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Present status and future outlook for conservation of Chironji (*Buchanania lanzan* Spreng.)

R.S. Sharma[1*], Ramakrishnan, R.S., [2] Stuti Sharma[3], Ashish Kumar[2], Manvendra Singh[4], Namrata Dwivedi[1], S.V. Singh[1,] Ayushi Purohit[1]

[1]Biotechnology Centre, Jawaharlal Nehru Krishi Vishwa Vidyalaya, Jabalpur, Madhya Pradesh, India-482004
[2]Seed Technology Research Unit, Jawaharlal Nehru Krishi Vishwa Vidyalaya, Jabalpur, Madhya Pradesh, India-482004,
[3]Department of Plant breeding,Jawaharlal Nehru Krishi Vishwa Vidyalaya, Jabalpur, Madhya Pradesh, India-482004
[4]Manvendra Singh,Khwaja, Moinuddin Chishti Language University, Lucknow, Uttar Pradesh

*corresponding author e-mail address: radhebiotech88@jnkvv.org

ABSTRACT

Now a day's demand of herbal medicinal products and supplements has tremendously increased over the worldwide and more than 80% peoples relying on them for some part of primary healthcare. Due to lack efficient conservation approaches many plant species are endangered or near to extinct. Chironji (*Buchanania lanzan* Spreng.) is one of the prominent and economically important forest plants found in the Central regions of India. During the last two decades, due to overexploitation and less re-introduction, the population of chironji has been depleted and categorized as extinct species. While a technically knowledge is available on the *in vitro* culture of plants, there are limited literature related to plant conservation. This review highlights the progress in *in vitro* culture and various propagation methods technique to develop new protocol. Therefore, advances in plant conservation biotechnology with special emphasis on the preservation efforts of the *Buchania lanzan.* In a nutshell, this review is the epitome of the current status and future strategies to provide a concrete platform for future research directions for the conservation of the economically endangered forest plant of India

Keywords: *Buchanania lanzan* Spreng; *Conservation*; *Micropropagation*; *Germplasm*; *extinct;*

1. INTRODUCTION

In the developing world, peoples heavily rely on plants for their livelihood, nutrition, health and income. In India tribal's and local villagers relay on local medicinal plants to heal their illness. India has one of the richest ethno-botanical traditions in the world with the presence 15,000-20,000 medicinal plants species (Rana et al., 2016). Several medicinal plants species are being widely used to treat a plethora of acute and chronic diseases all over the world and considered as "Chemical Goldmines" due to the presence of natural chemicals. Chironji (*Buchanania lanzan Spreng*) is a native plant of the Indian sub-continent, belongs to the family Anacardiaceae and commonly known as Char, Achar, Charoli, Cuddaph Almond, and Priyal (Anon, 1952; Prasad, 2020; Kumar et al., 2012). It's generally found in the tropical deciduous forests of Northern, Western, and Central India and gives a monitory return to farmers and local communities of the country (Malik et al., 2010a and Singh et al., 2018a). Fresh fruits and their kernels are sumptuous having a pleasant, sweetish, sub-acid flavor, and are edible to local communities. Besides that, they are also supplied to the different kiosks of the country as a source not only to earn money but also to fulfil basic amnesties. Chironji is popularly renowned for its costly, high-priced kernel and acts as a substitute for almonds. It is served as a cooking spice and dry fruit in sweets, kheer, meat, korma, and eaten in the raw or roasted form (Rajput et al., 2018, a). Chironji seeds are the richest source of nutrients and minerals hence possess aesthetic and medicinal properties (Wen Shu, 2019; Siddiqui et al., 2014; Banerjee and Bandyopadhyay, 2015).

Now a day's a substantial decline in the population of chironji plants has been recorded. Due to overexploitation, climate change, low regeneration, destructive harvesting of immature fruits in the forest and non-forest areas, the plant is facing a severe threat of vulnerability and extinction (Rai, 1982; Singh and Peter, 2007; Malik et al., 2012a). In addition to lack of government support to protect these extinct species are also a reason for deterioration and extinction. The chironji plant has been entered into the red-listed medicinal plant species of Indian origin, which requires extensive conservation strategy as reported by the Foundation of Revitalization of Local Health Tradition (FRLHT), Environmental Information System (ENVIS)-Centre on Medicinal Plants, Bangalore, Government of India. In 2009, *Buchanania lanzan*, was included in the Red Data Book of the International Union for Conservation of Nature and Natural Resources (IUCN). Thus, this review summarizes the existing literature of chironji which will help to recognize from beginning to end research on various aspects and will provide a concrete platform for further improvement of a neglected underutilized economically endangered tribal forest tree of Central India for their conservation.

