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A case study in the utilization of the underutilized crop; *Salacia* species in lowland wet zone of Sri Lanka

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ABSTRACT

A large population in developing countries depends on herbal drugs for their health care needs. We recognized a central gap in recent ethno-pharmacological research in Salacia species, which impacts factors applicable for a sustainable, equal socio-cultural, and safe supply of herbal medicines. The study was conducted at the lowland wet zone in Sri Lanka to understand the current environmental, economic, and social status of various Salacia species. Data were collected from using a mixed-method approach with a general review of the literature in a systematic online search with a hand search of bibliographies, face to face interviews, and discussions with respondents from March to May 2019. The data were collected from a total of 100 respondents that consisted of cultivators (60), collectors (2), traders (10), processors (5), and consumers (23). The survey results revealed that Salacia species in the wild are illegally harvested by unskilled persons for different purposes and economic benefit through illegal sales. It also revealed various issues such as the lack of knowledge about Salacia species, harvesting time, unavailability of desired Salacia species, and government restrictions or bans on wild collection faced by Salacia species collectors in the region had occurred in this field. This suggests that there is a need to develop practical and economically sound strategies for the efficient utilization of Salacia species to improve the condition of marginalized communities, which is a process that should eventually lead the country towards greater economic stability.

Key words: *Economic status, medicinal value, Salacia species, social status, utilization*

INTRODUCTION

A crop unrecognized in the scientific literature or unidentified in economics terms was the key consideration of our study. But these species were recognized by the local people throughout the centuries utilizing nutrition, health, medicinal, and economic values. According to National Red List (2012), the genus *Salacia* which belongs to the family Celastraceae is represented by five species in Sri Lanka. They are *Salacia reticulata* Wight. (Himbutu wel/Kothala Himbutu), *Salacia chinensis* L. [*Salacia prinoides* (Wild.) DC.] (Heen Himbutu wel), *Salacia oblonga* Wall. Ex Wight & Arn. (Gal Himbutu), *Salacia diandra* Thw. and *Salacia acuminatissima* Kosterm., spec. Nov. (celastr) which are considered in this study. It is a large genus with creeping or climbing shrubs or often small trees. *S. reticulata*, *S. acuminatissima*, *S. diandra*, and *S. oblonga* is endangered while *S. chinensis* is near threatened (MOE, 2012).

World attention on *Salacia* species

There has been an ever increasing demand from developed countries for many drugs from plant sources such as *Salacia* species during the past decade and multi-national companies try to produce medicines and nutritious products using resources from countries like Sri Lanka. Arunakumara and Subasinghe (2010) noticed that traditional

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practitioners are eager to find out the most effective parts of the plant for different health care purposes and continue to use them even without the proof provided by standard clinical trials. According to them, at least two Sri Lankan plants (*S. reticulata* and *S. prinoides*) have been patented due to pharmaceutical potential in producing anti-diabetic drugs.

Countries like Japan and United States have investigated *Salacia* species and several publications have also been made without any reference to Sri Lankan participation (Pushpakumara *et al*., 2002).

Medicinal importance of *Salacia* species

According to Morikawa *et al.* (2015) *Salacia* species play a momentous role in diabetic control worldwide for thousands of years, and it has now become a subject of broad studies for diabetes control and management. Even at present, studies continue on the *Salacia* species to investigate their potential capabilities in controlling diabetes and management.

Katalanol is the most active component in the aqueous extracts of *Salacia reticulata*, which are traditionally used in India, Sri Lanka, and Thailand to treat diabetes (Yoshikawa *et al*., 1997, Yoshikawa *et al*., 2002). Dried roots and stems in powders are used in medicinal preparations such as decoction or tea prepared by boiling the powders in water. The roots and stems of *S. reticulata* and the roots of *S. oblonga* are specific remedies for the initial stages of diabetes in the traditional Ayurvedic medicine (Ratnasooriya *et al*., 2003; Flammang *et al*., 2006; Arunakumara and Subasinghe 2010; Basu *et al*., 2013).

