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Review article

Medicinal importance of *Choerospondias axillaris* (Roxb.) Burtt & Hill fruits in Nepal

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Abstract: *Choerospondias axillaris*, a large, deciduous and subtropical fruit tree has been recognized as a potential agroforestry tree for income generation for subsistence farmers in Nepal. The tree, locally called 'lapsi', , produces fruits with high vitamin C content, which are consumed fresh, pickled and processed for preparing varieties of sweet and sour, tasty food products that are marketed locally and have potentials for exporting. A total of 301 Village Development Committees in 29 hill districts have reported cultivation and protection of Lapsi trees for some socio-economic purpose. Lapsi was grown from east to west Nepal from 850 m to 1900 masl. Distribution of Lapsi has been found in much wider areas in the country than reported earlier. Over 40,000 trees are at fruit bearing stage and more than 450,000 new trees are planted in various districts of Nepal.

Keywords: *Choerospondias axillaris* - Lapsi - Vegetative propagation - Fruit tree - Agro forestry.

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INTRODUCTION

Nepal is a landlocked country situated in the central part of the Himalayas between China to the north and India to the south, the east and the west. The country has been geographically divided into three ecological belts: Mountains, Hills and Terai. All three ecological belts extend lengthwise from east to west across the country. The climate varies from alpine cold semi-desert type in the trans-Himalayan zone to tropical humid type in the tropical lowlands in the south. It has an area of 147,181 Km^2, average length of 885 km east to west, and average width of 193 km north to south. The country has an immense variety of topography, ranging from lowland plains in the south with elevation as low as 90 meters to the Himalayan mountain range in the north with elevation up to 8848 meters at the Mount Everest. The climate varies from alpine cold semi-desert type in the trans-Himalayan zone to tropical humid type in the tropical lowlands in the south. Nepalese economy heavily relies on agriculture and contributes 33 percent to Gross Domestic Product (GDP) that generates direct employment to 67 percent population and 76.3 percent agricultural households, the major source of livelihoods of the Nepalese people (LSS 2010–2011). There are altogether 75 districts and 5 development regions: Eastern, Central, Western, Mid-Western and Far Western and about 36% of the total population resides in the Central Development Region, which covers 19 districts including Kathmandu valley (Shakya 2011).

DISTRIBUTION

Lapsi, *Choerospondias axillaris* (Roxb.) Burtt & Hill is indigenous fruit tree of Nepal found growing within 900–2000 m above sea level in many parts of the country (Poudel *et al.* 2001). It is grown in 301 village Development committees of 29 hill districts of Nepal for some socio-economic purpose (Poudel *et al.* 2001). Lapsi trees are commonly found in places like Pharping, Machhaya gaon (Kirtipur), Phulbari, Panchkhal, Namobuddha, Kavre, Panauti and Dhulikhel of Kavrepalanchowk district as well as in Jiri, Charikot of Dholkha district and Chautara of Sindupalchowk district (Fig. 1).

The tree has long been cultivated in rural Nepal for its fruit. The lapsi tree is widely used for private

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planting in hills, as part of community forestry program (CBS 1998). In the natural forest lapsi trees are sparsely distributed. Over 40,000 trees at fruit bearing stage and more than 450,000 new trees were planted in these districts of the country. There is a tremendous opportunity for income and employment generation through proper management and use of Lapsi tree in Nepal (Poudel *et al.* 2001).