1.1. ORIGIN AND DISTRIBUTION

Buchanania lanzan Spreng is an Indian native plant (Kritikar and Basu, 1935) and first time described by Francis Hamilton, in 1798 in Burma and the genus *Buchanania* was named after him (Duthie, 1960). *Buchanania* species mainly occur in dry deciduous and dry mixed deciduous forests found in all the Central parts of India including Vindhyan Zone (Mirzapur and Sonbhadra districts) and the Bundelkhand region of Uttar Pradesh (Rajput et al., 2018). Seven species of *Buchanania* have been reported in India, among two *B. lanzan* and *B. axillaries* produce edible fruits and are observed in patches. However, other species including *B. Lanceolata*, *B. Platyneura*, *B. Lucida*, *B. glabra*, and *B. acuminate* are non-edible and found in the specific localities. Among all these species, *B. lanzan Spreng* is the commercially and economically important, and widely distributed species in India (Chauhan et al., 2012), while *B. axillaris* is dwarf in size and produces the best quality edible kernel. It is widely distributed in India, Bangladesh, Nepal and Sri Lanka. In India, it is observed in Madhya Pradesh, Chhattisgarh, Jharkhand, Gujarat, Uttar Pradesh, Maharashtra, Orissa, Andhra Pradesh and some parts of Bihar. A rich morphological and genetic diversity is available in the dry deciduous forests of Central India. Chironji plant is hardy and thrives well on rocky, gravelly red, and black soils but unable to sustain under waterlogged conditions. In addition to forest, it is also found in the rocks, mountains, semi-arid areas, resource-poor areas, and wastelands (Malik et al., 2012, b). Generally, for its natural habitat, tropical and subtropical climate is most suitable but it can withstand adverse climatic conditions including drought, temperature, heavy precipitation, and injury admirably (Singh et al., 2018, b).

1.2. MEDICINAL VALUE

Phytoconstituents of *B. lanzan* have been used since ancient time for various medicinal and pharmaceutical purposes. Chiroji is well known for rich in secondary metabolites producing phenolics and other like tannin, saponin, phenols, flavonoids and flavanols. Every plant part such as leaves, seeds, roots, bark, kernel etc contains diverse metabolites and used for medicinal purposed (Table 1).

1.3. PRESENT STATUS

Chironji is not cultivated as a commercial crop and only stray plantation is found in their natural habitat. However, due to some government efforts its regular plantation is observed in the protected forests of Madhya Pradesh and Chhattisgarh. Tribal peoples generally collect the raw material from the forest and sell it to the local market to earn the money for their livelihood. In India, collection and selling of nationalized forest produce are done by Chhattisgarh Minor Forest Produce (CGMFP) Federation only. This agency is responsible for providing the appropriate prices to the peoples according to the quality of produce and has a large network throughout the central part for the collection of superior quality Non-Nationalized Non-Wood Forest Produce (NWFP). According to the national estimate ~5000-10000 MT kernel per year is exported at the national level with varying prices as per the kernel quality. In India, the approximate rate of chrironji kernel is ranged from Rs. 750 to 1000 per kg. The demand of Bastar (Chattishgarh) chironji is very high in the National and International market and the government is focusing to integrate it with geographical identity, but now it is found in some specific patches and due to its high demand, the prices are hiked by Rs. 1400 per kg which is exported to many Asian and European countries.

