Vegetative propagation of *Angelica glauca* Edgew. and *Angelica archangelica* Linn.: two high value medicinal and aromatic herbs of the Himalaya

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Abstract: *Angelica glauca* Edgew. and *A. archangelica* Linn. (Apiaceae) are high value medicinal and aromatic plant species of the Himalaya. Their *ex-situ* cultivation is recommended for conservation and regular supply of raw material for pharmaceuticals and ethno-medicinal uses. Vegetative propagation of these species was carried out at Pothivasa (2200 m asl): a part of Western Himalaya, Uttarakhand, India. Three treatments *viz*., IBA, IAA and GA_3 with different concentrations (100, 200 & 500 ppm, each) were tried to stimulate sprouting and rooting. IBA 100 ppm showed better results in both the species. These treatments may be used for mass multiplication of these species. [Nature and Science. 2009;7(8):76-82]. (ISSN 1545-0740).

Key words: *Angelica* spp., conservation, medicinal herb, treatments, vegetative propagation

1. Introduction

Angelica glauca Edgew. and *A. archangelica* Linn., belong to family Apiaceae, are high value medicinal and aromatic plant species of the Himalaya. *A. glauca*, locally called as Choru or Gandhrayan, is native and endemic plant species, distributed along 2600 to 3,700 m asl in Uttarakhand, Jammu & Kashmir and Himachal Pradesh (Butola and Badola, 2004). The species is known for its multiple uses in traditional as well as in modern medicine. The rhizomes of the species are considered as cardio active, cordial and useful in constipation (Anonymous, 1985). Whole herb is reported to be useful to cure stomach troubles, bilious complaints, menorrhagia, infantile atrophy and as a stimulant (Chopra et al., 1956 and Anonymous, 1985). *A. archangelica* locally called as Rickhchoru in Garhwal region and commonly known as European angelica or wild parsnip, is an aromatic, stout, perennial herb with 60-200 cm in height. It is native to Austria, Belgium, Denmark, Germany, Greenland, Hungary, Ice-land, Poland and Central Russia. In India, it is found in Western Himalaya mainly in Kashmir (1000-3900 m), Garhwal and Kumaon regions at altitudes of (2600 m–3900 m); also reported from Sikkim at (3000-3300 m). The herb, including the fruits and roots, is used for flavoring, and is reported to possess carminative properties. The root is aromatic and is reported to posses' diaphoretic and diuretic properties, and is used in flatulent colic. It is sometimes applied externally as a counter-irritant. Internally it is used in digestive complaints, flatulence or as a tonic for cold and respiratory system (Anonymous, 1985).

Market demand of these species for pharmaceuticals and ethno-medicinal utility, are met through harvesting from wild populations. Due to unsustainable harvesting, habitat loss and grazing pressure these species have been assigned as endangered for the Himalayan region (Ved et al., 2003). Vashistha et al. (2006) reported the status of both *Angelica* spp. as endangered on the basis of population survey from Garhwal Himalaya. Both the species are propagated by the seed and vegetative parts. However, the existing report on seed germination is not reliable in view of their low germinability (Butola and Badola, 2004; Vashistha, 2006; Vashistha et al., 2009) and slow growth (Butola and Badola, 2006).

Vegetative propagation is one of the potential and useful methods that need to be tried for those species, which are economically important, difficult to raise through seeds and other means. Plant propagation through vegetative means multiplies these plants and preserves their essential genetic characters. This is an easy and effective technique for multiplication and conservation of plant species. Sexual reproduction is considered less important than vegetative propagation for arctic and alpine species (Bliss, 1971). Plant growth regulators and other chemicals are widely used in vegetative propagation to improve rooting and subsequent growth of cuttings (Nadeem et al., 2000; Butola and Badola, 2007). Present study was carried out to develop vegetative propagation protocol for the selected species using rhizome segments.

