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An insight into the morphological, ethno medicinal, phytochemical and pharmaceutical properties of *Buchanania lanzan*

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Abstract
Buchanania lanzan Spreng, commonly known strop, char, piyal, achar, charoli, and chironji belong to Anacardiaceae family. It is a priced medicinal plant with a host of medicinal properties, such as anti-cancer activity, anti-inflammatory, anti-oxidant activity, anti-diabetic, anti-ulcer activity, anti-diarrheal activity, anti-venom activity, memory booster, anti-hyperlipidemic activity.This tree is characterized by dark grey crocodile bark with a red blaze, Fruit, and a yellowish-red drupe. This plant has high-value Indian folk medicine and socio-economic value. In English this tree commonly known as "Almondette", whole plant i.e., roots, leaves, fruits, seeds and gum used for various medicinal. Various parts are used in ayurvedic medicine as depurative, skin cancer, constipating, brain tonic, cardiotonic and for glandular swelling. This article suggests that *Buchanania lanzan* possess several ethnobotanical, pharmacological and phytochemical attributes.

Keywords: *Buchanania lanzan*, phytochemistry, traditional system, medicinal plant

1. Introduction
Traditional system of medicines or herbal medicines is the original source for most of the medicines**.** The chemical diversity of natural products whether as pure compounds or as standardized extracts, provides unlimited opportunities for drug discovery. According to WHO 70% population uses medicinal plant [1-3]. Medicinal plants contain wide variety of bio-chemical constituents which are helpful for curing different critical Human diseases.
Buchanania lanzan Sprengbelon Anacardiaceae family which is a commercially useful tree species. In 1798 Francis Hamilton first described this plant. In India, these plants are found Jharkhand, Andhra Pradesh, West Bengal, Bihar, Chhattisgarh, Maharashtra, Gujarat, Madhya Pradesh, Orissa, Rajasthan and in Varanasi and Mirzapur districts of Uttar Pradesh [3].
Traditionally, this plant has been used by herbalists and healers in the Indian state of Chhattisgarh for cancer treatment and prevention. *Buchanania lanzan* bioactive constituents such as tannins, quercetin, alkaloids, gallic acid, flavanoids, fixed oils and phenolic. These secondary metabolites prevention of Anticancer property, anti-inflammatory, Antioxidant activity, Anti-diabetic, Antiulcer activity, Anti-diarrheal activity, Antivenom activity, Memory booster, Biotechnological property and anti-hyperlipidemic property [2-4].

Taxonomical Classification
Kingdom: Plantae
Subkingdom: Tracheophytes
Division: Angiosperms
Class: Eudicots
Subclass: Rosids
Order: Sapindales
Family: Anacardiaceae
Genus: *Bhuchanania*
Species: *Lanzon*
Botanical Name: *Bhuchanania lanzon* [4]

Vernacular names
English: Almondette tree, cuddapah almond
Arabic: Habulsamnah
Urdu: Hironji
Hindi: Char, Chironji, Pra-savak
Bengali: Chironji, Piyal, sarop
Gujarati: Charoli
Kanada: Charoli
Marathi: Charoli
Malyalam: Cheru, Moongapezhu, Priyalam
Oria: Charu
Persian: Nakulekwajah
Sanaskrit: Upavatth, Dhanu, Akhatth, Lalana
Tibetan: Pilaya
Telugu: Chaarumaamidi, jarumamidi, Chari, Saarachettu.

Geographical Source
Buchanania lanzan Spreng (Chironji) originated in the Indian subcontinent [4]. The tree can be found growing naturally in the eastern tropical deciduous forests (West Bengal, Jharkhand). The majority of Western and Central India experiences monsoonal weather. The yellow sandy-loam soil is ideal for the tree's growth. Rainy, cold, and hot seasons distinguish the climate of this central Indian region. Temperatures range from 42.6 to 40.3 degrees Celsius at the maximum, and 6.7 to 4.9 degrees Celsius at the minimum [2-4].

