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Study on 100 medicinal and aromatic plants (MAPs) with special references to their vegetative propagation and for ex-situ conservation in herbal garden

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Abstract
Each plant species in nature are marked for the presence of certain chemical compounds, essential substances/oils etc and are unique in nature with their action potential. Based on the climatic condition and their adaptability plants are showing their availability in specific parts of the world. A plant needs to adopt in changeable environmental conditions for sustaining in nature.
There are so many reasons leading to loss of the plant species such as degradation of natural habitat, over exploitation, introduction of the new species etc. To adjust in their natural sites plants rapidly propagating by their various modes like by seeds and also by the other parts than seeds is marked as the mode of vegetative propagation. Plants having several modifications which support it to propagate using vegetative parts like by Bulb, Tuber, Rhizome, Corms etc. Numerous seeds produced by the various plants once or twice in a year which are dispersed from one place to another by different modes.
Current study is of vegetative propagation of hundred valuable Medicinal and Aromatic Plants (belonging to varied families and habit) for their rapid production as well as for ex-situ conservation in the Herbal Garden.

Keywords: medicinal plants, aromatic plants, vegetative propagation, ex-situ conservation, herbal garden

Introduction
Medicinal plants performing a significant role in health care of the peoples over the world (Bekalo *et al.* 2009) [1]. Traditionally used medicinal plants are mostly and widely collected from forest areas (Gupta, 1986) [7].
Biological resources conservation is a remarkable step to protect the species in natural habitats and is also valuable for maintaining the species diversity as well as sustainability of the nature. Many factors lead to the presence of the plant species in variable ecological sites such as destruction of natural habitat, Pollution, new species introduction etc.
Medicinal plants diversity and vegetation analysis logged over hill forest was assessed by Norhajar *et al.*, 2010. Plants are a major source for traditional methods of treatment for various disorders over the world. Around 80 % peoples use the plants as traditional medicine source (De Silva, 1997) [2].
Ethno-botanical study of medicinal plants was observed by Gireesha *et al.*, 2013 [6] and ethno-medicinal investigation of medicinal plants used by tribes was made by Padal *et al.*, 2013 [12]. Herbal plants also used as a source of cosmatics recorded by Gediya *et al.*, 2011 [5]. In vitro conservation of *Bacopa monnieri* – an endangered medicinal plant was focused by Rathore and Singh, 2004 [13]. Rapid vegetative propagation method for Carob was studied by Hamide *et al.*, 2011 [8].
Conservation of medicinal plants (Past, present and future trends) was noticed by Kasagana and Karumuri 2011 [10]. Medicinal plants conservation and cultivation by traditional medicine preparation in Nigeria studied by Oladele *et al.* 2011 [11]. Hassan *et al.* focused on Ex-situ management study of some high value medicinal plant species in Swat, Pakistan. Deshmukh in 2010 [3] studed on Ex-situ conservation studies on ethno-medicinal, rare, endemic plant species from Western Ghats of Maharashtra.
Floristic study from different ecological areas has been made by many researchers like Singh and Singh 2002 [15]. The Asclepiadaceae and Pericloaceae families were focused by Santapaui and Irani 1962 [14].
Present research is an effort towards the vegetative propagation and ex-situ conservation of the important and endangered Medicinal and Aromatic plants in Herbal Garden.

Materials and methods
Vegetative propagation of 100 Medicinal and Aromatic plants was carried out in the year 2016 at Herbal Garden developed for ex-situ conservation of MAPs in GGV- (A Central University) Bilaspur, Chhattisgarh in central India. Poly bags of depth 15 cm and width 10 cm were selected and filled a mixture of dung, Sand and black soil equally (Weight around 730 gms after filling these components).
For each one species of the Medicinal and Aromatic plants there are six poly bags were prepared and arranged in a sequence as per the listed in Table-1. Different parts of Medicinal and Aromatic plants were selected on the basis of their diseases free, healthy and matured condition. These were prepared for better growth to achieve the above goal. The experiment was set by applying plant parts like bulb, tuber, rhizome, corm etc in poly bags/fields following suitable technique.
Woody parts of the stem was selected and made oblique cut and deep in the soil of poly bags obliquely. Modified plant parts like bulb, tuber, rhizome, corms were applied for initiation of new adventitious buds for fast and efficient growth of the MAPs. In initial stage the poly bags which

include plant parts for propagation were supplied water as per need of the plants. Daily monitoring/observation were done for proper care and for protection of the newly developing plants.

