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NEW IMPROVEMENTS IN PLANT QUALITY OF *ANGELICA ARCHANGELICA L.* AS A CROP SPECIES OF FOOD AND PHARMACEUTICAL INTEREST

Camelia SAVA SAND, Maria-Mihaela ANTOFIE

Lucian Blaga University from Sibiu, Faculty of Agricultural Sciences, Food Engineering and Environment Protection, 5-7 Dr. Ioan Ratiu, Sibiu City, Sibiu County, Romania
Email:camelia.sand@yahoo.com

Corresponding author: camelia.sand@yahoo.com

Abstract

Angelica archangelica L. is a medicinal plant species with a real continuously developing potential for its use in homeopathy and food industry for future. The species is known and cultivated since ancient times for treating certain diseases. In the last century active chemical compounds of pharmaceutical importance have been described and lately more and more European countries are using this plant in the food industry as such or as food ingredient. The scope of this article is to evaluate agricultural practices for improving canopy production in angelica 'De Cristian' population, originating from the wild and collected in Brasov area during 1990. A distance between rows of 80 cm is ideal for this species cultivation as a crop plant in similar agro-ecosystems in South East Transylvania.

***Key words*:** *Angelica archangelica, crops, field cultivation, morphometry, Romania*

INTRODUCTION

Angelica archangelica L. is a protected plant species with a high cultural value all over the world that it is used today in the pharmaceutical industry as well as in food industry and adding homeopathy and cosmetics uses [15]. In Romania the species is not allowed to be harvested from the wild as it is protected by law since 1977 when it was declared as a nature monument species [1]. Still the species may be cultivated and may be introduced into the crops species group easily, in riparian agro-ecosystems, positioned at lower altitudes (500-600 m) and sheltered but sunny places [4, 5].

Roots, petiole leaves and fruits possess proved pharmaceutical effects such as the following: carminative, stimulant, diaphoretic, stomachic, tonic and expectorant which are stronger in fruits, although the entire plant has such virtues. Pure volatile oils from angelica (i.e. 'Aetheroleum Angelicae'), which initially is colourless, in time turn in green colour, as well as composite oils proved to be an excellent treatment externally of rheumatic diseases [6]. Composite oils of angelica (i.e. 'Spiritus Angelicae' also a volatile oil composed from angelica extract, camphor and alcohol) in low dosage are cerebral exciting and in high-dose become narcotic and induce depression [11].

The extract from the upper part of the plant (i.e. 'Herba Angelica') supports toxin elimination, have anti-inflammatory activity for rheumatic diseases and cure diseases related to these proved activities (i.e. colds, colic and urinary diseases) [13]. Although angelica should not be administered to patients who have favourable predisposition for diabetes as it induces blood sugar rise and the sugar excretion into urine. Among other beneficial effects angelica extracts may be used in the cure for alcoholic dependency due to nausea effects when it is associated with alcohol. Also it may be used as a good vehicle for nauseous drugs. The extracts from aerial parts of the plant may have also slight effects in stomach and gut diseases – reducing malfunctioning of fermentation and nutrients absorption [9], as well as in cancer therapy [14].

Rhizome extracts of angelica are used in stomach and gut disease supporting the guts secretory function and regulating guts fermentation processes [12].

Food industry applications for *Angelica archangelica* L. Aroma is much appreciated and used since ancient times when sugar products were extremely rare. Today it is widely used in trade with delicacies, producing a flavour much appreciated for the manufacture of confectionery and liqueurs. The food processing of this species is small but important as industry in the Southern and Western parts of France where the cultivation area more concentrated is Clermont-Ferrant. Angelica flavour is similar with that of juniper and fruit is much used in combination with juniper leaves or partially substituting them for gin distillers. The stem is much used in the preparation of canned fruit jams and generally being used by some confectioners as an aromatic garnish [6].

In terms of food industry angelica comprises one of the ingredients included in the composition of anise essence. Angelica was one of the ingredients aromatic based used also since ancient times on both banks of the Rhine in Europe where it was cultivated and used in French and German cuisine. Thus, seeds extracts and essential oils of plants are largely used for flavouring ice cream, candy, grocery items, puddings, syrups and alcohol. Volatile oil from the seed is used to flavour toothpastes and perfumes industry [7].

The scope of this article is to discuss a different cultivation technology for increasing the production of volatile oils in *Angelica archangelica*, a Romanian population 'De Cristian', for further supporting the use of this technology for food production.

MATERIALS AND METHODS

Plant material *Angelica archangelica* L. is a protected wild species in Romania which is blooming during June and July in the last years due to climate change. In these experiments were used 10 kg seeds per ha that have been sowed in 15 of September 2012 and are originating from 'De Cristian' population native from Brașov area (North: 45.673698 and East: 25.541689). We are mentioning that the experimentation area expresses similar climatic conditions with that of Brașov [8, 10].

Field experiment. Two plots of 1,000 m^2 each have been tested in this experiment that are positioned in the experimental field of Lucian Blaga University of Sibiu (North: 45°48′54″ and East: 24°1′40″) with appropriate conditions for supporting the cultivation of the species (river bank, moisture and sunny place) under the meteorological conditions of the year 2013.

Crop Technology. Two types of distance between plants rows such as 60 (variant V1) and 80 cm (variant V2) that are imposed by used agricultural equipment. The culture was bio and therefore no soil amendments or fertilizers have been used.

Oil extraction and analysis follows the methods described by Bergonzi and collaborators [3].

Plant Morphometry was performed for measuring the height of the plants, no of leaves into the rosette, no of branching per plant, no of inflorescence per plant, the diameter of basal part of the stem and observations related to the roots and rhizomes in order to evaluate the general development process of the crop plant.