Morphology
Habitat: *B. lanzan* tree is an evergreen tree found in deciduous forests throughout much of India.

Height
In general, it reaches heights of up to 16 m and girths of up to 1.7 m, a small to moderate-sized tree (Fig 1).

Root
This root is cooling, depurative, acrid, astringent, and constipating.

Bark
The bark is dark Gray or black (Fig 2), regularly divided into small rectangular plates, resembling like a crocodile hide and reddish inside.

Leaves
Petiole 11-24 mm, globous; leaves simple, alternate, exstipulate; lamina, broad oblong, base round or acute, apex obtuse or emarginate, margin whole, globous above and densely tomentose below, coriaceous; lateral nerves, 10-20 pairs, pinnate, prominent, pubescent, secondary laterals prominent, intercostals prominent (Fig 3).

Flower
Flowers are bisexual and the colour is greenish white. It appears from January to March. Inflorescences are cymose type. Each inflorescence has 590 flowers on average.

Fruit: In April and May, drupes are yellowish-red, oblong, laterally compressed, black, stone hard, with 2 valves, with one seed. Per inflorescence, only 4–26 fruits were produced.

Fig 1: Whole plant of *B. lanzan*

Fig 2: Bark of *B. lanzan*

Fig 3: Leaf of *B. lanzan*

Traditional uses

From Ancient time *Buchanania lanzan* is used by tribunal community for their various treatments. Whole part of *B. lanzan* are used various treatment, e.g., Cancer, Skin disease, body pain etc. Fixed oil extracted from kernels is called as 'char.' Fixed oils derived from seeds are used to treat skin conditions and lessen granular neck swelling. Extract oil good remove blemishes from the face. Leaf used as wound healing [3]. Leaf extract of *Buchanania lanzan*, Tribal community of Chhattisgarh, West Bengal, Jharkhand are used for healing, anti-diarrhoeal, analgesic, and antiulcer treatment [3, 5, 6]. Leaf extract used for blood diseases treatment, purgative treatment, and digestive disorder treatment. Leaf juice or powders are used to wounds. The roots *Buchanania lanzan* are acrid, cooling, depurative and constipating anduseful in diarrhea treatment. Laxative fruit of *Buchanania lanzan*. That relieves thirst, body pain, and fever. The gum oozed obtains from the cut-bark and it is water soluble, treat intercostals pain [6]. In Andhra Pradesh gum with liquefied in cow`s milk for cure rheumatic pains and providing cardiac support. The roots Powder and dried leaves mixed with buttermilk is a traditional redress for treating diarrhoea [6, 7]. In India Seed Powdered mixed with milk and treat for face pack such as Skin suppleness and Skin Glow [7, 8].

Analysis of Phytochemical

In Ayurveda *B. lanzan*is widely used tree. According to Ayurveda stem bark of *Buchanania lanzan* is used in Jvara (fever), Trsa (thirst) and Rakatisara (dysentery) [9, 10]. *B. lanzan* contain major class of compounds such as Flavonoids, triterpenoidsand cardanol [8]. Stem bark mainly contains alkaloids, tannins, saponins, sugars, triterpenoids, and flavonoids [9]. Glycolipids have been obtained from this plant and other compounds are cardanol, cardol, anacardic acid and fatty acids [10]. The leaves of BL contain quercetin, quercetin-7-O-rhamnoside, gallic acid, kaempferol, quercetine-3-Orhamnogluvosside and myricetin 3-rhamnoside [10]. The *B. lanzan* fruit constitute of fructose, α and β glucose and sucrose. The fruits showed laxative properties that are used to thirst, fever, pain, cough, and asthma [12, 13]. The seeds contain protien (8%) amino acid, that composition of methionine (0.5%), leucine (7.5%), lysine (3%) and phenylalanine (2.9%). The seed is lightly bitter taste and it is used as tonic of the body and the brain, stomachic [11]. Seed and oil also contain fibres, minerals, fats, vitamins B1, B2, C, copper, iron, magnesium, phosphorus, potassium, sodium, sulphur, fatty oil [14]. Seeds are almond-flavoured, used as a cooking spice in India [15].