Materials and methods: In the month of October, rhizomes of selected *Angelica* species were collected from natural habitat Tungnath (TN): an alpine zone (3600 m asl) located between 30°14' N Lat. and 79°13' E Long. in Rudraprayag district of Garhwal, Uttarakhand Himalaya, India. The rhizomes were washed thoroughly with running tap water. Each rhizome was cut into small pieces (approx 6 cm long) as there were apical buds present on the rhizome. The root part was not considered for propagation. These were treated with different hormonal concentrations by dipping them in particular hormonal solution for 24 hrs. One lot was dipped in distilled water to treat as control. Hormonal solutions of 100, 200 and 500 ppm concentrations of GA_3, IBA and IAA were used as treatments. For individual treatment three replicates with twenty cuttings each were used. Subsequently, treated segments were planted in soil beds in October 2004 at Pothivasa (PV) situated in temperate zone (2200 m asl) between 30°28' N Lat. and 79°16' E Long. in Rudraprayag district of Garhwal, Uttarakhand Himalaya, India. Soil beds with pH 4.67-5.01, soil organic carbon 1.0-1.23% and nitrogen content 0.04-0.23% while potassium and phosphorus content was very low in the soil of the experimental site (Vashistha et al., 2007). After the onset of next growing season in May 2005 number of sprouted segments and rooting were recorded in each treatment.

Data analysis: The data was analyzed statistically using MS-Excel 2003. Data presented here are mean values of treatments with standard deviation. ANOVA was used to interpret the variation and to identify the best treatment.

Results and Discussion: Results of vegetative propagation of *A. glauca* and *A. archangelica* are shown in table 1 & 2, respectively. Results indicate that maximum sprouting and rooting was observed in 100 ppm of IBA (88.33% and 85.00%, respectively). Rooting of the rhizome cuttings was fairly high in *A. glauca* (68.33%) and *A. archangelica* (78.33%) even without using any intervention. However, further increase in rooting percentage was possible by applying different concentrations of IBA, IAA and GA_3 (100, 200 and 500 ppm). Butola and Badola (2007) have recommended IAA and IBA as promising treatments to improve rooting, growth and biomass in *A. glauca* and *Heracleum candicans.* Variation was found significant among different treatments on the basis of ANOVA ($P<0.05$). When, sprouting as well as rooting was compared with control by using LSD, variation was found significant for IBA 100 ppm and IAA 100 ppm and rest of all treatments were found non-significant. In case of *A. archangelica*, maximum sprouting and rooting was observed in IBA 100 ppm (91.67%, 88.33%, respectively). In this species, variation was significant ($P<0.05$) only for IBA 100 ppm and rest of all treatments were found non-significant (Table 2).

Table 1. Effect of different growth hormones on vegetative propagation of *A. glauca* using rhizome segments.

Treatments	Sprouting Percentage	Rooting Percentage
Control	70.00±5.00	68.33±2.89
IBA 100 ppm	88.33±2.89*	85.00±5.00*
IBA 200 ppm	75.00±5.00	73.33±2.89
IBA 500 ppm	68.33±2.89	65.00±5.00
IAA 100 ppm	85.00±5.00*	83.33±7.64*
IAA 200 ppm	68.33±5.77	66.67±7.64
IAA 500 ppm	63.33±2.89	61.67±2.89
GA_3 100 ppm	75.00±5.00	71.67±2.89
GA_3 200 ppm	61.67±2.22	60.00±5.00
GA_3 500 ppm	51.67±2.89	48.33±2.89
F value & LSD (P<0.05)	20.23* 5.80^{+}	14.85* 6.55^{+}

* Significant

Table 2. Effect of different growth hormones on vegetative propagation of *A. archangelica* using rhizome segments.

