

REVIEW

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# Cure and prevention of cardiovascular diseases: herbs for heart



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## Abstract

Herbs contribute to more than 60–70% in development of modern medicines in the world market either directly or indirectly. The herbal treatments for congestive heart failure, systolic hypertension, angina, atherosclerosis, cerebral insufficiency and venous insufficiency etc. has been known since ancient times. Unlike allopathic medicines, Ayurveda medicines are considered safe, however, the adverse reactions of herbal drugs is also reported. In this paper, we have compiled 128 herbs and their parts that have medicinal value to prevent, alleviate or cure heart disease related disorders. Jaccard Neighbour-joining cluster analysis using Free Tree software was used to assess the relative importance of plants in context with its healing potential for heart related disease. Based on the medicinal value in context with the heart, five major clusters of the selected 128 herbs were made. Correlation of the distance between herbs revealed that most of these herbs were found to have more than one medicinal property. The distance in dendrogram depicted closeness of properties curing heart disease; as less the distance between two medicinal plants or two groups they will more close to cure particular heart disease. During drug development, a medicinal plant can be replaced by another plant of same group or by another plant of its neighbour group but from same pedigree. Thus, in case of non-availability of herbs or if it belongs to the category of rare, threatened, and endangered species, such method may add to new ways of drug development.

**Keywords:** Healthcare, Herbs, Cardiovascular diseases, Hypertension, Herbal drugs

## Introduction

According to WHO, cardiovascular diseases (CVDs) kill 17.9 million people per year, accounting for 31% of all global deaths. Heart attacks and strokes account for 80% of CVD deaths [1]. Populations in low and middle income countries (LMICs) contribute 75% of the CVD deaths [2]. It is predicted that by 2030 more than 22.2 million people will die annually from CVDs. Due to high prevalence of CVD among older adults in LMIC, population with CVD has increased and become a major challenge in future for the health care system. The therapeutic potential of herbs in healthcare system is well known in all over the world whether it is for diseased state or proper maintenance of health [3, 4]. Since Ayurvedic medicines belong to natural sources, they are

considered safe compared with allopathic medicines. However, many adverse reactions of herbal drugs is also reported [5, 6]. Ayurvedic medicines can cause adverse effect if the patients continue to take medicines with no monitoring. Prolonged use or overdose of herbal medications lead to side effects e.g. high risk of cardiovascular events. A major drawback is the lack of information on the social and economic benefits on the industrial utilization of medicinal plants [7, 8]. The standard pharmacovigilance techniques (WHO guidelines) when applied presents challenges such as the ways in which herbal medicines are regulated, used, named, and perceived [9]. Very often patient undergo medication with Allopathic and Ayurvedic medicines simultaneously and dose-related responses are rarely measured and reported. Conventional pharmacovigilance tools, such as prescription-event monitoring and the use of computerized health record databases, for evaluating the safety of herbal medicines has limitations too. Reporting of

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adverse events possibly caused by herbal and traditional medicines in an extensive manner is needed for the systematic and rational use of drugs [9].

Since herbal medications do not require proof of efficacy and safety and there is lack of enough clinical data on herbal medication although, most of the herbs demonstrate an effect on biological mechanisms [10]. Clinical studies so far on herbal medications are limited in sample size and its impact on relevant clinical outcomes is not much studied. There is increased risk of side effects as it is not tested in pregnant women and children. Sometimes there is even contamination with other conventional medications and there also exists risk of drug interactions. Even substitution with alternative plant species is also reported. Enough and improved knowledge herbal medications is essential. Also, there should be transparency between patient- physician and possible benefits, side effects should be discussed. Thus, herbal drug development is possible only if there is development of standardized herbal products.

The present study was conducted to assess the relative importance of herbs that has medicinal potential to regulate heart and cure related disease. This may add to enhance drug discovery approaches for its promotion and development i.e. to generate safety data-either before or after marketing of the formulation.

## Materials and methods

Plants having medicinal properties for treatment of various heart diseases were extracted from secondary database search e.g. Google Scholar, PubMed and published research articles. Based on this, dataset of 128 different medicinal plants were further grouped and assessed for its relative medicinal potential to regulate and treat heart disease (Table 1 [12-27] <http://www.nmpb.nic.in/>, [https://en.wikipedia.org/wiki/Scutellaria#Traditional\\_use](https://en.wikipedia.org/wiki/Scutellaria#Traditional_use)). The percentage of plant parts used for the treatment of heart disease were further assessed (Fig. 1). Heart disease and the Plant uses were categorised in three parts: Plants used in only one diseases of heart, two disease of heart, three diseases of heart were grouped together (Table 2 [27]). Jaccard Neighbour-joining dendrogram were obtained through collected dataset of 128 different plants useful for heart disease ailment, computed performed with the help of Free Tree software version 0.9.1.50 and FigTree version 1.2.2. And mathematical consensus tree so obtained after 1000 replicates of bootstrap. Herbs were recorded as '1' for present or '0' for absent of a particular medicinal property related to heart. The objective of the cluster analysis was to develop sub grouping of plants on the basis of their properties to treat heart disease. This method of clustering not only clusters sample, but also it clusters various clusters that were formed earlier in the

clustering process. In this method, each sample or variable was treated as a cluster of 1 and the closest two clusters are joined to form a new cluster [28].