Table 1: Screening of phytochemical of *B. lanzan* [10-12]

Phytochemical	Petroleum ether	Ethyl acetate	Dichloro methane	Methanol	Water
Alkaloids	-	+	-	+	+
Amino acid	-	-	-	-	+
Carbohydrates	-	-	-	-	-
Phenols	-	+	+	+	+
Oils and Fat	+	-	+	+	-
Flavonoids	-	+	+	+	-
Glycosides	-	+	-	+	-

Pharmacological uses

Buchanania lanzan contain various chemical components such as, alkaloids, flavonoids, saponins, proteins, amino acids and phenolic. This component plays important rule against various diseases [13].

Anti-diabetic and Anti-hyperlipidemic activity

According to WHO 11.9 million people are Diabetic. Furthermore, 578 million peoples in 2035 and 700 million people will be affected in 2045 due to diabetes. Diabetes is a collection of metabolic ailments that are classified as hyperglycaemia, insufficient insulin secretion. So, to deal with this situation 800 plants with anti-diabetic activity has been identified till now [16]. The anti-diabetic and anti-hyperlipidemic activity of the methanol extract of *Buchananialanzan* was observed on Wister rat by applying streptozotocin + nicotinamide, regulated intraperitonially to persuade type I and type II diabetes. The Wister rat along with

blood glucose levels >190=mg/dl were administered (methanol leaf extract) with positive regulation for 21 days and thenlipid and blood glucose profile were assessed. It was observed that significant blood glucose level reduction and reduced serum lipid profile, compared to normal value in streptozotocin persuaded type I and type II diabetic's rat [4, 17].

Anticancer Activity

Cancer is the major worldwide cause of death [18]. Cancer is the uncontrolled growth of cells and tissues which then form a tumour and spread to an entire organ. Now day's plants are being used in modern medicinal treatment to deal with these deadly complications [19].

The total extract (70% ethanol) of *B. lanzan* leaves have anticancer properties which was proved by using diethy lnitrosamine (DEN) induced hepatocarcinoma in male Wistar rats. Antitumor efficiency was measured via oral ethanolic leaves extract and according to OECD guideline-423 doses were fixed after performing acute toxicity study. 5-flurouracil (10 mg/kg) was administered to the standard group. After treatment with the ethanolic leaves juice, serum samples were collected for estimation of various parameters like SGOT (Serum glutamic-oxaloacetic transaminase), SGPT (Serum glutamic-pyruvic transaminase), total protein, bilirubin, alkaline phosphatase, and anti-oxidants like LPO, SOD and catalase which are considered as biomarkers in hepatocarcinoma. There was a significant decrease in SGOT and SGPT level in all extract treated groups as compared to the DEN treated group (p<0.001) and in case of antioxidant enzymes there was a significant (p<0.001) increase in SOD, catalase level, significant (p<0.001) decrease in LPO was observed in all extract treated groups compared to DEN treated group. It was also observed that when an animal is treated with extract there is a decrease in total protein, ALP and bilirubin when contrasted to the DEN treated group. The ethanolic extract from leaves showed a significant dose dependent reduction in DEN induced hepatocarcinoma [4, 20].

Anti-Ulcer Activity

The ethanol extracted from the roots of *B. lanzan* proved to be therapeutic on ethanol prompted ulcer in rats and thus pylorus ligation induced ulcer in mice were assessed for their antiulcer action effects. Extract showed dose-depended defense against the gross harmful effects of ethanol and pylorus ligation on the gastric mucosa of animals, and both showed noteworthy defense against the ulcer index model. Thus, the results evidently confirmed that the ethanolic extract possessed good defensive and healing effects on gastric ulcer [4, 21].