1.4. CRITICAL GAPS IN CONSERVATION AND PROPAGATION OF CHIRONJI

The diversity of chironji species is facing severe attrition due to urbanization, agriculture intensification and other human interventions in the tribal inhabited part and protected forest of Central India, which holds a large scale natural population of *chironji* species (Singh, 2011). Local farmers do not grow chironji species in their cropped area or home gardens but prefer to exploit the naturally existing wild population from the forest for their personal as well as commercial purpose. Consequently, the natural existing population of chironji in the forests and other specific regions is facing a severe threat of extinction. The other main problem associated with the reforestation or domestication of chironji is the low germination percentage of seeds due to hard seed coat, recalcitrant in nature, and association of an internal seed born fungal contamination with the storage of seeds (Choubey et al., 1997; Shukla and Solanki, 2000). Moreover, the fungal attack by *Fusarium sp*. (wilting disease) is the most common after sowing the seeds in the soil which leads to the death of the seedling in the early stage (Sharma et al., 1998; Joshi et al., 2017). The early seedlings are also attacked by a combination of *Fusarium monililforme* var. *subglutinans* Wr. and Rg., *F. semitectum* Berk & Rav present in soil (Sharma et al., 1998). Humidity and high temperature are the two main factors associated with fungal contamination and when the harvested seeds are exposed to sunlight, they lose their germination capacity and viability (Shende and Rai, 2005).

2. CONSERVATION STRATEGY FOR MASS MULTIPLICATION OF THE CHIRONJI SPECIES

Currently some efforts have been made by researcher to bring awareness and under domestication of this economically important forest plant. Some reviews also emphasised the importance and suggested for improvement of the chironji. For the conservation of chironji both ex-situ and in-situ approaches should be adapted at community level with the involvement of the government. A schematic model is suggested for its conservation and protection from future extinction (Fig.1). In the present era, the most suitable strategy for germplasm conservation is to espouse instantaneous ex-situ conservation including genebanks and cryo-banking complemented with in-situ conservation in protected areas such as National Parks (Malik et al., 2010,b). In India, ex-situ gene banks for chironji species have been established in Horticulture Research Institutes of ICAR at Godhra, Gujarat, and Lucknow, to develop innovative methods as well as advanced techniques for the conservation and further mass multiplication. Selection of elite germplasm from the indigenous collection and their improvement is carried out under the supervision of the Agriculture Department and Forest Divisions. Germplasm collection from different places of Central India has been cryostored as the base collection with varying diversity in the form of 176 accessions in the National Cryogene bank at NBPGR, New Delhi for posterity and to utilize in due course of time (ICAR-NBPGR Cryo database). Successful cryopreservation of seed kernel and embryonic axes has been achieved using desiccation followed by fast freezing and air desiccation-freezing methods respectively, with high viability up to 85% after cryopreservation. A comprehensive base collection of diverse accessions has been successfully established in the genebanks. Presently, our efforts are also on collection and conservation of chironji germplasm form the protected forest area of Madhya Pradesh. Table 2 represents the list of collected germplasm of chironji for their charatctezation and selection of elite germplasm.

2.1. Propagation Methods

There are no standard methods for large-scale propagation and plants are multiplied by seed and raising of seedlings (Rai, 1982; Narayan et al., 2014). The Percentage of germination in freshly extracted seeds is poor because of the hard seed coat on the kernels. In a study, Shukla and Solanki, 2000, reported 83.00% of seed germination within 18 days accomplished with moderate seedling growth by mechanically damaging the stony endocarp even before sowing in the month of June. Seed treatment of sulphuric acid (5-7%) was also found very appropriate for the promotion of seed germination in chironji. One-year-old seedlings are can be used for grafting and multiplication through vegetative methods (Singh et al., 2018c). Previously, some researchers tried different types of explants and media compositions for in vitro regenerated of chironji species as shown in Table-3.

2.2. VEGETATIVE PROPAGATION

Vegetative propagation methods like chip budding and softwood grafting were standardized and reported in Chironji (Singh et al., 2007). But due to less availability of rootstocks and dependency on seasonal conditions vegetative propagation is limited in chrironji. Singh et al., 2014 has standardized a modified softwood grafting method for the propagation of 1-2 years old plants. They used one-year-old rootstock for wedge grafting during the onset of monsoon and got 60–70% success after three months. The addition of root promoting hormones such as IAA, IBA 20-200ppm in the medium was found to be most effective for root initiation during softwood grafting. In the fields, in situ softwood grafting method also be used for raising the orchards directly. For that purpose, rootstock seeds are sown in the month of June with a size of 1x1x1m pits as per the layout, and raised rootstock seedlings were softwood grafted after 1-2 year. The scion material was defoliated 10–15 days before grafting by allowing the petiole to remain attached to the scion shoot. The scion becomes ready as the apical bud swells and the petioles dropdown. The maximum success rate was obtained in the month of July and later it was less than 40% with negligible variation (Singh and Peter, 2007).