Sharmal *et al.* (2010) stated that *S. oblonga* contains Salacinol and Katalanol which are a-Glucosidase inhibitors. Arunakumara and Subasinghe (2010) reported that *S. chinensis* also shows α-glucosidase inhibitory activity.

Threaten condition of *Salacia* species in Sri Lanka

According to Keeragalaarachchi *et al.* (2016), Kothala Himbutu has high demand in the national and international markets. Therefore, people uproot them from the wild on a large scale. The decline of *Salacia* species can be attributed to the effects of habitat destruction and modification for farming, forestry, and herbal trade collectors and natural changes to the forests.

The economic value of *Salacia* species

In many parts of the Sri Lankan wet zone particularly in the adjoining forest are the wild collection of *Salacia* species used mainly by the poor in their livelihood activity and a key source of cash earnings for these groups. *S. reticulata*, *S. oblonga*, and *S. chinensis* are very similar in appearance; they are misleadingly used in traditional medicinal practices. Due to that, *S. reticulata* is overused and also *S. oblonga*, *S. chinensis* misleadingly used to treat diabetes.

The *Salacia* species industry in Sri Lanka has a huge potential in developing into a major agri-business in Sri Lanka where an ever-increasing demand exists due to the expanding tourism industry and medicinal industry and herbal drug industry. However, the *Salacia* species industry is being constrained, particularly by its high demand and low supply. The value addition has been recognized as the sole and promising solution. This survey will help to build the economic importance of *Salacia* species in Sri Lanka. Therefore, the conservation of this valuable plant is very important before reaching endangered Sri Lanka. This conservation program will help to conserve this valuable plant not only in Sri Lanka but also in other countries as well. In this background, this study was carried out to evaluate the socio-economic relationship of *Salacia* species in relation to

the exploitation and conservation of *Salacia* species. This study also aims at emphasizing the greatest importance of the investigation of *Salacia* species that have not been the subject of socio-economic studies, although their popular uses have been reported.

MATERIALS AND METHOD

A unique feature of the wet zone in Sri Lanka in which the study was conducted is a high degree of endemism. Wet lowlands have the highest number of endemic plant species among all the climatic zones than the other regions in Sri Lanka (Peeris, 1975; Gunatilleke and Gunatilleke, 1990). Lowland wet zone represents the area below 1,000 m in elevation, and also it spreads in the southwestern quarter of Sri Lanka. Colombo, Gampaha, Kalutara, Galle, Matara, Kegalle districts, and part of Ratnapura belong to lowland wet zone (Gunatilleke and Ashton, 1987b; Ministry of Forestry and Environment, 1999), and the study was carried out in these areas. Plant species of the lowland wet zone of Sri Lanka is largely distributed in the tropical lowland rainforests below 1,000 m altitude. These forests have a seasonal wet climate. Mean annual rain fall is 2,500 mm – 5,000 mm without prominent dry spell, and mean annual temperature is 27 ^{o}C at sea level in lowland wet zone.

Three districts from the Western province, two districts from Sabaragamuwa province, and two districts of the Southern province (Figure 1) were considered for the study and a mixed-methods approach was employed to collect the data.