Anti-venom Activity

The ethanol extracted from the bark of *B. lanzan* proved to be a viable medicinal element against the toxicity induced by *Naja kaouthia* snake venom. The extract was evaluated for neutralization of myotoxicity, phospholipase A2 activity and human red blood cell lysis produced by *Naja kaouthia* snake venom. Myotoxicity condensed up to an important level which was characterized by waning in creatin phosphokinase level. Straight and subsidiary hemolytic study was completed at several concentration of extract. More than 49.99% of hemolysis was meaningfully neutralized by the extract [22, 23].

Antioxidant Activity

Flavonoids, prevalent chemical compounds in the human diet, are renowned for their robust antioxidant effects, encompassing antimicrobial, anti-fungal, and anti-inflammatory properties [24]. These antioxidants play a pivotal role in counteracting oxidative stress induced by free radical damage. The *in vitro* assessment of antioxidant activity in the methanolic extract from *Buchanania lanzan* kernel utilized the 1, 1-diphenyl-2-picryl-hydrazyl and reducing power methods. The Folin–Ciocalteu method was employed for the quantitative determination of the total polyphenolic content in the extract. The presence of phytochemicals like triterpenoids, flavonoids, tannins, and saponins within the extract provided substantiation of its antioxidant activity [22, 25].

Wound Healing Activity

The ethanolic extract obtained from *Buchanania lanzan* fruits was administered to Albino rats to evaluate its effectiveness in promoting wound healing, particularly in the presence of dexamethasone-induced impairment. The study encompassed three distinct wound models, incision, excision, and dead space injuries. Various parameters, including breaking strength for incision wounds, epithelialization and wound shrinkage for excision wounds, and granulation tissue dry weight, breaking strength, and hydroxyproline content for dead space wounds, were meticulously examined.

In the incision wound model, the group treated with dexamethasone displayed a significant (p<0.001) reduction in wound breaking strength compared to the control group. However, the concurrent administration of *B. lanzan* with dexamethasone led to a noteworthy (p<0.001) increase in the breaking strength of the dexamethasone-treated group. Additionally, an in-vivo study supporting wound healing was conducted using carrageenan-induced paw edema to assess anti-inflammatory activity. An herbal gel, derived from the active ethyl acetate sub-fractions at concentrations of 1% and 5%, underwent evaluation for spread ability, pH, color, stability, and appearance. The 5% gel exhibited a substantial increase in the percentage of wound contraction and an elevation in tensile strength, with values of 177 g (p<0.050) and 181.21 g (p<0.010), respectively [26, 27].

Memory Booster

Alzheimer's disease is a progressive neurodegenerative brain disorder characterized by the gradual onset of symptoms such as memory loss, altered behaviour, personality changes, and ultimately, fatality [28]. Biochemical abnormalities, including a decrease in acetyltransferase and acetylcholine biosynthesis, coupled with an increase in acetylcholinesterase (AChE) and altered metabolism, are strongly linked to the extent of cognitive impairment [29]. The neuro-psychopharmacological effects of the petroleum ether extract from the seeds of *B. lanzan* (PEB) were investigated in experimental rats, administered orally at a dose of 500 mg/kg.

The impact of the seed extract on memory acquisition and retention was evaluated using elevated plus maze and step-down apparatus models. Additionally, the activity of the AChE enzyme in discrete regions of the brain was assessed. Administration of PEB (500 mg/kg) to both the positive control and treated groups resulted in a significant reduction in transfer latency in the elevated plus maze, an increase in step-down latency in the step-down apparatus models, and a decrease in acetylcholinesterase enzyme activity in various brain regions compared to the other groups [27, 30].