## Results

In this paper we have listed 128 plants, its habit and parts used for treatment of heart disease (Table 1). Comparative analysis of parts used of percentage of total plants showed that root and rhizome is the most frequently used plant parts followed by leaves, while gum being the least frequently used plant parts in context with ailment of heart disease (Fig. 1). The order (maximum to minimum) of plant parts used for heart disease ailment is root and rhizome-leaf-stem-flower-fruit and seed-other parts-gum (Fig. 1). Analysis of plants used for various types of heart diseases showed that only one plant i.e. *Crocus sativus L.* has the potential to cure five types of heart disease-hypertension, heart attack and reduction in blood fat, anti-oxidant and cardiac tonic thus indicating its relevancy in context with cardiovascular diseases (Table 2). Similarly, plants having medicinal property to cure four heart disease category were also few (Table 2). Maximum number of plants were found to be in category of curing only one heart disease type. Very few plants were observed to have medicinal property capable of treating multiple heart disease type (Table 2).

Cluster analysis based on Jaccard Neighbour-joining dendrogram using collected dataset of 128 herbs useful for heart with the help of Free Tree software version 0.9.1.50 and FigTree version 1.2.2. and mathematical consensus tree was obtained after 1000 replicates of bootstrap (Fig. 2). Five major clusters of the selected 128 herbs were observed on the basis of their medicinal value in context with heart. Within a cluster most of herbs showing similar properties and medicinal similarity negatively correlated with the cluster distance. Correlation of the distance between herbs also revealed that most of these herbs were found to have more than one medicinal property (Fig. 2).

## Discussion

A variety of modern medicines have been developed from herbs that are being used by native people [29]. Herb serve as both preventive and therapeutic purposes of many diseases. Use of herbs for cardiovascular diseases such as congestive heart failure, systolic hypertension, angina pectoris, atherosclerosis, cerebral insufficiency, and arrhythmia is prevalent since ancient time [30]. Herbs has been a continuing source for medicine e.g. antineoplastic drug paclitaxel derived from *Taxus brevifolia*, digitoxin from *Digitalis purpurea*, reserpine from *Rauwolfia serpentina* etc [1]. These herbs are used for treatment of cardiovascular diseases. Use of