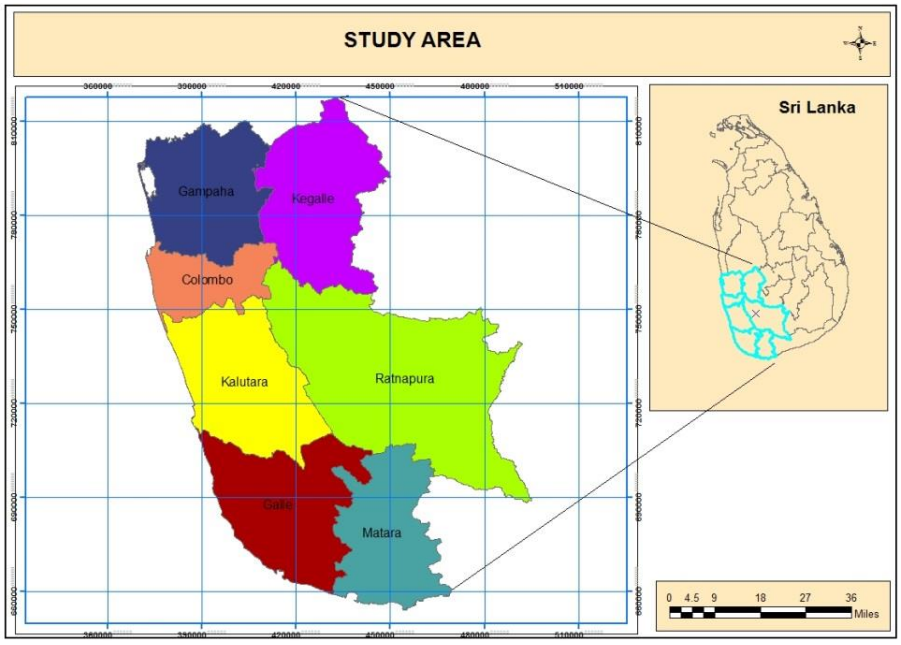

Figure 1: Map showing the study area in the south-west of Sri Lanka

A general review of the literature available based both on a systematic online search, and a search of bibliographies was conducted. It used to receive an idea about and current environmental, economic, and social status with the availability of raw materials or value-added products of *Salacia* species at respective village markets, and at their household premises. The way of contribution of *Salacia* species to medicine and household income generation also were addressed.

Since too little was identified of the population beforehand (due to the absence of secondary sources) to consent for (stratified) random sampling, had to use

non-probabilistic sampling methods (Barry, 2007). A 'quota' method was used in blend with the snowball method.

A semi-structured questionnaire survey using people-centered model was carried out randomly using a population sample of hundred people including medicinal plant cultivators/farmers/producers (60), medicinal plant collectors (2), middlemen/drug sellers/traders/Ayurvedic doctors (10), drug manufacturers/processors (5), and herbal raw material suppliers/consumers (23) in districts of lowland wet zone of Sri Lanka. The survey method and Key Informant Interviews (KIIs) were used to collect secondary data involved with visiting the team of researchers to the selected locations where the product is growing, collecting, trading, and selling, which has supported to investigate the products, prices, places, and promotions of *Salacia* species raw materials and/or value products of it. The results of the semi-structured questionnaire survey were statistically analyzed using the SPSS (version 17.0) software calculating data with mean values and standard deviation. Significant differences were determined at p-value = 0.05. To analyze data and information collected were analyzed by using descriptive statistical methods such as bar charts and tables.

RESULTS AND DISCUSSION

(A) Evaluation of the socio-economic relationship concerning the exploitation and conservation of *Salacia* species

(1) Demographic characterization of the sample population

Sixty percent are cultivators, 23% are consumers, 10% are drug sellers, 5% are drug manufacturers, and 2% are *Salacia* species collectors who have participated in the survey. The trade-in medicinal plants in Sri Lanka can be characterized as oligopolistic in nature, owing to only a few large industrial consumers and traders. More than 75% of medicinal plant producers, medicinal plant collectors, and manufacturers of herbal raw materials belong to the age group of more than 50, 20% belong to the age group of 30-50, and 5% belong to the age group of 18-30. Ninety percent of them are male, and 10% of them are female, who do this as a part-time work to raise money for households. Sixty percent of them have more than 20 years, 20% of them have 10-20 years, 15% of them have 5-10 years, and 5% of them have 0-5 years of experience in their relevant fields.

(2) Training on Salacia species

The total contribution to the national economy of *Salacia* species is small, but their value per weight is highest among traded plants. Due to the lack of training in the trade of *Salacia* species in terms of product transactions with fair markets and market rules, many farmers do not have a good understanding of the trade of *Salacia* species, while they had adequate initial capital to a business.