Curative Properties

B. lanzan is a broadly used plant with a history of old-fashioned medicinal use for the treatment of numerous

diseases. It is used as a tonic and to treat bloody diarrhoea and intrinsic hemorrhage in the form of a decoction. A grown child who has stopped receiving breast milk should be fed sugar candies, madhuka (*Glycyrrhiza glabra*) honey, parched paddy, and *B. lanzan* kernels prepared into a sweet bolus. Kernels can be used as an aphrodisiac by powdering them and mixing them with milk. It can also be used in case of fever and burning perception. Powder of the bark mixed with honey is valuable in blood dysentery. This plant has an extensive history of use in tribal cultures across tropical areas of the world. At present, in this period of herbal science, detailed research is being conceded out in every such plant to determine their pharmaceutical properties. The percentages of tri-saturated, monounsaturated, di-unsaturated, mono-saturated, and tri-unsaturated glycerides in the oil are 3.22%, 35.81%, 45.50%, and 15.51%, respectively. The distinct distinguishing nature of the *B. lanzan* seed oil is its composition which contains 22.71%, 31.02%, and 11.30% dipalmitoolein, dioleopalmitin, and triolein respectively. Three chief chemical constituents sequestered from the methanolic extract of leaves are epinitol, vomicine, and celidoniol. This classification was made using a variety of spectral analyses, including mass spectroscopy, infrared, and H nuclear magnetic resonance, in addition to chemical tests [31-33].

Chemo-Preventive Activity

The ethanol extracted from the bark of *Buchananian lanzan* has a therapeutic use against cyclophosphamide encouraged genotoxicity and oxidative stress in rats. The biomarker intermediary in liver of mice were used as chemoprotection i.e., occurrence of micronuclei in bone marrow, the degree of lipid peroxidation, condensed glutathione and the status of the antioxidant enzymes, superoxide dismutase and catalase. The outcomes of treated mice were observed in the liver. The results displayed that pre-treatment along with extract, daily, for 7 days expressively reduced the chromosomal damage and lipid peroxidation with concomitant changes in antioxidants and detoxification systems and pointed out the presence of phytoconstituents in the crude extract which offers a kind of therapeutic fortification against cyclophosphamide persuaded genotoxicity and oxidative stress in rats [4, 34].

Biotechnological Activity

Somatic embryogenesis and plantlet regeneration procedures are used to evaluate the biotechnological activity of *Buchanania lanzan*. Calluses were obtained from immature zygotic embryos which are then cultured on Murashige-Skoog, added with several amalgamations of 2, 4-dichlorophenoxyacetic acid (2, 4-D), 6-benzyladenine (BA) and 1-naphthaleneacetic acid (NAA). The maximum frequency (60%) of somatic embryo induction was attained in cultures grown on MS medium which were mixed with 4.52 µM 2, 4-D, and 5.33 µM NAA and 4.47 µM BA. The medium added with 15 µM abscisic acid (ABA) was most operative for maturation and germination of somatic embryos. So, this study description on somatic embryogenesis in *B. lanzan*, may prove to be useful for in-vitro propagation, ex-situ conservation and genetic handling of this species [35]. In additional study a tissue culture method for the rapid clonal multiplication of *B. lanzan* was developed. The ornamented seeds were cultured on Murashige-Skoog (MS) medium supplemented with various concentrations of auxins and cytokinins alone or in blend. Amalgamation of benzyl amino purine (BAP) and napthalene acetic acid (NAA) were found to be greater. Murashige-Skoog medium supplemented with 22.20mM of BAP and 5.38mM of NAA endorsed the development of the maximum number of shoots. Furthermore, MS medium, comprising of 23.30mM kinetin, induced profuse rooting of the initiated shoots. It was obvious that multiple shoot development is one of the active practices for rapid clonal proliferation [4, 36].