**Table 1** List of plants, its habit and parts used for treatment of heart disease

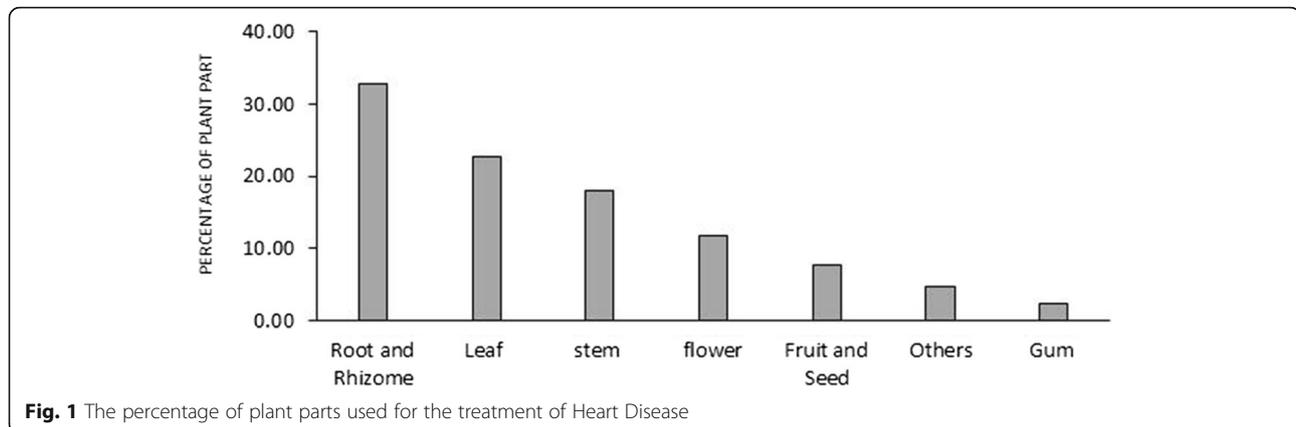
S. No.	Scientific name	Common name	Family name	Habit	Part used
1	<i>Achillea millefolium</i>	Common Yarrow	Asteraceae	Herb	Fruit (Seed)
2	<i>Acorus calamus</i>	Calamus	Acoraceae	Herb	Root (Rhizome)
3	<i>Actaea racemosa</i>	Black cohosh	Ranunculaceae	Herb	Leaf and stem ( <a href="http://www.nmpb.nic.in/">http://www.nmpb.nic.in/</a> )
4	<i>Allium sativum</i>	Garlic	Amaryllidaceae	Herb	Root
5	<i>Aloe vera</i>	Aloe vera	Asphodelaceae	Herb	Leaf
6	<i>Amomum subulatum</i> Roxb	Black cardamom	Zingiberaceae	Herb	Leaf, Seed, Fruit
7	<i>Anchusa italica</i> Retz.	Anchusa	Boraginaceae	Herb	Flowers
8	<i>Anethum graveolens</i>	Dill	Apiaceae	Herb	Fruit (Seed), Fruit
9	<i>Anthemis gayana</i> Boiss.	Mayweed	Asteraceae	Herb	Leaf and flower
10	<i>Apium graveolens</i>	Ajmoda	Apiaceae	Herb	Fruit
11	<i>Aquilaria agallocha</i> Roxb.	Agarwood	Thymelaeaceae	Tree	Stem Wood
12	<i>Arctium minus</i> hill.	Lesser burdock	Compositae	Herb	Root
13	<i>Bambusa arundinacea</i> Retz.	Bans	Poaceae	Shrub	Leaf
14	<i>Berberis darwinii</i>	Barbery	Berberidaceae	Herb	Rhizomes [11]
15	<i>Berberis integerrima</i>	Zerešk	Berberidaceae	Shrub	Fruit
16	<i>Berberis vulgaris</i>	Common barberry	Berberidaceae	Shrub	Fruit
17	<i>Boerhavia diffusa</i>	Puarnava	Nyctaginaceae	Herb	Root, Whole Plant
18	<i>Boswellia sacra</i>	Olibanum-tree	Burseraceae	Tree	Gum resin [12]
19	<i>Calamintha acinos</i> (L.) Clairv.	calamints	Lamiaceae	Herb	Aerial parts
20	<i>Calendula officinalis</i> L.	English marigold	Asteraceae	Herb	Flowers
21	<i>Camellia sinensis</i>	Tea	Theaceae	Shrub	Leaf
22	<i>Capsicum annuum</i>	Capsicum	Solanaceae	Herb	Fruit
23	<i>Carissa carandas</i> linn.	Karanda	Apocynaceae	Shrub	Fruit
24	<i>Carthamus tinctorius</i>	Safflower	Asteraceae	Herb	Fruit (Seed)
25	<i>Centaurea behen</i> L.	Behen	Compositae	Herb	Roots
26	<i>Centella asiatica</i> (L.) Urban	Gotu kola	Apiaceae	Herb	Leaf, Whole Plant
27	<i>Cichorium intybus</i>	Chicory	Asteraceae	Shrub	Flower, Leaf, Root, Fruit (Seed)
28	<i>Cinnamomum camphora</i> (L.)	Camphor tree	Lauraceae	Tree	Camphor
29	<i>Cinnamomum cassia</i> (L.)	Chinese cinnamon	Lauraceae	Herb	Bark
30	<i>Cinnamomum verum</i>	Cinnamon	Lauraceae	Tree	Bark (Stem), Leaf
31	<i>Citrus medica</i> L.	Citron	Rutaceae	Tree	Fruit
32	<i>Commiphora myrrha</i>	Myrrh	Burseraceae	Tree	Oleo-Gum Resin
33	<i>Commiphora wightii</i>	Guggul	Burseraceae	Tree	Oleo-Gum Resin, Stem, Root
34	<i>Coriandrum sativum</i>	Coriander	Apiaceae	Herb	Fruit, Leaf
35	<i>Crataegus monogyna</i>	Hawthorn	Rosaceae	Tree	Flower and Leaf
36	<i>Crataegus pontica</i> c. Koch.	Hawberry	Rosaceae	Tree	Fruit
37	<i>Crocus haussknechtii</i>	Autumn crocus	Iridaceae	Herb	whole plants [13]
38	<i>Crocus sativus</i> L.	Saffron	Iridaceae	Herb	Flowers
39	<i>Curcuma longa</i>	Turmeric	Zingiberaceae	Herb	Root (Rhizome, Tuber)
40	<i>Curcuma zedoaria</i> (Bergius)	Zedoary	Zingiberaceae	Herb	Rhizome
41	<i>Ecbalium elaterium</i>	Squirting cucumber	Cucurbitaceae	Herb	Fruit
42	<i>Eclipta prostrata</i>	Bhringraj	Asteraceae	Herb	Whole Plant
43	<i>Elettaria cardamom</i>	Cardamom	Zingiberaceae	Herb	Fruit (Fruit, Seed)