Table 1: Diversity of the Medicinal and Aromatic Plants (MAPs) propagated through their Vegetative modes.

S. No	Botanical name	Family	Habit	Propagation
1.	*Achyranthus bidentata* Blume	Amaranthaceae	Herb	Seed/Stem cutting
2.	*Acorus calamus* Linn.	Araceae	Herb	Rhizome
3.	*Adhatoda vasica* Linn.	Acanthaceae	Shrub	Stem cutting
4.	*Allium sativum* Linn.	Liliaceae	Herb	Bulb
5.	*Aloe vera (L.)* Burm. F. Mill.	Liliaceae	Herb	Bud
6.	*Alpinia galangal* (L.) Willd.	Zingiberaceae,	Herb	Rhizome
7.	*Alstonia scholaris* L.R.Br.	Apocynaceae	Shrub	Seed/Stem cutting
8.	*Amorphophallus paeoniifolius* (Dennst.) Nicolson	Araceae	Herb	Corm
9.	*Andrographis paniculata* Nees	Acanthaceae	Herb	Stem cutting
10.	*Angelonia angustifolia* Humb & Bonpl.	Scrophulariaceae	Herb	Stem cutting
11.	*Anisomeles indica* Linn.	Lamiaceae	Herb	Stem cutting
12.	*Argyreia nervosa* (Burm.f.) Bojer	Convolvulaceae	Herb /Climber	Stem cutting
13.	*Asparagus racemosus* Willd.	Liliaceae	Herb /Climber	Seed/Tuber
14.	*Baccopa monerri* Linn.	Scrophulariaceae	Herb	Stem cutting
15.	*Barleria prionitis* Linn.	Acanthaceae	Herb	Seed/Stem cutting
16.	*Basella alba* Linn.	Chenopodiaceae	Herb/ Climber	Stem cutting
17.	*Boerhaavia diffusa* Linn.	Nyctaginaceae	Herb	Stem cutting
18.	*Canna indica* Linn.	Zingiberaceae	Herb	Rhizome
19.	*Catharanthus roseus* (L.) G. Don.	Apocynaceae	Herb	Seed/Stem cutting
20.	*Centella asiatica* (L.) Urban.	Apiaceae	Herb	Stem cutting
21.	*Centratherum punctatum* Cassini.	Asteraceae	Herb	Seed/Stem cutting.
22.	*Chlorophytum borivilianum* San. & Fer.	Liliaceae	Herb	Bulb
23.	*Chromolaena odorata* (L.) King & H.E.	Asteraceae	Herb	Seed/stem cutting
24.	*Cissus quadriangularis* Linn.	Vitaceae	Herb	Stem cutting
25.	*Clerodendrum inerme* (L.) Gaertn.	Lamiaceae	Shrub	Stem cutting