RESULTS AND DISCUSSIONS

In 2013 were realized measurements regarding plant morphometry after blooming period during July and all results will be discussed accordingly bellow.

Plant development

According to results analysis of over 500 individuals for plants cultivated with 60 cm between rows (V1) there have been registered the following measurements: the mean height of the whole plant 175.23 cm a bit slight bellow for those plants harvested from the V2 variant (i.e. 80 cm between rows and about 400 individuals) and measuring a mean height of 181.09 cm (Photo 1).

Rosette development

In V1 the mean was of 11.85 leaves per rosette as a mean regarding all measured individuals which was low compared to that of plants obtained on the V2 and presenting a mean of 14.36 leaves per rosette. It is obviously that the larger distance between plants is stimulating the leaves development

for each plant rosette and sun has definitively a positive influence in this developing process.

Photo 1. Variant V2 for the cultivation in the field of Angelica archangelica ‚De Cristian'

Branching development

It appears that the branching process should be also supported by the sun in the wild for the species and in this experiment maintaining a distance of 80 cm may positively influence the process. Thus, in this case a mean value of 8.26 branching have been observed compared to the first variant (V1) where we identified around 7.05 branches. The volume of the aerial part of the plant is much depending on the space encountered into the natural habitat and therefore the second variant V2 is providing the best conditions for branching stimulating (Photo 2).

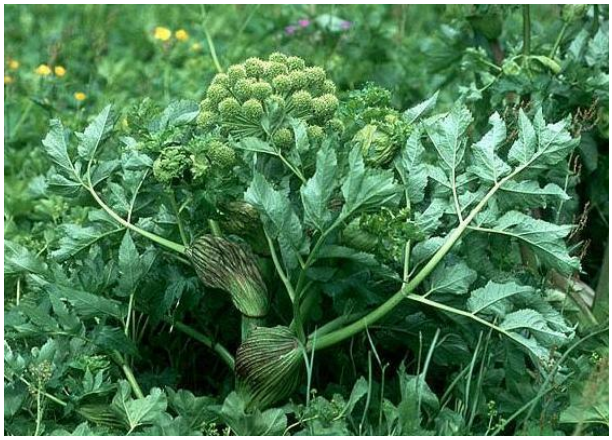

Photo 2. *Angelica archangelica* 'De Cristian' population during the blooming period

Inflorescence development

Plants cultivated in the first variant are producing a mean of 65.48 inflorescence per plant which is approximately similar with those of the second variant (V2): 67,21 inflorescence. Still, in the second variant the number of inflorescences is slightly increased compared to the first supporting the idea that plants needs more space for ensuring the complete development like in the wildness in their natural habitats.

Stem vigour

The vigour of the plant is also estimated base on the diameter of the stem and in V1 case plants presented a mean diameter of 15.6 cm slightly small compared to the plants obtained on V2: 17.4 cm supporting again the idea that the vigour of the plant is largely influenced by the space between plant rows. No influence is for the rest of the stem in diameter of all studied plants.

The content in volatile oil

In the same period samples from leaves, petioles and part of the plants have been taken for analysing the volatile oil content (ml %) for both variants V1 and V2. This procedure was realized during the morning between 8 and 10 o'clock to be consistent with the method applied. In this regard it was obtained slight low levels of volatile oils for plants obtained in V1 (0.042 ml % for leaves; 0.032 ml % for petioles and 0.03 8ml % for herba) compared to V2 (0.047 ml % for leaves; 0.033 ml % for petioles and 0.04 8ml% for herba) considering triplicates samples and which are consistent with the idea that this species as a crop needs more space than 60 cm to maturate the production of volatile oils. Leaves comprise more volatile oils compared to herba and compared to petiole presenting no difference compared to wild individuals.

Roots harvesting

As a general observation, the root system in case of plants cultivated on variant V1 is realized from tinny roots compared to that of V2 which stimulates in turn the overproduction of volatile oils. This observation is important for roots harvesting in autumn (i.e. October) when rhizomes will be short, juicy presenting roots according to the requirements for volatile oil extraction [2]. The roots may be harvested in the first year (i.e. autumn) as well as in the second year of vegetation (spring time before vegetation starting). Roots from primary year are much

juicy compared to that of the second year also reflected on the oil composition differences.

Petiole harvesting

Before root harvesting, mowing aerial parts of the plants is imposed and this also may be further used for pharmaceutical or food purposes. Before mowing, separately harvesting fresh petioles may become more important if the interest is to used them for food preparing such as flavouring ice cream, candy, grocery items, puddings, syrups and alcohol based patisserie products.

Fruits harvesting

According to a series of authors the period of time between harvesting and oil extraction should be as short as possible, but this is essential for all medicinal plants. The optimum period for fruit harvesting is in September and October depending on the forecasting conditions. The harvested fruits may also be dried out and maintained in drain bags. The total production was around 950 kg/ha per variant V1 (95.25 kg/plot) and 102 Kg /ha per variant V2 (i.e. 10.2 kg/ plot) also supporting the technique of using 80 cm between plants rows. For food industry volatile oil as well as hydro-alcoholic extract of root origin as well as fruit volatile oil becomes important raw materials. They may be used as natural aromatic ingredients for liquor and beverages (e.g. Benedictine, Chartreuse, etc.) and patisserie.

CONCLUSIONS

The agricultural potential of *Angelica archangelica* 'De Cristian' population as a crop species is already proved and cultivation technology is influencing the productivity of the species. The best results in terms of plant volume are given by the large volume plants need to develop under similar conditions like in the place of origin. The species may have all attributes to enter the market place for food and pharmaceuticals industries**.**

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