Conclusions

Natural substances are biocompatible, non-toxic, inexpensive, and readily available, whereas synthetic ones are NOT.*B. lanzan* has a high socio-economic norm for providing livelihood to the tribal demography. There is a lot of secondary metabolites in *B. lanzan* as a result of its ability to quench free radicals, which makes it a rich source of drugs. *B. lanzan* of stem contains alkaloids, tannins, saponins, sugars, triterpenoids and flavonoids, fruit contain of fructose, α and β glucose. Seed and oil have high essential metabolism, such as fibers, minerals, fats, vitamins B1, B2, B12. Seed, stem, fruit, leaf, flower, and Root of *B. lanzan* have antimicrobial, anti-diabetic, anti-antifungal, anti-oxidant, anti-cancer, and Biotechnological activity [37-51].

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Conflict of Interest

The author declares no conflict of interest.

References

1. Konar R, Chatterjee. *Solanum Xanthocarpum*: A Critical Approach to the Lesser Known Aspects of the Herb. Int J Sci Res Biol Sci., 2022, 9(5).
2. Venkata Smitha P, Kandra P, Sravani R, Raju BA. Screening of antimicrobial and antioxidant potentials of *Acacia caesia*, *Dillenia pentagyna*, and *Buchananialanzan* from Maredumilli forest of India. J Pharm Res. 2012;5(3):1734-1738.
3. Jain R, Jain SK. Effect of *Buchananialanzan* Spreng. Bark extract on cyclophosphamide-induced genotoxicity and oxidative stress in mice. Asian Pac J Trop Med. 2012;5(3):187-191.
4. Rai PK, Sharma DR, Sharma A. *Buchananialanzan* is a pharmacognostic miracle herb. Res J Pharmacogn Phytochem. 2015;7(3):182-188.
5. Kodati D, Pareta SK, Patnaik A. Antidiarrhoeal activity of alcoholic extract of *Buchananialanzan* Spreng roots. Pharmacology online. 2010;3:720-726.
6. Siddiqui MZ, Chowdhury AR, Prasad N, Thomas M. *Buchananialanzan*: a species of enormous potentials. World J Pharm Sci. 2014;1:374-379.
7. Prasad S. Chironji (*Buchananialanzan*): A retreating valuable resource of central India. Int J Bioresource Sci. 2020;7(1):1-4.
8. Niratker C, Sailaja D. Preliminary phytochemical screening and evaluation of antimicrobial activity of *Buchananialanzan* (chironji) from Chhattisgarh. World J Pharmaceu Res. 2014;3(9):514-522.
9. Srivastava B, Singh R, Bharthi V, Meena AK, Prakash O. A comparative phytochemical approach for substitution of stem bark with small branches in *Buchananialanzan* for medicinal use. Methods. 2018;13:14.
10. Jatav P, Tenguria RK. Determination of Total Alkaloids