(3) Education level for Salacia species trade

The finding of the survey revealed that the standard of education of traders was much higher than that of producers and it was those persons who had a better education history compared to others who were traders of *Salacia* species. Entrepreneurial abilities, risk-taking capacity, and education level are several significant considerations in determining the potential of individuals to dominate income-generating practices (Hishe *et al*., 2016).

(4) Identification ability of Salacia species

Most of the Ayurvedic medicinal plant industry people have knowledge and recognition ability only on Kothala Himbutu and Heen Himbutu. Even though most of them knew on endangered status of Kothala Himbutu, not try to cultivate any

Himbutu species for the future generation. Most people have diabetes in the present society, and they also prefer to take Ayurvedic products with Kothala Himbutu other than western medicine. Hence, we must aware general people about the significance of the Kothala Himbutu plant. According to the information from medicinal plant cultivators, medicinal plant collectors, and herbal raw material suppliers in the Angunukolapelessa area sell high amounts of Himbutu species. Stem bark in the mature growth stage is the part of the Kothala Himbutu plant people use for medicines.

(5) Overexploitation of Salacia species

The findings showed that numerous problems were commonly faced by *Salacia* species collectors, such as lack of information regarding *Salacia* species, harvesting period, and unavailability of the desired *Salacia* species, and legal constraints on wild selection. These species have achieved the status of near-threatened/threatened due to over exploitation, unauthorized export and habitat loss.

(6) Reasons that attracted to industry of Salacia species

The majority of the farmers (40%) has attracted to this industry because of self-interest. Fifty-seven per cent of farmers have joined the industry through motivation from friends. There were 7% of farmers attracted to the industry through the information obtained from newspaper articles.

(7) Cultivation and harvesting Salacia species

Many collectors gather herbal raw materials and do not try to re-cultivate the product. According to the knowledge obtained, the best cultivation approach for Himbutu species is seed propagation. The criteria for effective viable cultivation practices are to manufacture high-quality herbal medicines utilizing methods of low input cultivation while accepting that the commodity must reach a highly competitive foreign market (Hishe *et al*., 2016).

Much of the time, the whole *Salacia* plant is collected from planted areas. Without injuring or destroying the specific tree or plants, *Salacia* species may be collected and most stem bark is the component that is harvested. It may have a negative effect on the species by extracting a whole individual plant to remove the medicinal properties of the *Salacia* species. They primarily differentiate plants that are similar to Kothala Himbutu by the external appearance of the fruit. Because of the more or less identical morphology, it is challenging to find these plant species mature enough to collect and differentiate Kothala Himbutu from other *Salacia* species. Resource ownership was unknown and the first come first serve basis was practice and according to the survey findings, 60% of *Salacia* species in the wild are illegally collected in the area by less eligible citizens for various purposes and economic benefits by illegal sales.

Herbal raw material consistency and extraction sustainability are directly related to how plants are processed (Hishe *et al*., 2016). The collection of materials is indiscriminate, and there was hardly any control. This is taken into consideration and must make provision to increase awareness, and the importance of sustainable collection, and cultivation practices to maintain the community's long-term livelihood. In this regard, educational programs should be launched to address the issue of sustainable harvesting and the possibility of cultivating *Salacia* species; otherwise, harvesting wild trees would be increased. Further, there is a need for a program that focuses on extending assistance to the collectors and local dealers, introducing methods to a consistent supply of high quality, well-preserved material to purchasers while sharing information engaged in the process.

Demand for an uninterrupted and unchanged supply of medicinal plants and a rise in the amount of medicinal plant species in production with the expansion of the decline of forest supplies is an important strategy for fulfilling growing demand (Hishe *et al*., 2016).