2.3. ROOT CUTTING

Root cutting is not a commonly applied approach for most of the forest plants including chironji, however, due to the low percentage of seed germination and slow growth rate of seedlings, the method is adopted by some nurserymen. Root initiation at the site of root cutting was obtained by the treatment of auxin, IBA/IAA 1500ppm with 3.6–5.5 cm thickness with 67.66 % of success rate (Singh et al., 2002; Singh et al., 2014).

2.4 BIOTECHNOLOGICAL INTERVENTIONS

Moreover, propagation through vegetative means, such as softwood grafting, root cutting, budding, etc is a very slow and season-dependent process (Singh et al., 2018d). The published work indicated the necessity of mass multiplication of chironji through biotechnological intervention *i.e*. plant tissue culture. During the last two decades plant tissue culture has become one of the most powerful tools for the large-scale multiplication of many important and endangered plant and crop species. If it is done at a commercial level then the techniques are very cost-effective and useful for mass multiplication of the plants through various routes. Tissue culture techniques are being employed for the production of disease-free clones, gene pool conservation, prevent embryo abortion, creation of somaclonal variation, haploid production, and in vitro germplasm screening for desirable secondary metabolite producing traits. Recently, in the agricultural sector, this technique has been applied immensely in vitro propagation for large-scale plant multiplication of elite varieties of sugarcane, bamboo, teak, coconut, and other many medicinal and flowering plants (Jamsheed et al., 2013). Although, tissue-culture protocols for most of the crop species have been optimized and available for commercial use but still continuous optimization is required for many crops, especially cereals and woody plants.

Limited reports are available on plant tissue culture technique of chironji *via.*, immature zygotic embryo (Sharma, 2005), decoated seeds (Shende and Rai, 2005; Shirin et al., 2018), shoot tips and nodal segments (Niratker and Sailaja, 2014). In chironji, regeneration can be obtained through organogenesis or embryogenesis by the administration of different phytohormone either alone or in combination which enhances and accelerates the production of *in vitro* plants. Sharma et al., 2005, used immature zygotic embryos as explants for callus induction on MS media fortified with combinations of 2,4-dichlorophenoxyacetic acid (2,4-D), 6-benzyladenine (BA), and/or 1-naphthaleneacetic acid (NAA) and got success. Multiple shoot initiation reported in decoated seeds (Shende and Rai, 2005; Shirin et al., 2018a) and nodal segments (Shirin et al., 2018) cultured on MS medium enriched with various concentrations of auxin and cytokinin either alone or in combination. MS medium supplemented with 22.2 µM of BAP and 5.37 µM of NAA promoted the formation of the maximum number of shoots. Furthermore, MS medium containing 23.3 µM kinetin induces profuse rooting of the initiated shoots (Shende and Rai, 2005). Multiple shoot induction from shoot tips and nodal segments explants of chironji in half-strength MS medium supplemented with 1 mg/l BAP and 0.5 mg/l IAA with an average number of 3-4 shoots per explants was reported by Niratker and Sailaja, 2014. A recently published study reported maximum sprouting (88.89%) in nodal segments on MS medium with 0.05 µM kinetin and 0.5 µM BA followed by 0.5 µM kinetin and 0.1 µM BA. Around 3-4 shoots were formed per nodal segment after 20 days of inoculation (Shirin et al., 2018b).

2.5. MOLECULAR BREEDING

Due to cross-pollination and predominance of seed propagation chironji gives immense opportunity to locate elite trees having desirable traits. Huge variations in terms of acidity, size, sweetness, shape, and fruit-bearing habits in chironji under diverse climatic conditions were observed. Variability in flowering, fruiting and fruit quality attributes to different genotypes of chironji that could be a potential source for utilization and improvement in the chironji. The use of extensive breeding tools with biotechnological associations might be helpful to protect eroded chironji species.