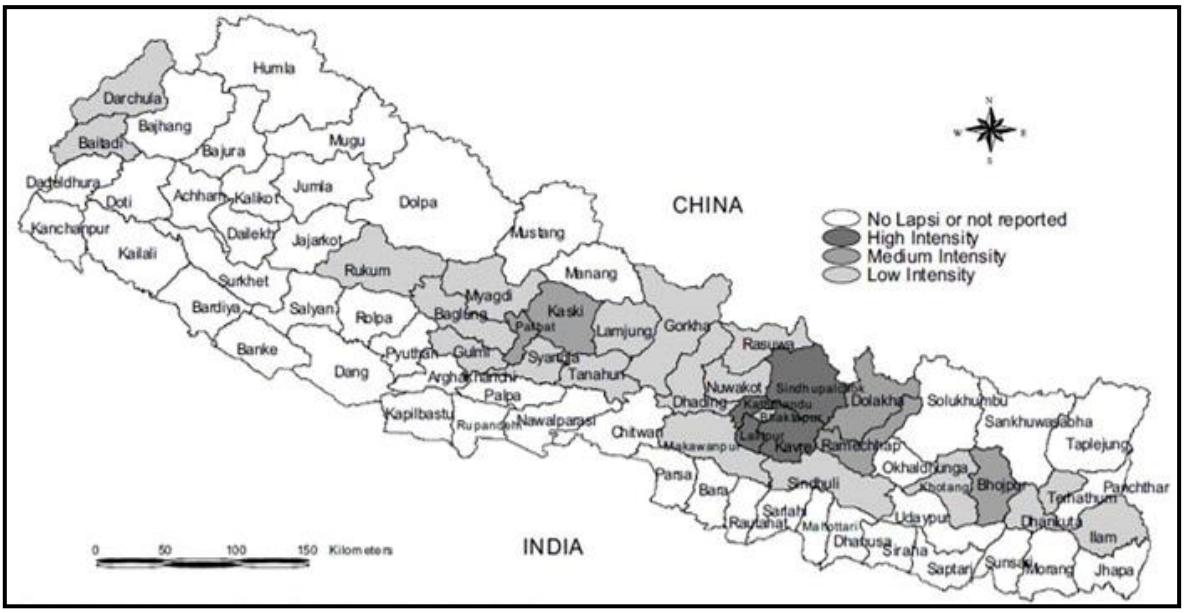

Figure 1. Distribution of Lapsi in various districts of Nepal.

HISTORICAL BACKGROUND

The urbanization of Kathmandu valley created opportunities for the development of adjoining districts. Lapsi has been harvested from the forests to feed the markets in Kathmandu. Lapsi fruits entered the market in the mid-1960s and trade increased rapidly buoyed by brisk demand in Kathmandu for unprocessed fruits as well as candy, mada, seeds and ground-skin. Increasing demand for Lapsi fruits in Kathmandu led forestry programs to initiate its production. Accordingly, the cultivation of Lapsi trees has increased as part of forestry activities since the early 1970s, and processing industries have been developing in and around the Kathmandu in response. At present the Lapsi tree is widely used for private planting in the hills, as part of the community forestry program which was implemented in most of the hill districts of Nepal in the early 1980s with the support from bilateral and multilateral donors. Programs included establishing and operating nurseries in villages in order to produce seedlings of preferred species for planting in community and private forests.

Figure 2. Lapsi tree cultivated at Champadevi Hill of Kirtipur, Kathmandu, Nepal.

FARMING AT NATIONAL LEVEL

A total of 301 Village Development Committees (VDCs) in 29 hill districts have reported cultivation and protection of Lapsi trees for some socio-economic purpose (Fig. 2). Lapsi grows from east to west Nepal between 900 m above sea level and 2,000 m above sea level in the Himalayan range (Fig. 1). Lapsi trees stand in small patches in the natural forest or scattered in the farmlands and at different religious sites. It is a potential agro-forestry tree species for income generating and nutrient supplementation in the mid hills of Nepal. Existence of lapsi as pre-historic vegetation types of '*Sleshmantak Ban*' (meaning Lapsi forest) around 'Pashupati Nath' in Kathmandu has been quoted in the '*Swasthani Brata katha*'. This deciduous tree can grow up to 20 meters tall and has smaller purple-brown branches and has been considered as suitable crop for multiple uses in mountain farms.

The Lapsi fruits (Fig. 3) are widely used in central Nepal. Major production pockets are around the outskirts of Kathmandu valley. Lapsi tree is familiar and scattered in the mid hills of Nepal in the forest as well as private land as a preferred agro forestry tree. With increase in market for Lapsi fruit, the popularity of Lapsi tree has increased. It has become a commercially important tree mainly in the districts surrounding Kathmandu valley. The increased demand of Lapsi as fruit in Kathmandu led forestry program to expand the plantation of the tree. Since then, Lapsi farming has become attractive for cultivation to the farmers. Since Lapsi is a relatively new crop for scientific research and often an ignored crop both from agricultural and forestry sector, there exists inadequate published literatures.

Figure 3. Lapsi fruits are ready for market at Champadevi Hill of Kirtipur, Kathmandu, Nepal.

Bhaktapur District as a Lapsi Area in Nepal

Bhaktapur district covering an area of 119 km^2 is the smallest district in Nepal. It is located in the eastern part of Kathmandu valley. The neighboring districts of Bhaktapur are Kavre Palanchok to the east, Kathmandu and Lalitpur to the west, Kathmandu and Kavre Palanchok to the north and Laitpur to the south. It lies between latitude 27º36' to 27º44' North and longitude 85º21' to 85º32' East. It has the average length of 16 km east to west, and the average width of 12.2 km north to south. The average height from the sea level is 1331 m. It has 2 parliamentary constituencies, 2 municipalities and 16 Village Development Committees. Its altitudes vary from 200-3018 masl, whereas the average temperature ranges from 20º C to 25º C. The average annual rainfall is 56 mm. The total population of Bhaktapur is 304,651 that consists of male 154,884 (50.84%) and female 149,767 (49.16%). The population growth rate is 2.71%. There are 68,557 households. The average household size is 4.44 (NPHC 2012). It has been found that almost every VDC in Bhaktapur has Lapsi trees especially in upland area. Most of the farmers residing the upland area have Lapsi tree in their lands. However, they are not growing these trees in commercial scale. They have got Lapsi trees growing naturally. In the natural forest Lapsi trees are sparsely distributed.