(8) Adulteration of Salacia species

The most significant knowledge obtained from them was that for their Ayurvedic goods, the buyers use certain plants that are close to Kothala Himbutu to confuse consumers and do not match the price charged for the raw materials. Since collection is still more widespread than cultivation, there are also enormous variations in the nature of raw materials. Adulteration of other plants is often performed with the motive of rapid financial benefit. The most useful knowledge obtained from collectors was that the buyers for their Ayurvedic arrangements to fool the common people adulterate the Kothala Himbutu from the other organisms of the genus.

Most of the time, people get raw materials from the Colombo area. They test Kothala Himbutu raw material before manufacturing Ayurvedic finished goods due to many adulterants of Kothala Himbutu, which affect the quality of Ayurvedic finished product.

(9) Supply of raw materials of Salacia species

Naturally or wild-grown crops with limited supplies were mainly used for home storage to sell later. Commercial cultivation was used for own consumption and part of harvest shared with social networks; neighbors, relatives, and friends. Further, farmers used four main marketing strategies: roadside stalls (seasonal), informal village collection centers, weakly fair at suburb town and traditional village fair to sell their products, including a considerable quantity of *Salacia* species. Wild collectors are only functioning seasonally and eyeing to collect demanded wild-grown *Salacia* species.

According to the details obtained from the survey, the mean annual quantity/volume of raw materials of the *Salacia* species requested is more than 1,000 kg and the mean annual quantity/volume of raw materials of the *Salacia* species requested is less than 1,000 kg in the Colombo field.

There was a rise in the amount of pharmaceutical goods produced with *Salacia* species sold in developed countries, much of which did not take due account of the health needs of these countries, suggesting obvious cases of misguided priority at the cost of their residents. These Ayurvedic finished products, such as Kothala Himbutu tea bags, have a high demand for social profits on the market.

(10) Mode of transport and drying, packaging, and storage of Salacia species

The plurality of producers of *Salacia* species (63%) in the study region used their motorcycles to deliver their goods to alternate markets. Around 20% of distributors used three-wheeler and foot cycles, respectively, while 15% used a small lorry to deliver them on foot and the remaining 2%.

They sun-dry the harvest, after harvesting in order to, maintains the quality of the raw materials. The packaging is generally plain, utilizing locally accessible and free items such as newspaper wrappings, plastic packages, and recycled glass bottles according to Hishe *et al.* (2016).

(B) Contribution of *Salacia* species to the economy of Sri Lanka

The importance of medicinal plants to the economy of developing countries like Sri Lanka remains critical and strategic. Even though, as a developing country, the production of Ayurvedic products from *Salacia* species and exporting them to developing countries is very difficult because the medicinal plant trade in Sri

Lanka is unorganized. The current practices are unsustainable unscientific too.

Medicines are the key roles in the maintenance of a healthy population that drives and sustains the economy of a country. In the long run, this will attract investors to the area of production of pharmaceuticals to invest their resources. In the other side, while improving the country's economic position, the healthcare distribution infrastructure would be strengthened by rendering critical pharmaceuticals accessible to the bulk of the people at reasonable rates. Most of them collect Himbutu plants in matured stage around the whole year within one day per week about 1-5 kg as individuals to get 200-600 Sri Lankan rupees per kg. The average cost of production and marketing of the drugs containing Kothala Himbutu is less than 50,000 Sri Lankan rupees, according to the information obtained (Table 1).

Table 1: Percentage of response for the mean cost (Rs.) of production and marketing of the drugs containing Kothala Himbutu (Sample size = 100)

Mean cost (Rs.) of production and marketing of the drugs containing Kothala Himbutu	**Response (%)**
50,000	69
>50,000	31

The mean cost of Kothala Himbutu containing drugs is more than 500 Sri Lankan rupees from Sri Lanka (Figure 2).

The mean quantity purchased from the Kothala Himbutu plant drug producers is more than 500 kg (Table 2).