An extensive survey was made in district Panchamahal, Gujrat, and its adjoining areas during the years 2004 and 2005 to identify elite types of germplasm among its population. Thirty promising genotypes labelled as CPT 1 to CPT 30 which exhibited a fairly wide spectrum of variability in various characters were selected (Singh et al., 2006). Moreover, those genotypes of chironji exhibited significant variation for floral, vegetative, physicochemical, and yield characters during 2011-2013. The vegetative growth in terms of rootstock girth, plant height, plant spread (North-South), and plant spread (East-West) varied between 5.96-1.63m, 23.99-53.38cm, 1.40-5.10 m, and 1.50-5.38 m, respectively. The time of flowering and fruit set ranged between 1st week of February- 3rd week of February and 3rd week of February- 2nd week of March, respectively. Based on the horticultural traits studied, genotype CHESC 7 was released with a variety named Thar Priya (Singh et al 2016). Chironji variety, Thar Priya was released by the Central Institute for Arid Horticulture, Bikaner in 2014 (Singh et al., 2015).

Table 2. List of collected germplasm from forest area of Madhya

S.No	Village name	Mandal/ Taluka/ Tehshil	District	Type of material collected	Collection date	Collection site/ acquisition source	Latitude (N)	Longitude (E)	Altitude (m)
1	Kishli	Bichhiya	Mandla	Seeds, Plants	17/07/19	Forest area	22.3019.602	80.550446	453
2	Lagma	Baihar	Balaghat	Plants	17/07/19	Forest area	21.974699	80.4557999	567
3	Khatiya	Bichhiya	Mandla	Seeds	17/07/19	Forest area	22.3202916	80.4975491	453
4	Mocha	Bichhiya	Mandla	Seeds	17/07/19	Forest area	22.31.01475	80.4878.472	453
5	Baihar	Baihar	Balaghat	Seeds, Plants	17/07/19	Forest area	22.15356	80.5413	567
6	Ukwa	Baihar	Balaghat	Seeds	17/07/19	Farmers Field	21.9721276	80.4726.997	608
7	Roopjhar	Baihar	Balaghat	Seeds	17/07/19	Forest area	21.9572905	804240671	567
8	Gangulpara	Balaghat	Balaghat	Seeds	18/07/19	Forest area	21.9558071	804005048	309
9	Bharweli	Balaghat	Balaghat	Plants	18/07/19	Forest area	21.842133	80.2354424	288
10	Manegaon	Bichhiya	Mandla	Plants	18/07/19	Forest area	22.2962367	80.4913519	298
11	Awlajhari	Balaghat	Balaghat	Seeds	18/07/19	Forest area	21.830888	80.22153404	309
12	Garra	Waraseoni	Balaghat	Plants	18/07/19	Forest area	21.8071611	80.1559412	305
13	Behrai	Waraseoni	Balaghat	Seeds, Plants	18/07/19	Forest area	21.8460144	80.1276796	309
14	Birsula	Waraseoni	Balaghat	Seeds	18/07/19	Forest area	21.8670062	80.10485	305
15	Bakoda	Laalbarra	Balaghat	Plants	18/07/19	Farmers' Field	21.875968	80.0987105	327
16	Laalbarra	Laalbarra	Balaghat	Seeds, Plants	18/07/19	Forest area	21.9203.662	80.0565722	288
17	Sihora	Waraseoni	Balaghat	Plants	18/07/19	Forest area	21.9862297	80.0307758	386
18	Nevargaon	Balaghat	Balaghat	Seeds	18/07/19	Forest area	22.0069767	80.0166368	288
19	Kanjai	Waraseoni	Balaghat	Seeds, Plants	18/07/19	Forest area	22.0237085	79.9897214	305
20	Ghisi	Balaghat	Balaghat	Seeds	18/07/19	Forest area	22.018262	79.8386073	288
21	Dharna	Barghat	Seoni	Seeds,	25/07.19	Farmers' Field	22.0217432	79.8321405	537
22	Pragya Nursery	Seoni	Seoni	Plants	25/07.19	Private Nursery	22.0851453	795903954	611
23	Lonia	Seoni	Seoni	Plants	25/07.19	Forest area	-	-	-
24	Chapara Nursery	Lakhnadon	Seoni	Plants	25/07.19	Private Nursery	22.611394	79.611275	607
25	Lakhandon	Lakhandon	Seoni	Seeds	25/07.19	Forest area	22.6029538	79.6118.119	607
26	Dhuma	Lakhandon	Seoni	Plants	25/07.19	Forest area	22.7323075	79.7138702	607
27	Hulki	Jabalpur	Jabalpur	Plants	12/07/19	Forest area	22.7810628	79.7335027	405
28	R/E circle Part-I Seoni	Bharghat	Seoni	Seeds, Plants	25/07.19	Forest Nursery	22.0489251	79.5767207	537
29	R/E circle Part-II Seoni	Bharghat	Seoni	Plants	25/07.19	Forest Nursery	22.0489251	79.5767207	537
30	R/E circle Aamgaon Seoni	Bharghat	Seoni	Plants	25/07.19	Forest Nursery	22.0284177	79.5948681	537
31	State Forest Research Institute Jabalpur	Jabalpur	Jabalpur	Plants	17/08/19	Forest Nursery	23.007380	0790.55.923	412
32	M.P. Forest Department Chapara	Lakhnadon	Seoni	Seeds Plants	25/07.19	Forest Nursery	22.3919858	79.5450038	607

