



Golden Camellias: A Review

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Authors' contributions

This work was carried out in collaboration among all authors. Authors TVD, TDM, NTT, HTS, DVT, PDT, NVT, DTD, MTL, VTL, NHT and NTTP managed the literature searches. Author TVD wrote the first draft of the manuscript. All authors read and approved the final manuscript.

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ABSTRACT

Golden camellias or yellow camellias are species belonging to genus *Camellia* L., family Theaceae. Fifty two species were described in southern China and Vietnam. Active ingredients such as polysaccharides, polyphenols, saponins, and flavonoids are well known characteristics of golden camellias. Its leaves and flowers have been long traditionally used for health improvement. It was found to be able to inhibit transplanted cancer, lower blood pressure, lower blood lipid, lower cholesterol, and prevent atherosclerosis. Currently, it costs 320–700US\$ per one kg of dry flowers. Such price attracts many local ethnic people to plant golden camellias for poverty reduction. This

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work reviews (1) species and natural distribution, (2) uses and healthcare values, (3) techniques for seedling production, planting and tending, and (4) opportunities and challenges for future development of golden camellias.

Keywords: Active ingredient; *Camellia L.*; poverty reduction; shade-tolerant species; yellow flower.

1. INTRODUCTION

Golden camellias or yellow camellias distribute in southern China and Vietnam. It has been used as traditional medicines for health improvement. In recent years, researches on physiologically active ingredients in leaves and flowers of golden camellias have been widely conducted. Techniques on seedling production, planting, and tending have been studied. In the market, it costs 320–700US\$ per one kg of dry flowers. Such price attracts local people to plant golden camellias for poverty reduction. This review summarizes researching results and raises opportunities and challenges for future development of golden camellias.

2. SPECIES AND NATURAL DISTRIBUTION

Golden camellias are shrubs and small-sized trees belonging to genus *Camellia* L. [1], family Theaceae [2-8]. Golden camellias have light to heavy yellow flowers and are 3–12 m tall at maturity in natural distribution conditions. The sizes of flower are different among species from 1 to 10 cm in diameter (Fig. 1). About 52 species (Table 1) of golden camellias have been described in southern China and Vietnam. Of which, nearly 40 species have natural distribution in Vietnam.

Golden camellias distribute in natural evergreen broadleaved forests [3-4,7-14], where there are no or some trees shedding full leaves in winter/dry season. Golden camellias are shade-tolerant species, which can only grow well under shading condition in whole life. The species are usually found in natural forests with canopy cover of 30–80%. Generally, golden camellias distribute in elevation zone of 100-1,000 m above sea level, mainly focusing on elevation of 300–700 m. The species prefer growing in high moisture soil and high air humidity areas. Therefore, they are usually found in valleys, near streams, and water bodies. In some cases, trees are also found in dry soil, where they grow badly and are in small size.

Like other species in genus *Camellia* L., golden camellias have big-sized seeds, which are mainly

dispersed by gravity [8,13,15]. Therefore, seedlings are usually found under or near crown of mother trees. If mother trees are found in upper slope then seedlings may be found further from mothers in downslope. In natural forests, seedlings/saplings (<1 m tall) may be found numerous however, number of adults (>2 m tall) are limited [16]. As a result, natural regenerations will be low, because of low competition capacity of golden camellia seedlings to surrounding vegetation. This may lead to threatened status of some species [17]. Golden camellias are found to have clustered distribution in nature. For the adult individuals, stems distributing in high forest cover areas have less number of flowers than stems distributing in low forest cover areas (high sunlight areas). Generally in areas with high rate of sunlight flowers are more yellow than that in low sunlight areas [15]. This may indicate the importance of sunlight in forming buds and flowers of golden camellias. Therefore, canopy should be open in plantations of golden camellias for higher flower productivity and quality.

Golden camellias have shallow root system and limited number of fine roots (roots with diameter ≤ 2 mm), which absorb water and nutrient for tree's life [18]. Such characteristic may result in low competition capacity for moisture, nutrients, and tree's anchoring. Therefore, tending should be conducted carefully at seedling stage to minimize competition, which may result in higher survival rate of seedlings. In addition, seeds of golden camellias are also food for rodents and other wildlife, this may cause low seedling density in nature.