Table 2: Percentage of response for mean quantity (kg) of Kothala Himbutu plant you purchased (Sample size = 100)

Mean quantity (kg) of Kothala Himbutu plant you purchased	**Response (%)**
0-500	38
>500	62

The mean production cost per capsule per tea bag (Figure 3) comprising Kothala Himbutu is more than 100 Sri Lankan rupees per capsule per tea bag.

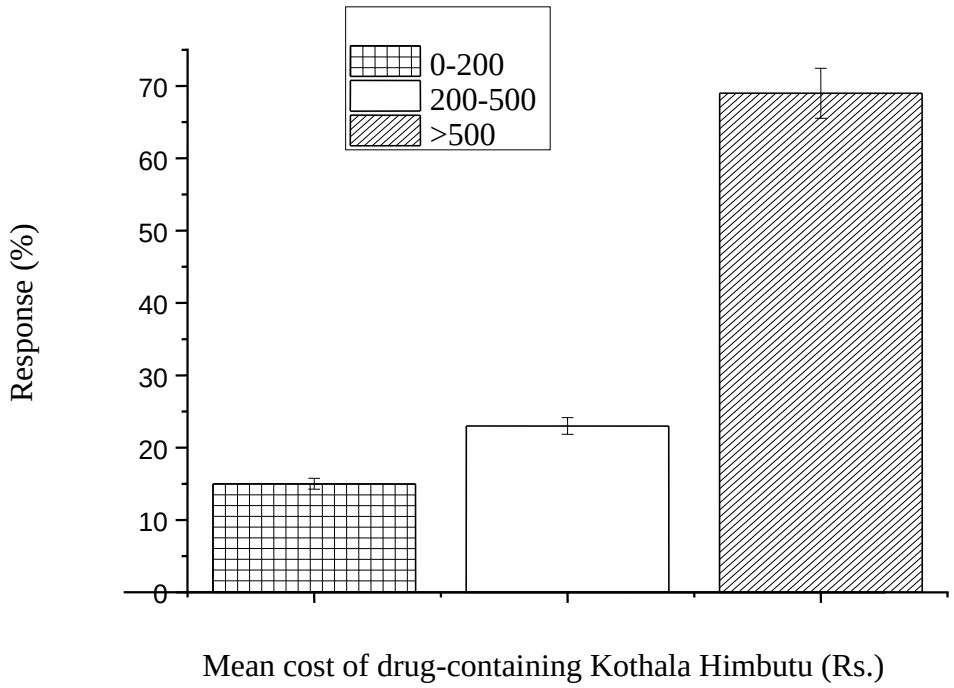

Figure 2: Response for a mean cost of drug-containing Kothala Himbutu

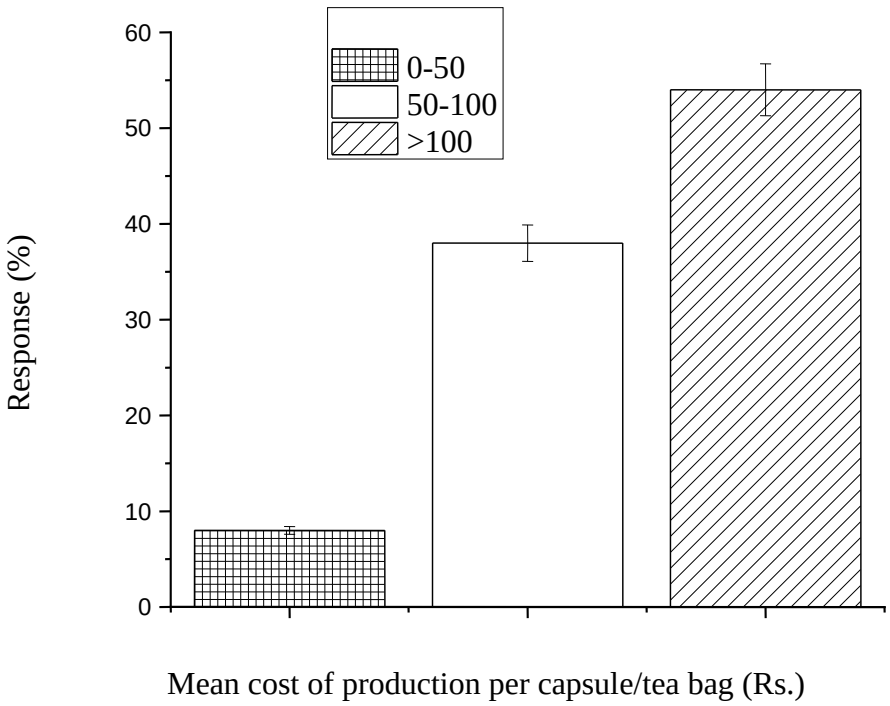

Figure 3: Response for mean cost of production per capsule/tea bags

Therefore, the average total income of the drug-containing Kothala Himbutu is over 50,000 Sri Lankan rupees (Table 3).

Table 3: Percentage of response for mean total income (Rs.) received by the drug-containing Kothala Himbutu (Sample size = 100)

Mean total income (Rs.) received by the drug	Response (%)
50,000	38
>50,000	69

The average selling price is increasing and the average quantity per year decreased from 2009 to 2019 (Figure 4).