**Table 1** List of plants, its habit and parts used for treatment of heart disease (*Continued*)

S. No.	Scientific name	Common name	Family name	Habit	Part used
44	<i>Falcaria vulgaris</i>	Sickleweed	Apiaceae	Herb	Leaf, flower and Stem
45	<i>Fragaria vesca L.</i>	Alpine strawberry	Rosaceae	Herb	Leaf, rhizome and Fruit
46	<i>Garcinia indica choisy</i>	Amsul	Clusiaceae	Tree	Fruit (Fruit, Peel)
47	<i>Garcinia cambogia (gaertn.) Desr.</i>	Citrin	Clusiaceae	Tree	Leaves and fruits [14]
48	<i>Garcinia pedunculata roxb.</i>	Amlavettas	Clusiaceae	Tree	Fruit
49	<i>Genus panax</i>	Ginseng	Araliaceae	Shrub	Root [15]
50	<i>Ginkgo biloba</i>	Ginkgo	Ginkgoaceae	Tree	Leaves [16]
51	<i>Gmelina asiatica linn.</i>	Badhar	Lamiaceae	Tree	Bark (Root)
52	<i>Gundelia tournefortii</i>	Gundelia	Asteraceae	Herb	Leaf
53	<i>Inula helenium</i>	Elecampane	Asteraceae	Shrub	Whole plant [17]
54	<i>Juniperus communis</i>	Common juniper	Cupressaceae	Tree	Fruit
55	<i>Lactuca sativa</i>	Garden lettuce	Asteraceae	Herb	Leaf
56	<i>Lavandula stoechas L.</i>	French lavender	Lamiaceae	Herb	Aerial parts and flowers
57	<i>Leonurus cardiac</i>	Motherwort	Lamiaceae	Herb	Whole plant [18]
58	<i>Magnifera indica linn.</i>	Aam	Anacardiaceae	Tree	Fruit
59	<i>Malus domestica Baumg.</i>	Table apple	Rosaceae	Tree	Peels and fruits
60	<i>Malva neglecta</i>	Common mallow	Malvaceae	Herb	Leaf and Stem
61	<i>Medicago sativa</i>	Alfalfa leaves	Fabaceae	Herb	Leaf
62	<i>Melilotus indicus</i>	Sweet clover	Fabaceae	Herb	Leaf
63	<i>Melissa officinalis L.</i>	Lemon Balm	Lamiaceae	Herb	Aerial parts and leaf
64	<i>Mentha × piperita L.</i>	Peppermint	Lamiaceae	Herb	Leaf
65	<i>Mentha spicata</i>	Spearmint	Lamiaceae	Herb	Leaf
66	<i>Myristica fragrans</i>	Nutmeg	Myristicaceae	Tree	Fruit
67	<i>Nardostachys jatamansi</i>	Jatamamsi	Caprifoliaceae	Herb	Root (Rhizome)
68	<i>Nectaroscordum tripedale</i>	Avon Bulbs	Amaryllidaceae	Herb	Flowers [19]
70	<i>Nerium oleander L.</i>	Nerium	Apocynaceae	Shrub	Leaf and flower
71	<i>Nigella sativa</i>	Black-caraway	Ranunculaceae	Herb	Fruit (Seed)
72	<i>Nymphaea alba L.</i>	White nenuphar	Nymphaeaceae	Herb	Flowers
73	<i>Ocimum basilicum</i>	Basil	Lamiaceae	Herb	Leaf, Whole Plant, Root, Fruit (Seed)
74	<i>Olea europaea</i>	Olive	Oleaceae	Tree	Seeds
75	<i>Paeonia officinalis L.</i>	Common peony	Paeoniaceae	Herb	Roots
76	<i>Paliurus spina-christi miller.</i>	Christ's thorn jujube	Rhamnaceae	Tree	Fruit
77	<i>Phyllanthus emblica L.</i>	Amla	Phyllanthaceae	Tree	Fruits and Leaves, branches, barks
78	<i>Picrorrhiza kurroa</i>	Katuka	Plantaginaceae	Herb	Root
79	<i>Piper longum</i>	Long pepper (pippali)	Piperaceae	Herb	Root, Fruit
80	<i>Piper nigrum</i>	Black pepper	Piperaceae	Herb	Stem, Fruit
81	<i>Pistacia vera L.</i>	Pistachio	Anacardiaceae	Tree	Seed [20]
82	<i>Polypodium vulgare L.</i>	Common polypody	Polypodiaceae	Herb	Roots
83	<i>Portulaca oleracea</i>	Common purslane	Portulacaceae	Herb	Fruit (Seed), Whole Plant
84	<i>Prunus scoparia (spach) schneider</i>	Wild almond	Rosaceae	Shrub	Seed [21]
85	<i>Pterocarpus santalinus L.f.</i>	Red sandalwood	Fabaceae	Tree	Bark and wood