26.	*Coleus scutellarioides* (L.) R. Br.	Lamiaceae	Herb	Stem cutting
27.	*Coleus forskohlii* (Willd.) Briq.	Lamiaceae	Herb	Seed /Stem cutting,
28.	*Colocasia esculenta* (L) Schott	Araceae	Herb	Corm
29.	*Commiphora wightii* (Arn.) Bhandari	Burseraceae	Shrub	Stem cutting
30.	*Costus speciosus* (J. Konig) Sm.	Zingiberaceae	Herb	Rhizome/ Stem cutting
31.	*Crinum latifolium* Linn.	Liliaceae	Herb	Bulb
32.	*Curculigo orchioides* Gaerth.	Hypoxidaceae	Herb	Seed/ Stem cutting
33.	*Curcuma amada* Roxb.	Zinziberaceae	Herb	Rhizome
34.	*Curcuma angustifolia* Roxb.	Zinziberaceae	Herb	Rhizome
35.	*Curcuma aromtica* Linn.	Zinziberaceae	Herb	Rhizome
36.	*Curcuma caesia* Roxb.	Zinziberaceae	Herb	Rhizome
37.	*Curcuma longa* Linn.	Zinziberaceae	Herb	Rhizome
38.	*Cymbopogon flexuosus* (Nees ex Steu) Wat.	Poaceae	Herb	Seed/Buds
39.	*Cyperus rotundus* Linn.	Cyperaceae	Herb	Rhizome
40.	*Dioscoria bulbifera* Linn.	*Dioscoriaceae*	Herb /Climber	Tuber/ Stem cutting
41.	*Eclipta prostrata* Linn.	Asteraceae	Herb	Seed/Stem cutting
42.	*Eryngium foetidum Linn.*	Apiaceae	Herb	Seed/Stem cutting,
43.	*Euphorbia nerifolia* Linn.	Euphorbiaceae	Shrub	Stem cutting
44.	*Euphorbia trigona* Mill.	Euphorbiaceae	Shrub	Stem cutting
45.	*Ficus glomarata* Roxb.	Moraceae	Tree	Seed/Stem cutting
46.	*Ficus hispida* L. F.	Moraceae	Tree	Seed/Stem cutting
47.	*Gloriosa superva* Linn.	Liliaceae	Herb	Seed/Rhizome
48.	*Grewia asiatica* L.	Malvaceae	Shrub	Stem cutting,
49.	*Gymnema sylvestris* (Retz) R. Br.	Asclepiadaceae	Herb /Climber	Seed/Stem cutting
50.	*Hedychium coronarium* J. Koenig	Zingiberaceae	Herb	Rhizome
51.	*Helicterus isora* Linn.	Sterculiaceae	Shrub	Seed/Stem cutting
52.	*Hibiscus rosa sinenses* Linn.	Malvaceae	Shrub	Stem cutting
53.	*Homalocladium platycladum* (F. J. Muell. Ex Hook.) L. H. Bailey	Polygonaceae	Herb	Stem cutting