FARMING AT INTERNATIONAL LEVEL

Lapsi distribution is not restricted to the Himalayas, however, the tree is also found in Thailand (Jackson 1994), Vietnam (Nguyen *et al.* 1996) and China (Hau *et al.* 1997, Zhou *et al.* 1997, Fen *et al.* 1999, Zhou *et al.* 1999, Lin *et al.* 2000). Lapsi trees are also reported from Sikkim, Assam and Darjeeling in India (Paudel 2003). However, Lapsi farming is not done in commercial scale. People collect Lapsi fruits from the forest and either processed or taken to the nearby market for sale.

USES

Indigenous Knowledge about Cultivation, Management and Use of Lapsi

Local farmers have wealth of indigenous knowledge about Lapsi cultivation, management and utilization. Almost all Lapsi fruits coming to markets to date are obtained from wild grown trees. Farmers have been protecting and growing naturally regenerated Lapsi plants in forest and farmland. They have increased cultivation of this tree for the last 10-20 years, especially when forest nurseries have begun to produce and distribute Lapsi seedlings. No evidence on the use of improved technologies/ varieties for quality fruit production was found in Nepal and no improved horticultural practices such as irrigation, fertilisation, and pruning were applied.

Lapsi was considered as one of the best agroforestry tree species to be grown in farmlands due to several reasons such as thinner crown density, tall and deciduous in nature that causes low level of shading effect on cereal crops. However, the disadvantage of growing Lapsi in farmland was also realized by farmers as crop damage occurs while Lapsi harvesting. It was also evident from interaction with Lapsi growers that they are quite aware about the crop impact of Lapsi trees in their bari (un-irrigated farms) lands and they try to minimize this effect by locating trees in the margins of farmland, corners and pasture lands.

Lapsi cultivation has been much influenced by marketing facilities such as access to motorable road and market centers; processing companies and traders activity (Paudel *et al.* 2000). The extensive cultivation of Lapsi around the districts of Kathmandu valley, and its catchment area provide absolute evidence on positive influence of market facility on Lapsi production.

Medicinal Uses of Lapsi Fruits

Choerospondias axillaris (Roxb.) Burtt & Hill is a medicinal plant also used in Mongolia. Fruits of *C. axilla*ries have been reported to possess several properties for treatment of myocardial ischemia, calming nerves, ameliorating blood circulation and improving microcirculation in Mongolia (Dai et al. 1992, Shi et al.1985). The constituents responsible for the effects of fruits of *C. axillaris* are phenolic and flavonoid compounds (Lian *et al.* 2003) because compounds of this kind are known to be antioxidants (Wang *et al.* 2008). The oxidative damage caused by reactive oxygen species (ROS), such as the superoxide radical ($O_2^{-)}$ and hydroxyl radicals (OH^-), on lipids, proteins and nucleic acids may trigger various diseases including cardiovascular disease. Epidemiological studies have shown that administration of antioxidants may decrease the probability of cardiovascular diseases (Abe & Berk 1998, Madhavi 1996).

Phenolic compounds are widely found in the secondary products of medicinal plants, as well as in many edible plants (Hagerman *et al.* 1998). The ability of phenolic compounds to serve as antioxidants has been recognized, leading to speculation about the potential benefits of ingesting phenolic-rich foods. Several studies have described the antioxidant properties of medicinal plants, foods, and beverages which are rich in phenolic compounds (Brown & Rice-Evans 1998, Krings & Berger 2001)

Blood flow arrest and reperfusion during AMI cause myocytes and endothelium injury through oxidative stress and inflammatory response, both of which involve ROS and peroxides that consume antioxidant defenses. Researchers have found that flavonoids content of *C. axillaris* could inhibit dexamethasone-induced thymocyte apoptosis (Li *et al.* 1998). In 2007, Ao *et al.* have reported that flavonoids content of *C. axillaris* could attenuate the serum levels of CK, CK-MB and LDH in isoproterenol-induced MI injury in rats (Ao *et al.* 2007). In light of the previous findings, Chunmei *et al.* (2014) hypothesized that TFC can inhibit oxidative damage and cardiomyocyte apoptosis associated with AMI. Epidemiological studies have shown that administration of antioxidants may decrease the probability of cardiovascular diseases (Abe & Berk 1998, Madhavi 1996).