**Table 1** List of plants, its habit and parts used for treatment of heart disease (Continued)

S. No.	Scientific name	Common name	Family name	Habit	Part used
86	<i>Punica granatum</i> linn	Anardana	Lythraceae	Shrub	Flower, Fruit (Fruit, Seed)
87	<i>Pyrus communis</i> L.	European pear	Rosaceae	Tree	leaves and bark and fruit [22]
88	<i>Rheum ribes</i>	Rhubarb of babilonia	Polygonaceae	Herb	Stem
89	<i>Rhus coriaria</i>	Sicilian sumac	Anacardiaceae	Shrub	Leaf and Fruit
90	<i>Rosa canina</i>	Dog rose	Rosaceae	Shrub	Flowers
91	<i>Rosa damascena</i> Mill.	Damask rose	Rosaceae	Shrub	Flowers
92	<i>Rubus caesius</i>	European dewberry	Rosaceae	Shrub	Fruit and Leaf
93	<i>Rumex crispus</i>	Curly dock	Polygonaceae	Herb	Fruit and leaf
94	<i>Ruscus aculeatus</i>	Butcher's broom	Asparagaceae	Shrub	Whole plant [23]
96	<i>Santalum album</i> L.	Indian sandalwood	Santalaceae	Tree	Bark and wood
97	<i>Scutellaria pekinensis</i>	Skullcap	Lamiaceae	Herb	Root [24]
98	<i>Senna alexandrina</i> mill	Senna	Fabaceae	Herb	Leaf, Fruit (Fruit, Seed)
99	<i>Sesamum indicum</i>	Sesame	Pedaliaceae	Tree	Leaf and Wood
100	<i>Silybum marianum</i>	Cardus marianus	Asteraceae	Herb	Fruit (Seed)
101	<i>Smyrniun cordifolium</i>	Smyrniun	Apiaceae	Herb	Seed
102	<i>Strychnos nux-vomica</i>	Vishatinaduka	Loganiaceae	Tree	Fruit (Seed), Stem Or Bark
103	<i>Suaeda aegyptiaca</i>	Suaeda	Amaranthaceae	Herb	Leaf
104	<i>Symplocos racemosa</i> Roxb.	Symplocos	Symplocaceae	Shrub	Bark [25]
105	<i>Tamarindus indica</i> L.	Tamarind	Fabaceae	Tree	Leaf and fruit
106	<i>Taraxacum officinale</i>	Dandelion	Asteraceae	Herb	Root (Rhizome)
107	<i>Taxus baccata</i>	Yew	Taxaceae	Shrub	Leaf
108	<i>Terminalia arjuna</i> (roxb.)	Arjuna	Combretaceae	Tree	Fruit (Seed), Bark (Stem)
109	<i>Terminalia chebula</i> Willd. ex	Myrobalan	Combretaceae	Tree	Fruits
110	<i>Terminalia horrida</i> Stoud.	Terminalia	Santalaceae	Tree	Fruits
111	<i>Thymus serpyllum</i> L.	Breckland thyme	Lamiaceae	Herb	Areal part
112	<i>Trachyspermum ammi</i>	Ajwain	Apiaceae	Herb	Fruit
113	<i>Tragopogon porrifolius</i>	Yellow salsify	Asteraceae	Herb	Root [26]
114	<i>Trigonella foenum-graecum</i>	Fenugreek	Fabaceae	Herb	Fruit (Seed)
115	<i>Ulmus glabra</i> Hudson.	Scotch elm	Ulmaceae	Tree	Leaf
116	<i>Urtica dioica</i>	Nettle	Urticaceae	Herb	Leaf and branches
117	<i>Usnea barbata</i> Ach.	Usnea barbata	Parmeliaceae	Herb	Filaments
118	<i>Valeriana officinalis</i>	Valerian	Caprifoliaceae	Herb	Fruit
120	<i>Vitis vinifera</i>	Grape vine	Vitaceae	Shrub	Fruit
121	<i>Withania somnifera</i>	Ashwagandha	Solanaceae	Herb	Root, Whole Plant
122	<i>Zingiber officinale</i>	Sondh	Zingiberaceae	Herb	Root, Whole Plant
123	<i>Zingiber officinale roscoe</i>	Ginger	Zingiberaceae	Herb	Root, Whole Plant
124	<i>Zingiber zerumbet</i> (L.) Sm.	Lempoyang	Zingiberaceae	Herb	Pseudo-stem ( <a href="https://en.wikipedia.org/wiki/Scutellaria#Traditional_use">https://en.wikipedia.org/wiki/Scutellaria#Traditional_use</a> )
125	<i>Ziziphus jujuba</i> (l) h.karst	Indian date	Rhamnaceae	Tree	Fruit
127	<i>Ziziphus nummularia</i>	Jhar ber	Rhamnaceae	Shrub	Flower, leaf and Fruit
128	<i>Ziziphus spina-christi</i>	Thorn jujube	Rhamnaceae	Tree	Leaf and Stem



herbal medicine though exist since past decade, this system of medicine has several lacunae. For example, herbal medicine lack scientific evidence or assessment. Many of the herbal medicines have toxic effects and major drug-drug interactions too. Therefore, in-depth research is needed to understand the pharmacological activity of the herbs. In this paper, cluster analysis of the potential herbs for heart with its ability to treat various heart related diseases was done to understand the possible combination of the herbs that may help in the development of more effective drug formulation that the existing one. As mentioned in the results section, almost every part of the herb has a medicinal property, although root and rhizome is most frequently used plant parts.

Herbs have more than one medicinal property i.e. it has the potential to prevent or cure more than one disease as demonstrated in our results. For example, only one herb *Crocus sativus* L. was found to have medicinal property with the potential to treat five heart disease type-hypertension, heart attack, reduction in blood fat, anti-oxidant, and cardiac tonic. Role of this herb against cardiovascular diseases is related to their antioxidant and anti-inflammation effects [31]. *Crocus sativus* is found to have antihypertensive and normalizing effect on blood pressure [32]. It is known to possess a potent inhibitory effect on heart rate and contractility of guinea pig heart via calcium channel-blocking effect [33]. Other studies also support cardiovascular effects of saffron and its components [34].