54.	*Ipomoea batatas* Linn.	Convolvulaceae	Herb	Tuber/Stem cutting
55.	*Jasmium gratiflorum* Linn.	Oleaceae	Herb	Stem cutting,
56.	*Justicia gendarussa* Burm.f.	Acanthaceae	Shrub	Stem cutting
57.	*Kalanchoe laciniata* Linn.	Crassulaceae	Herb	Leaf
58.	*Kalanchoe pinnata* (Lam.) Pers.	Crassulaceae	Herb	Leaf
59.	*Lippa javanica* (Burm.f.) Spreng.	Verbenaceae	Shrub	Stem cutting
60.	*Mentha arvensis* Linn.	Lamiaceae	Herb	Stem cutting
61.	*Mentha piperata* Linn.	Lamiaceae	Herb	Stem cutting
62.	*Mimosa pudica* Linn.	Fabaceae	Herb	Seed
63.	*Mirabilis jalapa* Linn.	Nyctaginaceae	Herb	Seed
64.	*Moringa oelifera* Lam.	Moraceae	Tree	Seed/stem cutting
65.	*Morus alba* Linn.	Moraceae	Shrub	Seed
66.	*Murraya paniculata* (L.) Jack	Rutaceae	Shrub	Stem cutting
67.	*Musa paradicica* Linn.	Musaceae	Herb	Rhizome
68.	*Nerium indicum* F. Le. Makino	Apocynaceae	Herb	Seed/Stem cutting
69.	*Nyctanthus arbortristis* Linn.	Nyctaginaceae	Shrub	Stem cutting
70.	*Ocimum gratissimum* Linn.	Oxalidaceae	Herb	Stem cutting
71.	*Ocimum kilimandscharicum* Linn.	Lamiaceae	Herb	Stem cutting
72.	*Paederia foetida* Linn.	Rubiaceae	Herb/ climber	Stem cutting
73.	*Pandanus tectorius* Soland. Ex.	Pandanaceae	Shrub	Root bud
74.	*Passiflora edulis* Sims.	Passifloraceae	Herb/ Climber	Stem cutting
75.	*Pedalium murex* Linn.	Pedaliaceae	Herb	Buds
76.	*Pedilanthus tithymaloides* (Linn.) Poit.	Euphorbiaceae	Herb	Stem cutting
77.	*Piper betle* Linn.	Piperaceae	Herb/ Climber	Stem cutting
78.	*Piper longum* Linn.	Piperaceae	Herb/ Climber	Stem cutting
79.	*Plectranthus amboinicus* (Lour.) Spreng.	Lamiaceae	Herb	Stem cutting
80.	*Plumbago zeylanica* Linn.	Plumbaginaceae	Herb	Seed/ Stem cutting
81.	*Plumeria rubra* Linn.	Apocynaceae	Shrub	Stem cutting
82.	*Polyanthus tuberosa* Linn.	Amaryllidaceae	Herb	Bulb
83.	*Quisqualis indica* Linn.	Combrataceae	Herb/ Climber	Stem Cutting
84.	*Rauvolfia serpentina* Benth.ex Kurz	Apocynaceae	Herb	Seed/Stem cutting
85.	*Rauvolfia tetraphylla* Linn.	Apocynaceae	Herb	Seed/Stem cutting
86.	*Sansevieria roxburghiana* Schult. & Schult. F.	Agavaceae	Herb	Rhizome
87.	*Solanum nigrum* Linn.	Solanaceae	Herb	Seed/Stem cutting
88.	*Stevia rebaudiana* (Bert.) Bertoni.	Asteraceae	Herb	Seed
89.	*Synadenium grantii* Hook. F.	Euphorbiaceae	Shrub	Stem cutting
90.	*Tabernaemontana coronera*	Apocynaceae	Shrub	Stem cutting
91.	*Tagetes patula* Linn.	Asteraceae	Herb	Seed/Stem cutting
92.	*Thevetia peruviana (Pers.)* Schum.	Apocynaceae	Shrub	Seed/Stem cutting
93.	*Tinospora cordifolia* (Willd.) Miers.	Menispermiaceae	Herb /Climber	Seed
94.	*Urginea indica* Roxb.	Liliaceae	Herb	Bulb
95.	*Vetiveria zizanioides* (Linn.) Nash	Poaceae	Herb	Seed/Root bud
96.	*Vitex negundo* Linn.	Verbenaceae	Tree	Stem cutting
97.	*Vitis vinifera* Linn.	Vitaceae	Herb/ Climber	Stem cutting
98.	*Woodfordia fruticosa* (L.) Lurz.	Lytharaceae	Shrub	Stem cutting
99.	*Zephyranthes rosea* Lindl.	Amaryllidaceae	Herb	Bulb
100.	*Zinziber officinale* Rose.	Zinzaberaceae	Herb	Rhizome