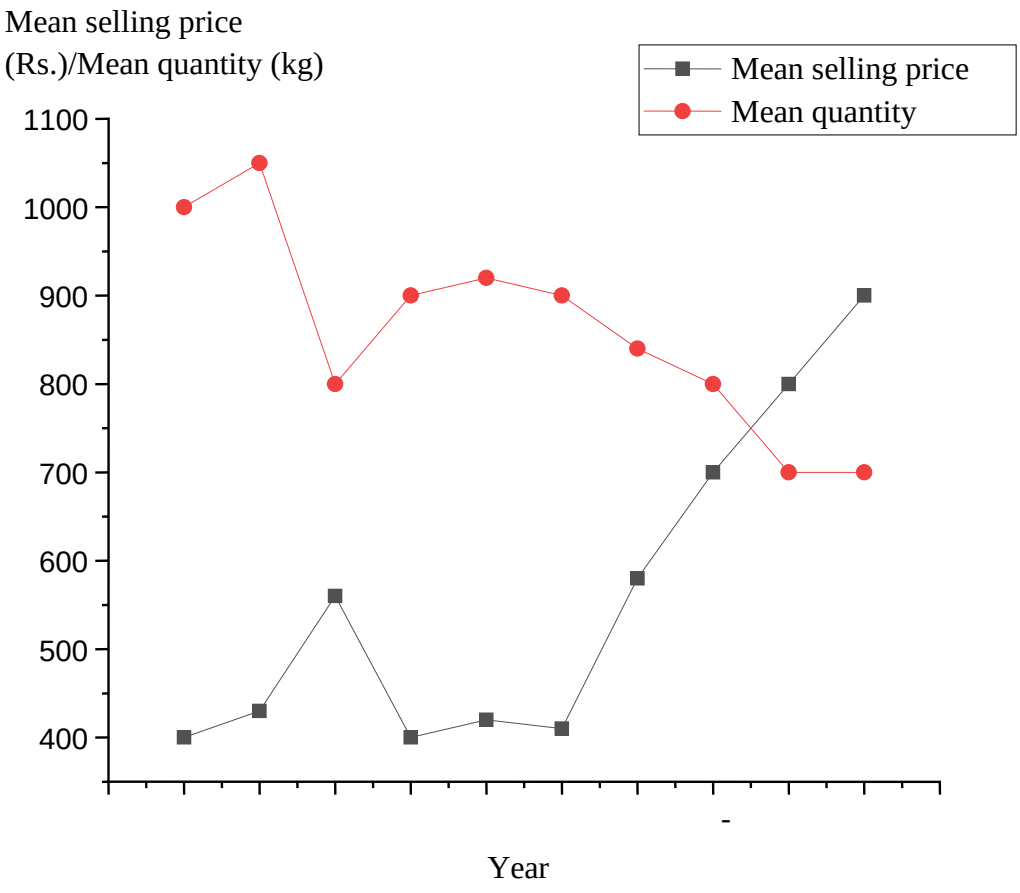

Figure 4: Mean selling price versus mean quantity per year

Some people are used to make cups out of heart wood and keep water over night for drinking as a remedy for diabetes. The circular ring pattern on the wood makes it attractive. According to a traditional formula passed on in an oral tradition to members of the family of the Ayurvedic physician, local people use *S. reticulata* as herbal tea (Kothala Himbutu tea) by steeping a tea bag of the herbal mixture in boiling water and ingesting. It is possible to distribute Ayurvedic properties of Kothala Himbutu among the general public.

The main challenge for the market for these Ayurvedic raw materials is that they do not have adequate supply for demand and, therefore, there is a need to balance consumption and conservation. Recently, the development of Ayurvedic herbal products from the *Salacia* species has increased and depends on the raw material supply volume. Strengthening the specifications and quality for Ayurvedic medicinal products developed from *Salacia* species, as requested by the international markets, could contribute to the availability and accessibility of successful medicinal products in the local market.

There are opportunities to improve the position and income of the poor by improving their power to negotiate prices, provide stable markets for their products, or create opportunities for local-level value-added processing. Employment in cultivation could boost income security, health standards, and connectivity to more formal agricultural technology.

(C) Conservation/recovery and management of *Salacia* species in lowland wet zone of Sri Lanka

a) Manage the species on forest patches

This would be an expensive operation but many other native species, both plant and animal, would benefit, including other endangered species. For example, *Salacia* species could be transferred to suitable habitats. However, seed probably takes at least 5 to 7 months to germinate and grow into a plant, and it may take that long to determine whether the species has been successfully established.

b) Protect plants at carefully selected sites in an attempt to represent the full range of remaining genetic diversity

i) Contact landowners and encourage conservation - All landowners should be informed of the presence of *Salacia* populations on their property. Private landowners should be informed of the options for legal protection.