Three herbs-*Citrus medica* L., *Crataegus monogyna*, *Elettaria cardamom* possess medicinal property with the potential to treat four heart disease type. *Citrus medica* L. “Otroj” (Brain citron), is a member of Rutaceae family. Evidence supports its cardioprotective potential due to its potent antioxidant and free radical scavenging activity [35]. *Crataegus* species is shown to represent a safe, effective, nontoxic agent in the treatment of cardiovascular disease and ischemic heart disease (IHD) [36]. Its mechanism of action include direct scavenging of reactive

oxygen species, enhanced superoxide dismutase, and catalase activities, antioxidant activity, down regulation of caspase 3 gene etc. [36]. *Crataegus monogyna* are rich in polyphenols and both of its leaves and flowers or alternatively the fruit are used medicinally [37]. It helps to regulate both high and low blood pressure, in addition to slowly breaking down cholesterol and fat deposits in the body [37]. It increases conversion rates of LDL or “bad” cholesterol into HDL or “good” cholesterol in the liver and improves blood and oxygen supply to the heart muscle. In cases of congestive heart failure and circulatory disorders, *Hawthornis* is prominently being used in a holistic approach to heal the body itself [37]. It plays a role in alleviating irritation and swelling of the blood vessels. Study has shown that small cardamom *Elettaria cardamom* effectively lowers blood pressure, increases fibrinolysis, and boosts antioxidant status in stage 1 hypertensive patients without affecting blood lipids or fibrinogen levels [38]. A rat study has also demonstrated the ability of cardamom oil to restore lipid homeostasis in the presence of hypercholesterolemia [39]. This study has shown reduction in atherogenicity index by dietary intervention with cardamom powder and cardamom oil hence, the cardioprotective potential of cardamom [39]. The bark of *Terminalia arjuna* has been demonstrated to show cardioprotective effects against doxorubicin induced cardiotoxicity by increased coronary artery flow and protection of myocardium against ischemic damage [40]. *Terminalia chebula* pericap has also been reported to have cardioprotective activity [41].

The dendrogram obtained for 128 medicinal plants by Jaccard Neighbour joining dendrogram method depicts 128 different medicinal plants having property to cure some type of heart disease/ailment. The medicinal plants in one group showed to have similar properties to cure same heart disease. The distance in dendrogram depicts closeness of the properties curing the heart disease; less the distance between two medicinal plants or two groups, the more it is closer to cure particular

**Table 2:** Heart disease and the Plant Uses (A-C)**A. Plants used in only one disease of heart**

Reduction of blood pressure	<i>Achillea millefolium</i> , <i>Ecbalium elaterium</i> , <i>Falcaria vulgaris</i> , <i>Prunus scoparia</i> (spach) Schneider, <i>Berberis integrima</i> , <i>Crocus haussknechtii</i> , <i>Olea europaea</i> , <i>Silybum marianum</i> , <i>Smyrniium cordifolium</i> , <i>Taxus baccata</i> , <i>Tragapogon caricifolius</i> , <i>Ziziphus nummularia</i>
Angina	<i>Actaea racemosa</i> , <i>Camellia sinensis</i> , <i>Garcinia cambogia</i> (gaertn.) Desr., <i>Genus panax</i> , <i>Ginkgo biloba</i> , <i>Medicago sativa</i> , <i>Ruscus aculeatus</i>
Anti-oxidant	<i>Amomum subulatum</i> Roxb, <i>Anchusa italica</i> Retz., <i>Bambusa arundinacea</i> Retz., <i>Boerhavia diffusa</i> , <i>Boswellia carteri</i> Birdw., <i>Calamintha acinos</i> (L.) Clairv., <i>Centaurea behen</i> L., <i>Cinnamomum cassia</i> (L.), <i>Curcuma zedoaria</i> (Bergius), <i>Lavandula stoechas</i> L., <i>Pistacia vera</i> L., <i>Pterocarpus santalinus</i> L.f., <i>Rosax damascena</i> Mill., <i>Symplocos racemosa</i> Roxb., <i>Tamarindus indica</i> L., <i>Terminalia horrida</i> Stoud., <i>Usnea barbata</i> Ach., <i>Zingiber zerumbet</i> (L.) Sm.
Treatment of blocked arteries	<i>Anthemis gayana</i> Boiss.
Cardio myopathies	<i>Apium graveolens</i> , <i>Strychnos nux-vomica</i>
Blood purification	<i>Arctium minus hill</i> , <i>Juniperus communis</i> , <i>Malva neglecta</i> , <i>Portulaca oleracea</i> , <i>Rhus coriaria</i> , <i>Rosa canina</i> , <i>Rubus caesius</i> , <i>Suaeda aegyptiaca</i>
Congenital heart disease	<i>Carissa carandas</i> linn., <i>Garcinia indica choisy</i> , <i>Garcinia pedunculata roxb.</i> , <i>Gmelina asiatica linn.</i> , <i>Magnifera indica linn.</i>
Heart attack	<i>Carthamus tinctorius</i> , <i>Inula helenium</i>
Hypertension	<i>Centella asiatica</i> (L.) Urban, <i>Cinnamomum verum</i> , <i>Crataegus pontica</i> c. Koch., <i>Myristica fragrans</i> , <i>Nigella sativa</i> , <i>Paeonia officinalis</i> L., <i>Paliurus spina-christi miller</i> , <i>Piper longum</i> , <i>Piper nigrum</i> , <i>Scutellaria pekinensis</i> , <i>Terminalia arjuna</i> (roxb.), <i>Withania somnifera</i> , <i>Zingiber officinale</i>
Reduction in blood fat	<i>Coriandrum sativum</i> , <i>Gundelia tournefortii</i> , <i>Lactuca sativa</i> , <i>Mentha spicata</i> , <i>Polypodium vulgare</i> L., <i>Senna alexandrina mill</i> , <i>Sesamun indicum</i> , <i>Trigonella foenum-graecum</i> , <i>Urtica dioica</i>
Nourishing of the heart	<i>Fragaria vesca</i> L.
Increase in venous blood	<i>Melilotus indicus</i>
Cardiac tonic	<i>Nerium oleander</i> L.
Cardiac disorders and arrhythmias	<i>Ulmus glabra</i> Hudson.

