucl. Instrum. Methods Phys. Res. B* 2005, 236, 617–623.
46. Tsolele, R.; Mtunzi, F.M.; Klink, M.J.; Pakade, V.E. An alternative low-cost adsorbent for gold recovery from cyanide-leached liquors: Adsorption isotherm and kinetic studies. *Adsorp. Sci. Technol.* 2018, 37, 3–23.
47. Calderon, A.R.M.; Alorro, R.D.; Tadesse, B.; Yoo, K.; Tabelin, C.B. Repurposing of nickeliferouspyrrhotite from mine tailings as magnetic adsorbent for the recovery of gold from chloride solution. *Resour. Conserv. Recycl.* 2020, 161, 104971.
48. Pangeni, B.; Paudyal, H.; Inoue, K.; Kawakita, H.; Ohto, K.; Alam, S. Selective recovery of gold(III) using cotton cellulose treated with concentrated sulfuric acid. *Cellulose* 2012, 19, 381–391.
49. Abdolali, A.; Ngo, H.H.; Guo, W.; Zhou, J.L.; Zhang, J.; Liang, S.; Chang, S.W.; Nguyen, D.D.; Liu, Y. Application of a breakthrough biosorbent for removing heavy metals from synthetic and real wastewaters in a lab-scale continuous fixed-bed column. *Bioresour. Technol.* 2017, 229, 78–87.