3. USES AND HEALTHCARE VALUES

Like green tea (*Camellia sinensis*), golden camellias have been traditionally used to make tea for its beneficial properties and dry flowers are used more frequently than leaves [15]. Both fresh and dry flowers and leaves can be used. However, dry products are preferred as they can be stored for a long time. Flowers are also soaked in alcohol, which is reported to improve health for drinkers. Recently, some cosmetics are made from flower and leaf extracts of golden

camellias such as golden silk oil, organic golden camellia oil, and facial cream.

Species in genus *Camellia* contain a variety of physiologically active ingredients as

polysaccharides, polyphenols, saponins, and flavonoids [19-22]. Clinical findings showed that the camellias could inhibit transplanted cancer, lower blood pressure, lower blood lipid and lower cholesterol, and prevent atherosclerosis [23-24].

Table 1. List of 52 golden camellias

No.	Scientific name	No.	Scientific name
1	<i>Camellia achrysantha</i> Hung T. Chang & S. Ye Liang	27	<i>Camellia longruiensis</i> S. Y. Liang & X. J. Dong
2	<i>Camellia aurea</i> H.T. Chang	18	<i>Camellia longzhouensis</i> J.Y. Luo
3	<i>Camellia chrysantha</i> (Hu) Tuyama	29	<i>Camellia megasepala</i> Hung T. Chang & Trin Ninh
4	<i>Camellia chrysanthoides</i> H.T. Chang (<i>C. xiashiensis</i> ; <i>C. longzhouensis</i>)	30	<i>Camellia micrantha</i> S. Ye Liang & Y. C. Zhong
5	<i>Camellia crassiphylla</i> Ninh & Hakoda	31	<i>Camellia multipetala</i> S. Ye Liang & C. Z. Deng
6	<i>Camellia cucphuongensis</i> Ninh & Rosmann	32	<i>Camellia murauchii</i> Ninh & Hakoda
7	<i>Camellia dalatensis</i> Luong, Tran & Hakoda	33	<i>Camellia nitidissima</i> C.W.Chi
8	<i>Camellia dilinhensis</i> Ninh & V.D. Luong	34	<i>Camellia nitidissima</i> var. <i>phaeopubisperma</i> S. Ye Liang & Z. H. Tang
9	<i>Camellia dormoyana</i> (Pierre) Sealy	35	<i>Camellia parvifolia</i> Makino
10	<i>Camellia euphlebica</i> Merr. ex Sealy	36	<i>Camellia parvipetala</i> J. Y. Liang & Z. M. Su
11	<i>Camellia fascicularis</i> Hung T. Chang	37	<i>Camellia petelotii</i> (Merr.) Sealy
12	<i>Camellia flava</i> (Pit.) Sealy	38	<i>Camellia phanii</i> Hakoda et Ninh
13	<i>Camellia gilbertii</i> (A.Chev.) Sealy	39	<i>Camellia pingguoensis</i> D. Fang var. <i>terminalis</i> (Liang et Su) S. Y. Lang
14	<i>Camellia grandis</i> (C.F. Liang & S.L. Mo) H.T. Chang & S. Ye Liang (<i>C. ptilosperma</i>)	40	<i>Camellia pingguoensis</i> D. Fang
15	<i>Camellia hakodae</i> M.Sealy	41	<i>Camellia pubipetala</i> Y. Wan & S. Z. Huang
16	<i>Camellia hamyensis</i> M.Sealy	42	<i>Camellia quephongensis</i> Hakoda et Ninh
17	<i>Camellia hirsuta</i> Hakoda et Ninh	43	<i>Camellia quinqueloculosa</i> S.L. Mo & Y.C. Zhong
18	<i>Camellia huana</i> T. L. Ming & W. J. Zhang (<i>C. liberofilamenta</i>)	44	<i>Camellia rosmannii</i> Ninh
19	<i>Camellia huulungensis</i> Rosmann & Ninh	45	<i>Camellia tamdaoensis</i> Ninh et Hakoda
20	<i>Camellia impressinervis</i> Hung T. Chang & S. Ye Liang	46	<i>Camellia terminalis</i> J.Y. Liang & Z.M. Su
21	<i>Camellia indochinensis</i> Merrill	47	<i>Camellia thanxaensa</i> Hakoda et Kirino
22	<i>Camellia indochinensis</i> var. <i>tunghinensis</i> (Hung T. Chang) T. L. Ming & W. J. Zhang (<i>C. tunghinensis</i>)	48	<i>Camellia tianeensis</i> S.Y. Liang & Y.T. Luo
23	<i>Camellia kirinoi</i> Ninh	49	<i>Camellia tienii</i> Ninh
24	<i>Camellia leptopetala</i> Chang & S.Y.Liang	50	<i>Camellia tonkinensis</i> (Pit.) Cohen-Stuart
25	<i>Camellia limonia</i> C.F. Liang & S.L. Mo (<i>C. limonia</i> f. <i>obovata</i> S.L. Mo & Y.C. Zhong)	51	<i>Camellia vuquangensis</i> Luong, Tran & L. T. Nguyen
26	<i>Camellia flavida</i> H.T. Chang	52	<i>Camellia flavida</i> var. <i>patens</i> (S.L.Mo & Y.C.Zhong) T.L.Ming