**B. Plants used in two diseases of heart**

Hypertension, heart attack	<i>Acorus calamus</i> , <i>Aloe vera</i> , <i>Commiphora myrrha</i> , <i>Leonurus cardiac</i> , <i>Picrorrhiza kurroa</i>
Reduction of blood pressure, reduction in blood fat	<i>Anethum graveolens</i>
Anti-oxidant, cardiac tonic	<i>Aquilaria agallocha</i> Roxb.
Angina, hypertension	<i>Berberis darwinii</i> , <i>Capsicum annum</i> , <i>Valeriana officinalis</i>
Reduction of blood pressure, blood purification	<i>Berberis vulgaris</i> , <i>Ziziphus spina-christi</i>
Reduction in blood fat, anti-oxidant	<i>Calendula officinalis</i> L., <i>Melissa officinalis</i> L., <i>Melissa officinalis</i> L., <i>Mentha × piperita</i> L.
Blood purification, reduction in blood fat	<i>Cichorium intybus</i>
Angina, anti-oxidant	<i>Cinnamomum camphora</i> L.
Angina, heart attack	<i>Commiphora wightii</i>
Blood purification, reduction in blood fat	<i>Eclipta prostrata</i>
Reduction in blood fat, anti-oxidant	<i>Malus domestica Baumg.</i> , <i>Trachyspermum ammi</i>
Reduction of blood pressure, treatment of hypolipidemia	<i>Nectaro scordeum tripedale</i>
Reduction of blood pressure, anti-oxidant	<i>Nymphaea alba</i> L.
Hypertension, cardiac tonic	<i>Phyllanthus emblica</i> L.
Hypertension, anti-oxidant	<i>Pyrus communis</i> L., <i>Rheum ribes</i> , <i>Thymus serpyllum</i> L.
Hypertension, reduction in blood fat	<i>Santalum album</i> L., <i>Vitis vinifera</i>
Angina, reduction in blood fat	<i>Zingiber officinale roscoe</i>

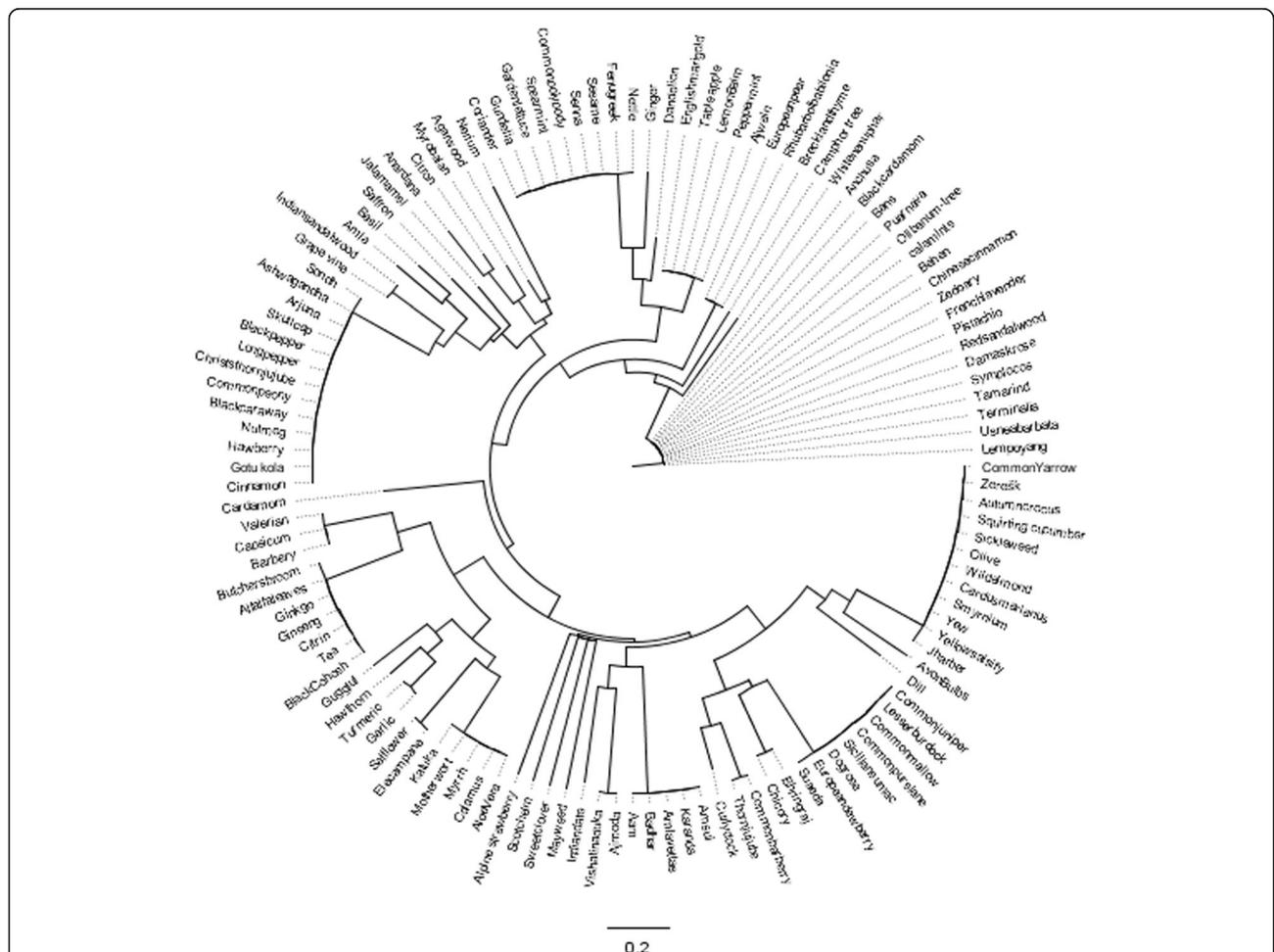
**C. Plants used in three diseases of heart**