and Tannins Contents in Leaves of *Buchananialanzan*. J Coastal Life Med. 2022;10:693-700.
11. Bothara SB, Singh S. Pharmacognostical studies of seeds on some plants belonging Chhattisgarh. Pharmacognosy J. 2012;4(28):24-30.
12. Shrivastava J, Madhuri TR. Phytochemical analysis and HPLC estimation of phytoconstituents of *Buchananialanzan* Spreng. Adv Pharm J. 2019;4(5):113-120.
13. Vijay MK, Sharma RS, Maloo SR, Jain V, Sharma A. *Buchananialanzan* Spreng (Chironji): An endangered socio-economic forest tree species of Central India.
14. Kadia R, Bhavsar S, Sapra P, Pandya H, Mankad A, Modi N. Phytochemical Investigation and Antioxidant Activity of Ethnomedicinal Plants from Ratanmahal and Udalmahuda Forest, Dahod.
15. Elias A, Habbu PV, Iliger S. An Updated Review on Phyto-Pharmacological and Pharmacognostical Profile of *Buchananialanzan*: A Pharmacognostic Miracle Herb. Int J Sci Res Sci Technol. 2021;8(6):298-310.
16. Méril-Mamert V, Ponce-Mora A, Sylvestre M, Lawrence G, Bejarano E, Cebrián-Torrejón G. Antidiabetic potential of plants from the Caribbean basin. Plants. 2022;20:101360.
17. Sushma N, Smitha PV, Gopal YV, Vinay R, Reddy NS, Mohan CM, Raju AB. Antidiabetic, Antihyperlipidemic and Antioxidant Activities of *Buchananialanzan* Spreng Methanol Leaf Extract in Streptozotocin-Induced Types I and II Diabetic Rats. Trop J Pharm Res. 2013;12(2):221-226.
18. Siegel RL, Miller KD, Wagle NS, Jemal A. Cancer statistics, CA: a cancer journal for clinicians. 2023;73:17-48.
19. Khan AW, Farooq M, Haseeb M, Choi S. Role of plant-derived active constituents in cancer treatment and their mechanisms of action cells. 2022;11(8):1326.
20. Mehta BK, Pattnaik A, Kumar A. Enhancement and validation of wound healing activity with herbal gel formulated from sub-fraction of *Buchananialanzan* Spreng. Bark extract. Int J Pharm Pharm Sci. 2014;6(7):281-286.
21. Kodati D, Pareta S. Antiulcer activity of ethanolic extract of *Buchananialanzan* Spreng. Roots. Ann Biol Res. 2010;1(4):234-239.
22. Patil RN, Rothe SP. *Buchanania lanzan*: An enormous medicinal value. Int J Adv Res Innov Ideas Educ. 2017;3(1):1479-1484.
23. Hegde K, Naseeb KM, Syed A, Deepak TK, Kalangottil A. Evaluation of antivenom activity of ethanolic extract of *Buchananialanzan* bark against *Naja kaouthia* snake venom. Unique J Pharm Biol Sci. 2014;2(2):39-45.
24. Shen N, Wang T, Gan Q, Liu S, Wang L, Jin B. Plant flavonoids: Classification, distribution, biosynthesis, and antioxidant activity. Food Chem. 2023;23:132531.
25. Warokar AS, Ghante MH, Duragkar NJ, Bhusari KP. Anti-inflammatory and antioxidant activities of methanolic extract of *Buchananialanzan* Kernel. Indian J Pharm Educ Res. 2010;44(4):363-368.
26. Mehta BK, Pattnaik A, Kumar A. Enhancement and validation of wound healing activity with herbal gel formulated from sub-fraction of *Buchananialanzan* Spreng. Bark extract. Int J Pharm Pharm Sci. 2014;6(7):281-286.
27. Neeraj, Bisht V, Purwar S. Chironji (*Buchananialanzan*) Wonder Tree: Nutritional and Therapeutic Values. Int J Curr Microbiol Appl Sci. 2020;9(2):3033-3042.
28. Reddy DS. Assessment of nootropic and amnestic activity of centrally acting agents. Indian J Pharmacol. 1997;29:208-221.
29. Ellen YS, Kathryn MU. Donepezil: Anti cholinesterase inhibitor for Alzheimer's disease. Am J Health-Syst Pharm. 1997;54(24):2805–2810.
30. Neelakanth MJ, Bhat MR, Taranalli AD, Veeresh B. Effect of *Buchanania lanzan* seeds on learning and memory in normal and memory deficit rats. J Res Pharm Biomedica. 2012;22(1):33-38.
31. Mehta SK, Jaiprakash B, Nayeem N. Isolation and phytochemical investigation on leaves of *Buchanania lanzan* (Chironji). Ann Biol Res. 2011;2(3):469-473.
32. Mehta KS, Mukherjee S, Jaiprakash B. Anti-inflammatory activity of the methanolic extract of *Buchanania lanzan* leaves by Carrageenan-induced rat paw oedema method. Int J Pharm Sci Rev Res. 2011;6(2):144-146.
33. Mehta KS, Nayeem N, Bains N. Adaptogenic activity of methanolic extract of *Buchanania lanzan* leaves: An experimental study in rat model. Pharm Sinica. 2011;2(3):107-112.
34. Sumithra M, Chitra J, Anbu J, Dawn S. Effect of Total Extract of *Buchanania lanzan* Leaves against Hepatocellular Carcinoma in Diethyl Nitrosamine induced Mice Tumor Model. Int J PharmTech Res. 2013;5(4):97-102.
35. Sharma P, Koche V, Quraishi A, Mishra SK. Somatic embryogenesis in *Buchanania lanzan* Spreng. *In vitro* Cell Dev Biol Plant. 2005;4(5):645-647.
36. Chanda S, Bhayani D, Desai D. Polyphenols and flavonoids of twelve Indian medicinal plants. Bioscan. 2013;8(2):595-601.
37. Mukherjee K, Konar A, Ghosh P. Organic Farming in India: A Brief Review. Int J Res Agron. 2022;5(2):113-118.
38. Konar A, Mukherjee K, Ghosh P *et al*. Traditional Medicinal Plants Used in Different Districts of West Bengal by the Tribal Communities. J Pharm Pharmacogn Res. 2022;11(5):104-110.
39. Kundu P, Sharma P, Mahato R, Saha M, Das S, Chatterjee S, *et al*. A brief review for the development of bio-nanoparticles using some important Indian ethno medicinal plants. J Med Plant Stud. 2020;8(6):26-33.
40. Ghosh P, *et al*. Morphological Features, Phytochemical and Ethnopharmacological Attributes of *Tabernaemontana divaricata* Linn.: A Comprehensive Review. J Pharm Pharmacogn Res. 2021;10(6):31-36.
41. Poddar S, Ghosh P *et al*. Phytochemical, ethnobotanical and phytopharmacological discussions about *Trianthema portulacastrum* Linn.: A brief review. J Pharm Sci Res. 2020;12(7):899-903.
42. Konar A, Ghosh P. Cassia fistula is a Miraculous Medicinal Plant: A Brief Review. Sarcouncil J Plant Agron. 2023;1(1):25-31.
43. Konar A, Kaur J, Chatterjee S, Roy A, Das Dalal D, Ghosh P. A critical approach of medicinal plants to impede COVID-19. World J Pharm Res. 2023;12(5):753-765.
44. Ghosh P, *et al*. Role of Natural Nutraceuticals in Management of Oxidative Stress Related Diseases. Research Trends in Multidisciplinary Research (Vol-44). p. 117-145. ISBN: 978-93-5570-664-5.
45. Ghosh P, *et al*. Role of Plant Pigments on Human Health