ii) Seek legal dedication - Such dedications can usually be made by private or public landowners, and thus they do not require the transfer of property rights. If established, such land owners should provide management for the habitats and plant communities associated with the *Salacia* species allow monitoring access. The Government should regulate the collection of *Salacia* species from the wild, the Government should prohibit the collection from the wild of threatened *Salacia* species except for propagation purposes, Ministries of Agriculture, Health and Trade, should develop and co-ordinate a programme to improve the techniques for harvesting and storing *Salacia* species and preparing their products.

iii) Conduct management assessment of public and private lands - Survey all extant *Salacia* populations for ecological conditions maintaining *Salacia* species and assess and identify management needs. Specific management problems should be identified and resolved, and determinations should be made as to the recovery potential of each site. Design new Medicinal Plant Conservation Areas (MPCAs) for *Salacia* species where, the area itself is not under threat and subject to the dynamics of the system and the extent of human pressure.

c) Fully protect plants from herbal trade collectors and other destructive animals at all sites

Effective advocacy would be needed for sites on private land and some sites may be beyond saving, for example sites where only dead plants have been found in recent years.

d) Maintain the species in cultivation

Most *Salacia* species can be maintained in cultivation

CONCLUSIONS

This study aims at emphasizing the greatest importance of the investigation of *Salacia* species that have not been the subject of socio-economic studies, although their popular uses have been reported. The findings of the study led to conclude that prompt action is required for sustainable utilization, conservation, and scientific validation of available knowledge on *Salacia* species before they are allowed to use industrially. The collection is not systematic and controlled, and as a result these species have come into destroyed collection, non-grading and improper care in drying and storage.

The study provides the information with a practical example of economic potential and research on these species, which may help policy planners at the national and international levels connect livelihood and socio-economic development with conservation of this natural resource. It can be concluded that *Salacia* species are in a reasonable position to capitalize as a source of addressing Ayurvedic medicine and income security.

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