Table 3. Micropropagation study of *B. lanzan* using different types of explants and media composition with varied concentration of different plant growth regulators

SN	Species/cultivar	Media	Culture condition	Results	References
1.	*B. lanzan* (spreng) seed	MS+BAP+NAA	25±1°C 16 hrs light and 8 hrs dark	8 days for first seed germination, seed performed best results for *B. lanzan Spreng.* under South-Eastern Rajasthan.	(Sharma *et al.*, 2020; Choubey *et al.*, 1997)
2.	*B. lanzan* (spreng) seed	Basal media	25±1°C 16 hrs light and 8 hrs dark	Tree is propagated from seeds	(Sharma *et al.*, 2005; Joshi et al., 2017)
3.	*B. lanzan* (spreng) seed	Basal media	25±1°C 16 hrs light and 8 hrs dark	Tree is propagated from seeds	(Sharma *et al.*, 2005; Joshi, 2017)
4.	Germination of somatic embryos	4.53 µM 2,4-D, + 5.32 µM NAA + 4.48 µM BA.	25±1°C 16 hrs light and 8 hrs dark	Developed a protocol for somatic embryogenesis and plantlet regeneration of Chironji by immature zygotic embryos	(Sharma *et al.*, 2005)
5.	*B. lanzan* (spreng) nodal segments explants	MS medium + 1 mg/l BAP and 0.5 mg/l IAA	25±1°C 16 hrs light and 8 hrs dark	Developed shoot tips and nodal segments	(Niratker *et al.*, 2014)
6.	*B. lanzan* (spreng) immature zygotic embryos	Murashige-Skoog (MS) +22.2 µM +BAP and 5.37 µM of NAA	25±1°C 16 hrs light and 8 hrs dark	Developed zygotic embryo	(Shende and Rai 2005)
7.	*B. lanzan* (spreng) seed	MS+BAP+NAA	25±1°C 16 hrs light and 8 hrs dark	8 days for first seed germination, seed performed best results for *B. lanzan* under South-Eastern Rajasthan	(Sharma et al., 2020 and Choubey et al., 1997)
8.	*Carrizo Citrang* Root	WPM +IAA+ IBA	25±1°C 16 hrs light and 8 hrs dark	Tree is propagated from root	(Kaur *et al.*, 2015).
9.	Seeds	70% germination	25±1°C 16 hrs light and 8 hrs dark	Tree is propagated from seeds	(Shukla *et al.*, 1999)
10.	Somatic embryogenesis	MS medium supplemented with various combinations of 2,4-D and BAP and NAA	27 ±28C, under a 12 h/12 h (day/ night)	The highest frequency (60%) of somatic embryo induction was obtained in cultures grown.	(Sharma *et al.*,2005)