and Environment. Research Trends in Environmental Science (Vol-16). 113-138. ISBN: 978-93-5570-685-0.
46. Ghosh P, *et al*. Extraction and quantification of pigments from Indian traditional medicinal plants: A comparative study between tree, shrub, and herb. Int J Pharm Sci Res. 2018;9(7):3052-3059.
47. Ghosh P, *et al*. Botanical description, phytochemical constituents and pharmacological properties of *Euphorbia hirta* Linn.: A review. Int J Pharm Sci Res. 2019;10(4):1605-1612.
48. Ghosh P, *et al*. Natural habitat, phytochemistry, and pharmacological properties of a medicinal weed - Cleome Rutidosperma DC. (Cleomaceae): A comprehensive review. Int J Pharm Sci Res. 2019;10(4):1605-1612.
49. Ghosh P, *et al*. An Overview of Environmental Remediation Technologies for Contaminated and Polluted Areas. Research Trends in Environmental Science (Vol-16). (Accepted).
50. Ghosh P, *et al*. Phytoremediation Technology: A Review. Int J Agric Plant Sci. 2023;5(1):44-49.
51. Choudhury S, Ghosh P, *et al*. Morphological features, phytochemical, and pharmacological study of *Leucas aspera* (Lamiaceae): A brief review. Int J Pharmacognosy Phytochem Res. 2020;12(3):132-137.