Angina, hyper-tension, heart attack	<i>Allium sativum</i> , <i>Curcuma longa</i>
Hypertension, anti-oxidant, cardiac tonic	<i>Nardostachys jatamansi</i>
Hypertension, reduction in blood fat, cardiac tonic	<i>Ocimum basilicum</i>
Congenital heart disease, reduction in blood fat, cardiac tonic	<i>Punica granatum</i> linn
Reduction of blood pressure, blood purification, reduction in blood fat	<i>Rumex crispus</i>
Angina, reduction in blood fat, anti-oxidant	<i>Taraxacum officinale</i>

**Table 2:** Heart disease and the Plant Uses (A-C) (Continued)

Reduction in blood fat, anti-oxidant, cardiac tonic	<i>Terminalia chebula Willd. ex</i>
Cardio myopathies, congenital heart disease, reduction of blood pressure	<i>Ziziphus jujuba(l) h.karst</i>
<b>D. Plants used in four diseases of heart</b>	
Congenital heart disease, reduction in blood fat, anti-oxidant, cardiac tonic	<i>Citrus medica L.</i>
Angina, hypertension, heart attack, nourishing of the heart,	<i>Crataegus monogyna,</i>
Hypertension, cardio myopathies, reduction of blood pressure, anti-oxidant	<i>Elettaria cardamom</i>
<b>E. Plants used in five diseases of heart</b>	
Hypertension, heart attack, reduction in blood fat, anti-oxidant, cardiac tonic	<i>Crocus sativus L.</i>

(Source: Babak Baharvand-Ahmadi Pathophysi et. al., 2017 [27])



**Fig. 2** The dendrogram depicts 128 different medicinal plants having property to cure some type of heart disease/ailment. The medicinal plants in one group shows that they have similar properties to cure same heart disease. The distance in dendrogram depicts closeness of properties curing heart disease; as less the distance between two medicinal plants or two groups they will more close to cure particular heart disease

heart disease. During drug development, a medicinal plant can be replaced by another plant of same group or by another plant of its neighbour group but from same pedigree (like garlic, turmeric and safflower) on the basis of their similar properties of curing that particular heart disease. Thus, in case of non-availability of the herbs or if it belongs to the category of rare, threatened, and endangered species, such method may add to new ways of drug development. During drug development, if any medicinal plant shows adverse effect, it can be replaced by a plant with similar medicinal potential, suitable for the same drug composition based on cluster analysis.

Generally, herbal medicines is considered harmless as it is derived from natural sources, however, adverse reaction of herbal medicines is also reported. For example, bleeding is the adverse effect of the herbal drug, Ginkgo biloba. Similarly, gastrointestinal disturbances, allergic reactions, fatigue, dizziness, confusion, dry mouth, photosensitivity are the adverse effect of the herbal drug St. John's wort. Lack of information on the social and economic benefits on the industrial utilization of medicinal plants is the major drawback in development of the medicinal plant-based industries in developing countries [7, 8].

Medicinal plants are the oldest known health-care products and its importance in the primary health care of individuals and communities in both developed as well as developing countries is increasing. However, further research is needed to find compounds of interest in these plants that can be used as safe and effective medicines to treat heart disease.

## Conclusion

More scientific research on these plants is needed in order to find new drugs for the treatment of cardiovascular diseases that have no or few side effects.

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## Authors' contributions

Suman Ray has provided the concept of the manuscript and written the draft of the manuscript. Tables, Figures and analysis was contributed by Mahesh Kumar Saini. Both authors read and approved the final manuscript.

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The authors declare that they have no competing interests.

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