2.6. NANO-BIOTECHNOLOGY

Nano-biotechnology is the interface of nanotechnology and biotechnology that has Nano-biotechnology is the interface of nanotechnology and biotechnology that has emerged as a crucial domain with its application in life science. These methods have produced superior nano-particles but still, a key understanding of improved manufacturing process is required which could be exploited at the industrial and commercial level to have better built, long-lasting, cleaned, safer, and smarter products such as home appliances, communication tools, medicines, transportation, agriculture, and industries. Therefore, the main focus is to design NPs using environmentally benign approaches (Neeraj, 2020). Zinc oxide nanoparticles (ZnONPs) were synthesized using an aqueous extract of Chironji leaves as fuel by solution combustion method. The Nps were evaluated for photoluminescence, photodegradation, antimicrobial and antioxidant activities, and the extract was found to be rich in antioxidants, polyphenols, and flavonoids. X-ray diffraction patterns of NPs were indexed to hexagonal wurtzite structure. NPs showed antibacterial activity against Klebsiella aerogenes, Escherichia coli, Pseudomonas desmolyticum, and Staphylococcus aureus. ZnO nanoparticles synthesized by water extract of chironji leaves exhibits efficient antioxidant and antimicrobial activities (Suresha et al., 2015)

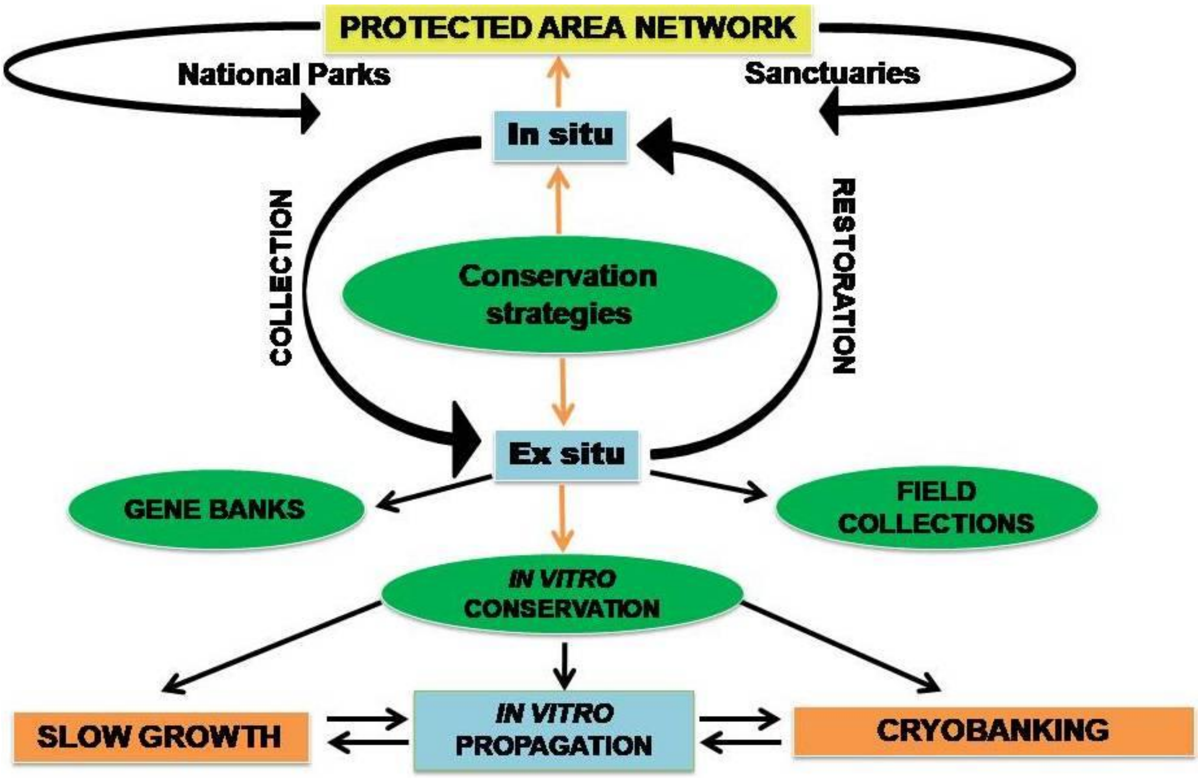

Fig: 1 Scheme representation of different conservation strategies for *Buchanania lanzan* Spreng.