Processing, Marketing and Trading of Lapsi Products

Fruit processing is taking place at domestic, semi-commercial and commercial scale. Farmers in remote areas are traditionally processing Lapsi for household needs as pickles (both fresh and packed), and mada. Mada

is a collective name for dried Lapsi mat prepared from the pulp and peel of Lapsi fruits by crushing in a wooden mortar and pastel (*Dhiki*), often mixed with salt, sugar or spices, sun dried, packed and sold in markets as dry fruit products. The production and sale of Lapsi fruits for processed products such as *mada*, candy and *titaura* (Fig. 4) is confined around urban areas, whereas local sale and bartering of Lapsi fruit for salt, sugar, cereals and stationary has been reported to take place even in remote areas. New processing companies are established in smaller town centers, as road network is being expanded. Most of the Lapsi products are consumed within Nepal. However, the possibility for exporting Lapsi products could be improved with better management and processing practices. The main marketable products are: Mada, Candy, Titaura, Lyassipau, Lapsi powder, Lapsi squash etc.

Figure 4. A product of Lapsi fruits called *Titaura* available in Kathmandu, Nepal. (Source: www.Titaura.biz)

PROPAGATION BY TISSUE CULTURE

Attempts in tissue culture of mature Lapsi trees using axillary buds from selected male and female trees have been initiated at the Institute of Applied Microbiology, University of Natural Resources and Applied Life Sciences, Vienna, since 1998. So far, surface sterilization procedure for the explants derived from grafted plants at different maturity stages has been developed. Axenic cultures could be successfully established in DKV medium supplemented with 1 mg/l benzyl-amino purine (BAP) (Driver & Kuniyuki 1984). Studies on further development and multiplication of shoots under the influence of different hormone combinations and culture conditions are currently underway.

OPPORTUNITIES

Lapsi is a wild, indigenous fruit tree of multiple benefits. It is a potential agroforestry tree species for income generation and nutrient supplementation in the middle mountains of rural Nepal. Lapsi has great potential as a cash-generating tree for hill farming communities in Nepal thus, reducing farmers' reliance on subsistence food production and to improve their welfare. Regular annual income generation by the tree has great positive impact on the poverty alleviation of indigenous people in general. Lapsi is a multipurpose tree that has higher income and employment generating potential without deteriorating the natural environment.

Farmers have been encouraged to grow Lapsi because of high demand of Lapsi from processors and collectors. Producers have not been able to fulfill the demand of markets. There is a great opportunity for income and employment generation through proper management and use of Lapsi tree. All the people involved in Lapsi business do not get worried of their stuffs' marketing. Processors say they can sell their varieties in the market even they don't get cash selling at the time of delivery. Lapsi wood is used as light construction timber and fuel-wood, seed stones are used as fuel in brick kilns and the bark has a medicinal value for treating secondary burn.

CHALLENGES

Current production and supply of Lapsi fruits do not meet the market demand for quality products on the one hand, and the production from remote areas has not been able to fill this gap on the other. Expansion of Lapsi cultivation for quality fruits production is limited mainly due to the associated risk of non-bearingness, as only

female trees produce fruits, normally after 7-10 years of planting. Neither appropriate techniques for early sex determination nor simple and reliable vegetative propagation methods were developed and disseminated. Because of this problem, farmers are worried whether the trees they have already grown will produce fruits. There is no proper branding and labeling practices prevalent. This happens to be the biggest hurdle in Lapsi enterprise development. An important issue is the lack of marketing information for Lapsi growing farmers since farmers with market information may fetch a higher price for their fruits. Small landholders and the landless are still deprived of emerging market opportunities because of a lack of information and credit possibilities. The absence of a growers' institution limits growers' bargaining capacity, and traders are getting the larger share of the benefits.

CONCLUSION

Lapsi has been identified as a potential agroforestry tree species for domestication for rural income generation and human nutrient supplementation. Lapsi fruits are rich in essential amino acids, minerals and vitamin C. Lapsi is processed to make candies of various composition and taste. There is a tremendous market opportunity for processed Lapsi, both in domestic and international market. The participatory approach used in the occurrence and distribution of Lapsi in Nepal has been effective to draw a distribution map of a single species of farmers' interest. Lapsi has been growing in 301 VDCs in 29 hill districts of Nepal and is further expanding. Information on distribution of Lapsi would help to identify better stands, individual trees for tree improvement.

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