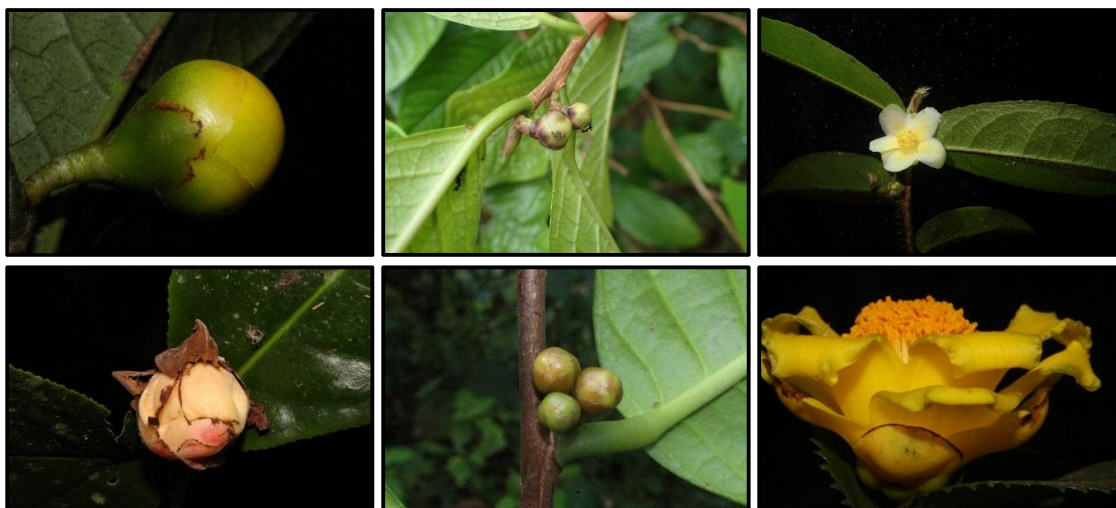


Fig. 1. *Camellia tuyenquangensis* (above left), *C. impressinervis* (above middle), *C. kirinoi* (above right), *C. megasepala* (below left), *C. hamyensis* (below middle), and *C. tienii* (below right). Flower of *C. megasepala* becomes more yellow after blooming

Research has demonstrated that the extracts from golden camellias have antioxidant activities, superoxide anions, and hydroxyl free radicals scavenging assays [21]. Golden camellias such as *C. nitidissima* have been used to treat sore throat, diarrhea, high blood pressure, irregular menstruation, and cancer prevention [19]. Studies on *C. euphlebia*, a golden camellia widely planted in Vietnam [15], indicated that leaves can be used for treatment of dysentery, hypertension, diarrhea, faucitis, and irregular menstruation [24], while its extracts are reported to possess anticarcinogenic, antioxidant, hypoglycemic, and hypolipidemic properties [25-26].