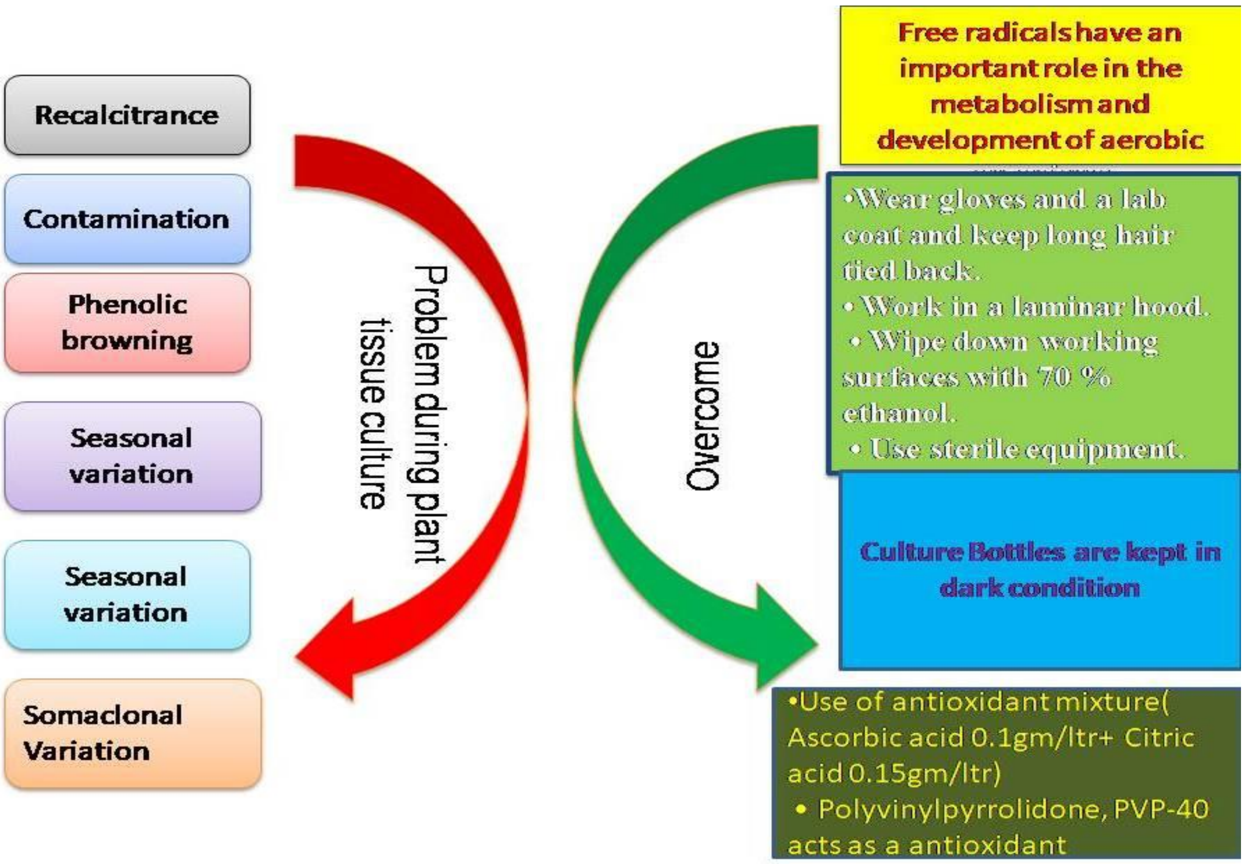

Fig: 2 Problems observed during micropropagation of *Buchanania lanzan* Spreng.

3. CONCLUSIONS

Despite the existence of huge biodiversity of medicinal plants in India, only some species have achieved adequate protection through conventional and non-conventional approaches. Among many economically important plant species, chironji an economically important medicinal forest plant, facing threat of extinction due to various human interventions in their natural habitat. Chironji plant could be a promising resource to the Indian tribal communities due to its multiple uses and survivability of plants under harsh conditions. Therefore, there is an urgent need to develop a conservation and mass multiplication strategy for such important species.

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5. ACKNOWLEDGEMENTS

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