Results & Discussion

Results of the present study recorded in Table -1 followed by Botanical names, Family, Habit and propagation of the Medicinal and Aromatic plants individually. Variations of MAPs are shown in Table-2. Methods of Medicinal and Aromatic plants vegetative Propagation given in Table-3 and Table-4 is for habit variation of the 100 studied Medicinal and Aromatic plants (MAPs).

Under the present study hundred Medicinal and Aromatic plants belonging to 43 different families were selected and collected from different habit as well as of different families. Variable numbers of the plant species of individual families were studied like one - one member of the family Agavaceae, Asclepiadaceae, Chenopodiaceae, Combrataceae, Cyperaceae, Dioscoriaceae, Fabaceae, Hypoxidaceae, Lytharaceae, Menispermaceae, Oleaceae, Oxalidaceae, Pandanaceae, Passifloriaceae, Pedialiaceae, Plumbaginaceae, Polygonaceae, Rubiaceae, Rutaceae, Solanaceae, Sterculiaceae, were selected for above propagation and conservation purpose.

Two - Two plant species were propagated for the families

such as Apiaceae, Convolvulaceae, Crassulaceae, Lamiaceae, Malvaceae, Piperaceae, Poaceae, Scrophulariaceae, Verbenaceae and Vitaceae. Three - Three individuals of the Medicinal and Aromatic plants were studied for the families like Araceae, Nyctaginaceae. Four plants of the family Acanthaceae, Euphorbiaceae and Five species of the plants for family Asteraceae, Moraceae were experimented.

Eight species of family Apocynaceae and Lamiaceae were studied for above purpose and maximum 10 species of Zingiberaceae were taken under the study of their vegetative propagation. There are different modes for regeneration of the Medicinal and Aromatic plants were observed. Maximum 40 species of the MAPs were capable to reproduce their new individuals by using their Stem cutting. 22 plant species were vegetatively propagated by their Seed/Stem cutting. 13 species were propagated by their Rhizome.

Rest of the plants were propagated using their Bud, Bulb, Corm, Leaf, Rhizome/Stem cutting, Root bud, Tuber etc. A total of 64 herbs, 12 Herb/Climber, 20 Shrubs and 4 Tree species of the MAPs studied for their propagation and for further ex-situ conservation in Herbal Garden.

Table 2: Family wise variation of MAPs.

S. No.	Family	Total Number of the Plants
1.	Acanthaceae	4
2.	Agavaceae	1
3.	Amaranthaceae	3
4.	Apiaceae	2
5.	Apocynaceae	8
6.	Araceae	3
7.	Asclepiadaceae	1
8.	Asteraceae	5
9.	Burseraceae	1
10.	Chenopodiaceae	1
11.	Combrataceae	1
12.	Convolvulaceae	2
13.	Crassulaceae	2
14.	Cyperaceae	1
15.	Dioscoriaceae	1
16.	Euphorbiaceae	4
17.	Fabaceae	1
18.	Hypoxidaceae	1
19.	Lamiaceae	8
20.	Lamiaceae	2
21.	Liliaceae	7
22.	Lytharaceae	1
23.	Malvaceae	2
24.	Menispermiaceae	1
25.	Moraceae	5
26.	Nyctaginaceae	3
27.	Oleaceae	1
28.	Oxalidaceae	1
29.	Pandanaceae	1
30.	Passifloraceae	1
31.	Pedaliaceae	1
32.	Piperaceae	2
33.	Plumbaginaceae	1
34.	Poaceae	2
35.	Polygonaceae	1
36.	Rubiaceae	1
37.	Rutaceae	1
38.	Scrophulariaceae	2
39.	Solanaceae	1
40.	Sterculiaceae	1
41.	Verbenaceae	2
42.	Vitaceae	2
43.	Zingiberaceae	10
Total		100

Table 3: Vegetative Propagation methods of MAPs.

S. No.	Mode of Multiplication	Number
1.	Bud	2
2.	Bulb	6
3.	Corm	2
4.	Leaf	2
5.	Rhizome	13
6.	Rhizome/ Stem cutting	1
7.	Root bud	1
8.	Seed	5
9.	Seed/Buds	1
10.	Seed/Rhizome	1
11.	Seed/Root bud	1
12.	Seed/Stem cutting	22
13.	Seed/Tuber	1
14.	Stem Cutting	40
15.	Tuber/ Stem cutting	2
Total		100