Main phytochemicals and compounds [27-29] isolated from golden camellias include α -spinasteryl- β -D-glucopyranoside, stigmasta-7,22-diene-3-O-[α -L-arabinopyranosyl (1 \rightarrow 2)]- β -D-galactopyranoside, kaempferol 3-O-[2-O-(trans-p-coumaroyl)-3-O- α -D-glucopyranosyl]- α -D-glucopyranoside, aromadendrin, catechin, phlorizin 4'-O- β -D-glucopyranoside, (3R,6R,7E)-3-hydroxy-4,7-megastigmadien-9-one, dodecanoic acid, 3 β -acetoxy-20-lupanol, and 3 β ,6 α ,13 β -trihydroxyolean-7-one. Aqueous extracts from golden camellias have been used for study on their effects to mice [24] showing anxiolytic and antidepressant activities, and for study on pyocyanin production and motility of *Pseudomonas aeruginosa* [28-29], an opportunistic pathogen of plants, animals, and humans [30].

4. TECHNIQUES FOR SEEDLING PRODUCTION, PLANTING AND TENDING

In 1990s individuals of golden camellias were dug up from natural forests and transplanted in suitable areas in southern China and Vietnam for flower purpose. Trees of all sizes were dug up, removed all branches and leaves to remain stem of <1 m and root system of 30–40 cm in length. Root system was soaked in hormone IAA (Indole-3-acetic acid) or IBA (Indole-3-butyric acid) with suitable concentration, and then transplanted. By this method, after planting 3–4 years trees started to bloom [15]. The activity has led to makeable reduce number of populations in the wild and is now prohibited. This may be a main reason leading to endangered status of some species [17]. In addition, collecting flowers in the wild has led to limited number of seedlings because of fruit reduction. Therefore, producing seedling from seeds seems to be difficult task recently. By producing seedlings from seeds, Hung and Lee [31] showed high germination rate of >90% for *C. nitidissima*. However, it is sexual propagation and therefore is not sure about the flower productivity and quality of next generation.

In recent years, vegetative propagation by cuttings have been conducted to produce seedlings. Branches of 1–2 years old were cut into segments of 7–10 cm in length which contain 2–3 leaves (Fig. 2). Each leaf was remained only

1/5–1/3 area, then suitable hormones such as IAA or IBA were used for rooting. The survival rate of cuttings may reach 99% under greenhouse conditions [31]. While experiment for *C. tamdaoensis* indicated that using hormone IBA at 1% resulted in rooting rate of 52.8% [32]. Ngo [33] indicated that *C. tonkinensis* has highest rooting rate of 83.3% at 1.5% IBA, rooting rate of 80.6% for *C. euphlebia* at 2.0% IBA, 77.8% for *C. tamdaoensis* at 1.5% IBA, and 83.3% for *C. cucphuongensis* at 2.0% IBA. Rooting medium and propagation season also have effect on rate of rooting, which indicated that using rooting medium of sterilized river sand and propagating in spring are the best for golden camellias [34–35]. Others [35–36] indicated using hormone NAA (Naphthaleneacetic acid) is also suitable for vegetative propagation by cuttings of golden camellias, which resulted in >70% rooting rates. Controlling temperature and humidity by greenhouse and automatic spraying system (Fig. 2) is important for high rooting rates, which must be in a range of 19–22°C and >90% humidity [16, 33,35–36].

Vegetative propagation transfers original gene sources of mother to next generation. The best characteristics of mother such as high flower productivity, big-sized flower, and high contents of phytochemicals will be transferred to seedlings. Therefore, the first step should be selecting mother trees with plus characteristics on flower. However, until recently there have been no records on mother tree selection in golden camellias [15]. To have best plantations in the future, selecting mother trees must be conducted carefully.

Golden camellias have been planted in greenhouses in China, where air temperature, humidity, and shading can be controlled automatically [31]. It indicated that keeping humidity at 85–90% and temperature at 20–26°C during daytime and 5–10°C lower during night time are the best. By these conditions, trees can produce buds two times and reach 40 cm in height a year. However, this is an intensive cultivation of golden camellias and is costly. There is requirement for cost-benefit analysis for this practical application.