Treatments	Sprouting Percentage	Rooting Percentage
Control	83.33±7.64	78.33±2.89
IBA 100 ppm	91.67±2.89*	88.33±5.77*
IBA 200 ppm	80.00±5.00	76.67±2.89
IBA 500 ppm	71.67±2.89	68.33±2.89
IAA 100 ppm	83.33±5.77	80.00±5.00
IAA 200 ppm	71.67±7.64	68.33±2.89
IAA 500 ppm	65.00±5.00	61.67±2.89
GA_3 100 ppm	76.67±5.77	73.33±7.64
GA_3 200 ppm	65.00±3.33	63.33±7.64
GA_3 500 ppm	55.00±5.00	51.67±2.89
F value & LSD (P<0.05)	11.80* 7.59^{+}	14.91* 6.68^{+}

*Significant

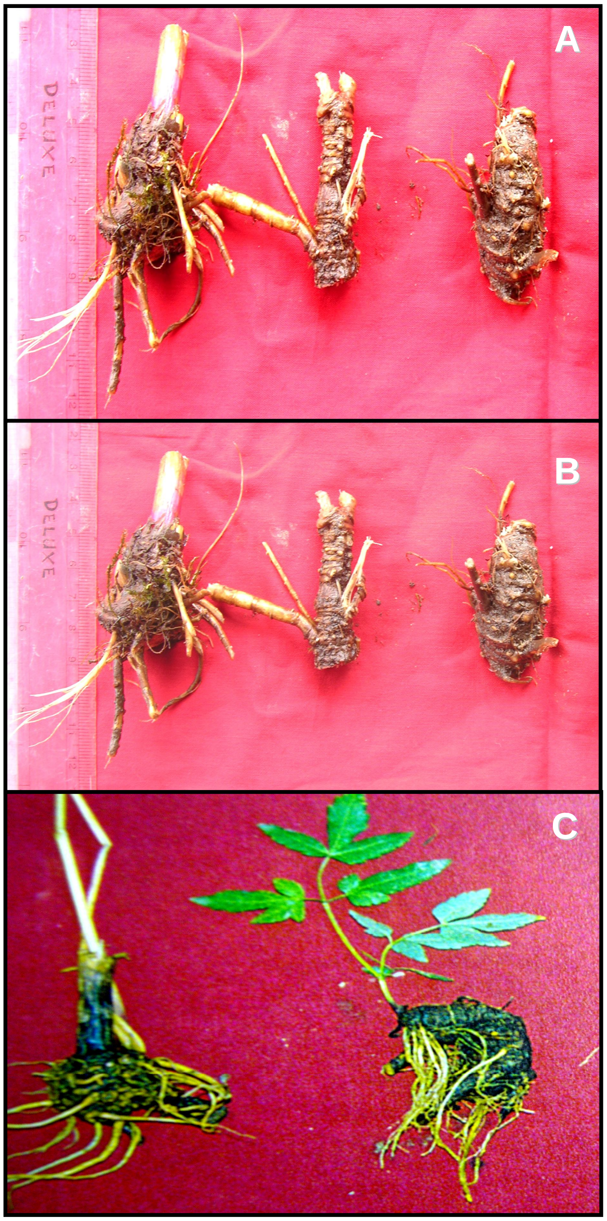

Plate 1. Vegetative propagation in *A. glauca*
A- Rhizome segments; B- Root initiation in rhizome segments;
C- Vegetatively propagated plants