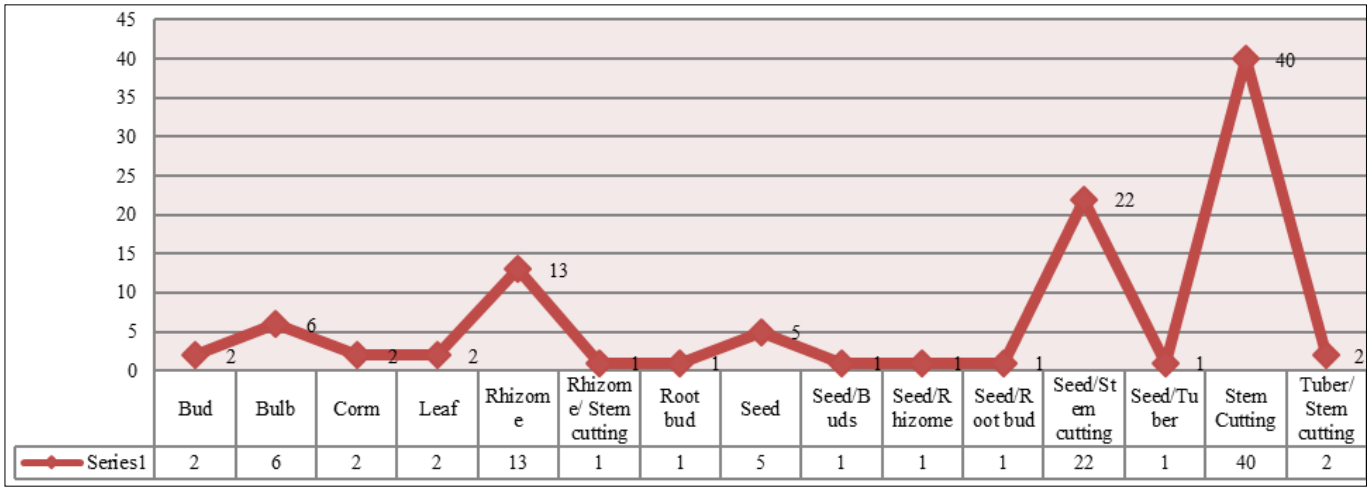

Fig 1: Vegetative propagation methods of MAPs.

Table 4: Habit Variation of MAPs.

S. No	Habit Type	Number of the Medicinal and Aromatic Plants
1	Herb	64
2	Herb/Climber	12
3	Shrub	20
4	Tree	4
Total		100

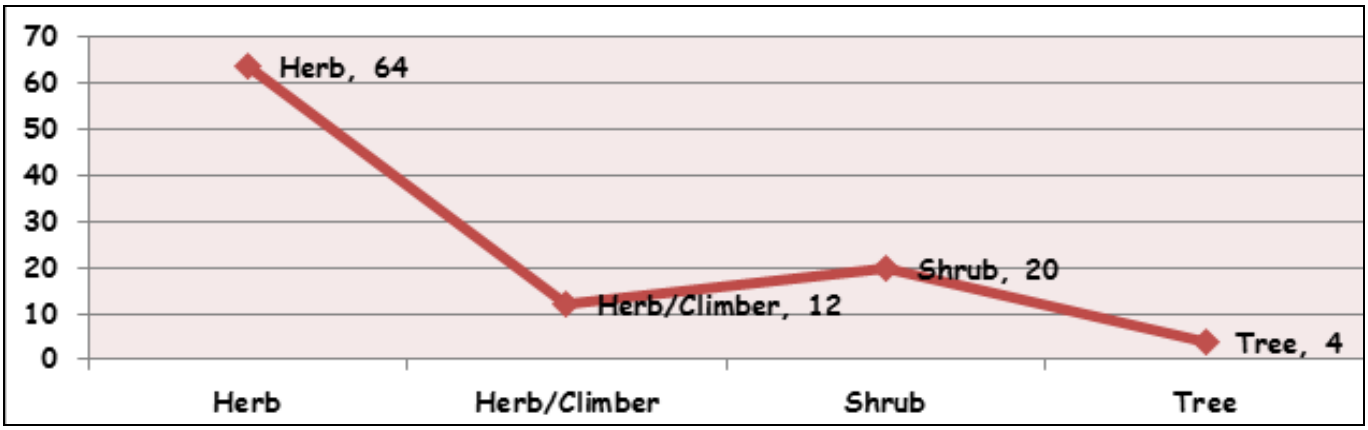

Fig 2: Habit Variation of MAPs.

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