Fig. 2. Vegetative propagation by cuttings for *C. impressinervis*. Shading bed 50-75% (above left), automatic spraying system (above right), rooted cutting (below left), and seedlings (below right)

Golden camellias have been widely planted under forest canopy, especially in secondary forest and pine plantation, which have canopy cover of 25–50% [15,37-38]. However, they are also planted in bared land [15,35,38]. In that case, shading is required. Shading can be carried out artificially by greenhouses [31] or by planting other tree species [35]. The planting density is also changing among golden camellias and planting methods. If growing on bared land, density 3,300-5,000 trees/ha can be used [35]. While it is around 500 trees/ha by growing under forest canopy [35,37-38].

Fertilizing plantation of golden camellias is applied once in a year in May–July, which supports forming numerous and healthy flower buds. Compost and NPK are usually used. Generally, disease and insect attacks are not usually found in plantations of golden camellias. However, biological control is widely used in blooming season to reduce insects coming to suck flowers, which is said to have effect on flower quality. Garlic and onion are soaked in alcohol for weeks, the extract is then sprayed to canopy of golden camellias [15]. This is a cheap and environmental friendly method for insect control in golden camellia plantations.

5. OPPORTUNITIES AND CHALLENGES FOR FUTURE DEVELOPMENT

Due to high value on human health, the commercial value of golden camellias is much higher compared to green tea. In Vietnam, one kg dry flowers costs 600–700 US\$ and one kg dry leaves costs 40–50US\$ in 2018 [15]. While it costs 320 US\$/ 1 kg dry flowers in China [39]. It is noted that a tree of *C. euphlebia*, a species with natural distribution in southern China and Vietnam, which is 2.5–3 m tall and 2.2–2.7 m crown diameter, can yield up to 3 kg fresh flowers, equaling to 0.5 kg dry per year [15]. Therefore, growing golden camellias could be potential for poverty reduction to ethnic people in mountainous areas. In Vietnam, harvesting flowers from natural forests is not available recently as all bloomed trees were dug up and transplanted in gardens. The future development of golden camellias is to plant best cultivars other than from individuals dug from natural forests. While natural populations of golden camellias are still much available in China [31,39]. It is not much available in Vietnam. Suitable and sustainable management strategies should be considered for natural populations, which first

must be preserved in-situ, and then apply suitable techniques to promote blooming and control quality.

To grow any species successfully, studies on mapping suitable planting areas, selecting best cultivars, planting and tending techniques must be carefully researched before recommending for practical application. There are 52 golden camellias (Table 1) described in China and Vietnam. Each species can grow in limited land areas, it has different flower size (Fig. 1), different active gradients, and healthcare values [21,25,27-29]. Therefore, details studies on such aspects must also be conducted before recommending for practical application.

With high price of 320–700US\$/ 1 kg dry flowers, it seems that golden camellias are potential tree species for poverty reduction to ethnic people in mountainous areas. However, such high price [15,39] may result from low productivity recently, because of limited areas. In the future, if areas of golden camellia plantation increase without careful plans, total flower productivity increases exceeding demand. As nature of demand and supply price of flowers will decrease, leading to lower benefit of golden camellia growers. Therefore, a sustainable development plan for golden camellias must be carefully considered. The plan must be developed by collaboration among policy makers, researchers, growers, and marketers.

6. CONCLUSION

Golden camellias are evergreen and shade-tolerant shrubs and small-sized trees. About 52 species have been described in southern China and Vietnam. Their leaves and flowers have been widely used as traditional medicines. It is reported to inhibit transplanted cancer, lower blood pressure, lower blood lipid, and lower cholesterol, and prevent atherosclerosis. To grow golden camellia successfully, studies on seedling production, growing and tending techniques have been carried out. These results are valuable for practical application. Beside opportunities for developing golden camellias, there also exist challenges for future development. Over plantings will lead to reduced price, and therefore low benefit. A sustainable development plan for golden camellias must be carefully considered by collaboration among policy makers, researchers, growers, and marketers.

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COMPETING INTERESTS

Authors have declared that no competing interests exist.

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