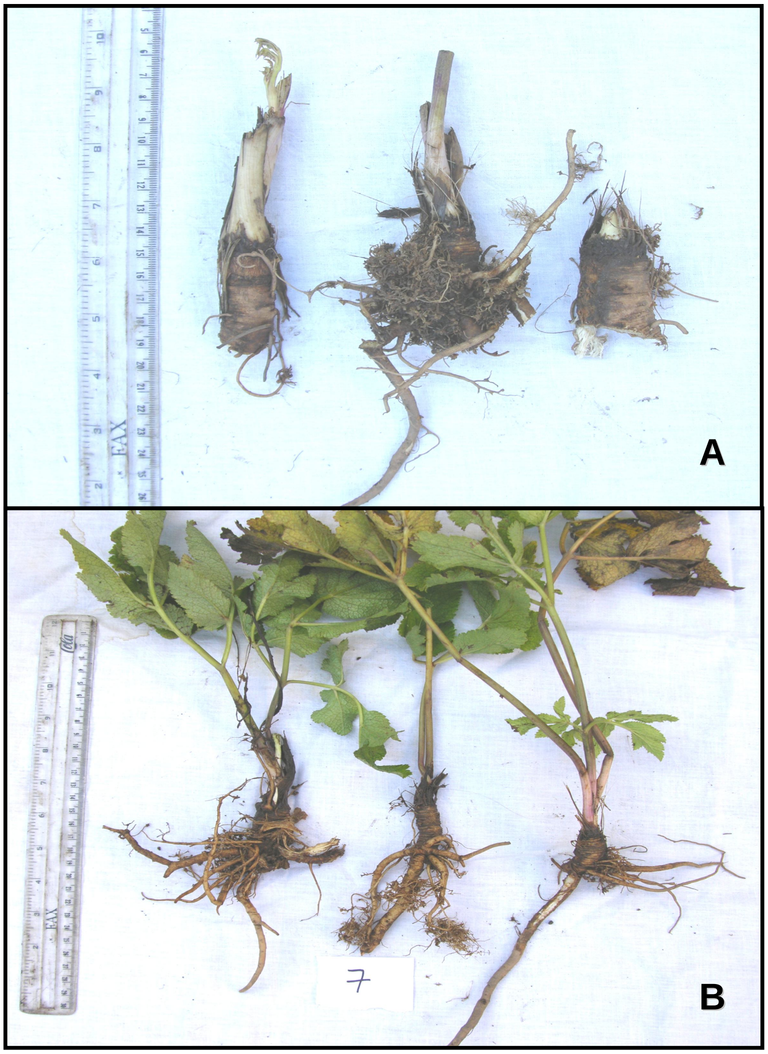

Plate 2. Vegetative propagation in *A. archangelica*
A- Rhizome segments; B- Vegetatively propagated plants

Rooting response under control set, however, indicates availability of natural auxins within the cuttings in adequate quantities to initiate the rooting. Moreover, better responses under IBA were in conformity with the reports of its effectiveness as compared to several naturally occurring auxins in promotion of adventitious roots (Hartmann and Kester, 1983). Higher concentrations of GA_3 (200 and 500 ppm) were found less effective in both the species. In the present study, transverse rhizome segments were used which responded well for differentiation of root/shoot system (Plate 1 and 2). Rawat et al. (1992) reported that the transversely segmented tuber have the potential to regenerate in new plantlets with well-differentiated root and shoot. Kuniyal et al. (2003) attempted to propagate *Aconitum atrox* through tuber segments at lower elevation in the Garhwal Himalaya. Apical segments produced single shoot while sub-apical, middle and basal were also able to regenerate several sprouts.

Vegetative propagation can be used as an efficient tool for mass scale propagation of tuberous roots of medicinally important species as in case of *Aconitum atrox*, the species fails to establish through seeds under natural conditions in an alpine environment (Kuniyal, 1999). In *Picrorhiza kurrooa*, vegetative propagation using stolon segments was found successful for cultivation up to 1800 m altitude with high moisture regime and proper aeration (Nautiyal et al., 2001). Maturity stage of planting material is suitable for multiplication as maximum numbers of buds are found in this stage (Manjkhola and Dhar, 2002). Therefore, in present study rhizome segments were used after complete maturity stage of the selected species.

Conclusion: In both the *Angelica* species, only rhizome segments can be used for vegetative propagation. The collectors of raw material may be suggested to use the terminal part of rhizome for cultivation and utilize the remaining root part for medicinal purposes. Considering the economic potential of these species, this technology has immense potential of easy adoption by the farmers, and has significant value for both conservation and sustainable utilization of these *Angelica* species.

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