Bulletin of the *Transilvania* University of Braşov
Series II: Forestry • Wood Industry • Agricultural Food Engineering • Vol. 4 (53) No. 1 - 2011

CURRENT ISSUES REGARDING THE CONDITIONING OF MEDICINAL PLANTS IN OZONATED ATMOSPHERE FOR CONSERVATION

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Abstract: *This paper presents the factors that cause degradation of medicinal plants, with applications to arnica and St. John's wort. After being harvested, they begin to lose water and wither, enzymatic degradation processes starting to take place, accelerated by some physical, chemical or photochemical processes, which cause changes in their chemical composition. In light of these aspects and the active principles content, inhibiting possibilities of enzymatic processes and removing other polluting factors are analyzed, in order to maintain their quality during conditioning, processing and conservation. We propose a method and a device for treating these plants using an ozonated atmosphere.*

Key words: *medicinal plants, conditioning, ozonated atmosphere, conservation.*

1. Introduction

Due to climatic conditions and geographical position, Romania has a varied and valuable spontaneous flora. Medicinal plants from the spontaneous flora of mountain areas are less affected by pollution, being particularly important, both in terms of large number of species, and their superior quality, as evidenced by the high content of active principles, responsible for their therapeutic action.

A disadvantage of using medicinal plants from the spontaneous flora is the risk of substitution with plants that have similar characteristics, and also exhausting some protected species, declared nature monuments.

The active principle is a substance derived from the plant's secondary metabolism, synthesized by the plant for its physiological needs. This can be a single organic substance or a complex of organic substances responsible for the therapeutic action or olfactory, flavouring and colouring properties [6].

The concept of active principle was firstly defined in 1527 by the Swiss Paracelsius, which showed that only an extremely small part of the plant is active (*Arcanum* or *Quinta essentia*). Research conducted since 1806 to the present, when the first vegetal active principle - morphine - was obtained in pure state from opium, were finalized with the isolation of a large number of such substances from various species of medicinal plants, which resulted in a widening in the field of application of

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phytotherapy. The content of active principles has a wide distribution in the plant's organs, accumulating differentially in the plant's tissues (leaves, flowers, fruits, seeds, roots and rhizomes).

The qualitative and quantitative content of active principles is largely influenced by stationed factors (soil, climate conditions, growth stage), but mostly by the way of harvesting, conditioning and storing, which can compromise the product partially or completely [4].

Research conducted so far on the inactivation of enzymes which produce qualitative changes on medicinal plants have shown that the stabilization operation can be done by changing the environmental conditions (temperature, humidity) by storing medicinal vegetable products at low temperatures, in a refrigerated room.

This procedure has the disadvantage that with increasing temperature, enzymes resume their activity, being a reversible process. Also, reducing the moisture percentage in plants does not ensure a removal of enzymatic activity, in which case in poor storage conditions in wet spaces, the degradation of active principles from plants continues.

Noticing the fact that even when using the slow drying process of plant material, some active principles are being degraded, after research methods of irreversible inactivation of enzymatic activity were developed. Specialized literature offers a number of processes by which irreversible stabilization is being done:

- Treating the organ of the vegetable product with organic chemicals or minerals that act as enzyme inhibitors: ammonium sulphate, sodium sulphate, sodium metabisulphite, sulphonamides, antiseptics, antibiotics, pH modifiers (citric acid, tartaric acid, lactic acid), antioxidants (ascorbic acid, flavones) [5];
- Perrot-Goris process by which enzyme inactivation is achieved by maintaining the plant material in alcohol vapour under pressure;
- Goris-Arnould process by which the plant material is kept for several minutes under pressurised vapours of water;
- Bourquelot method which consists in keeping the product fresh in hot alcohol and $CaCO_3$ (for preparation of extracts);
- Freezing.

2. Materials and Methods

The materials studied in this paper are the following herb plant organs: arnica and St. John's wort, which are presented below.

Arnica (*Arnica Montana L.*) of the Compositae family (Figure 1) is a perennial herbaceous plant with a strong underground rhizome which grows lanceolate leaves during the spring that are grouped in a rosette. From the middle of the leaves a cylindrical stem rises and is up to 1 m high, less branched, on which there are 1...2 pairs of opposite leaves, smaller than the base ones. It's characterized by a terminal yellow-orange inflorescence, with two lateral inflorescences situated below the terminal one. For medicinal purposes only the terminal inflorescence (*Flores Arnicae*) is harvested. The plant grows in wet meadows and pastures in the mountain and

Fig. 1. *Arnica* (*Arnica montana L.*)

subalpine areas. It is found in all the Carpathian chain, particularly in Transylvania and northern Moldavia. Reseeding is recommended during autumn in the places where the inflorescences were harvested because the plant is becoming increasingly rare in spontaneous flora [3]. Harvesting the rhizome and root is prohibited due to the rarity of the plant.

Chemical Composition: Arnica flowers contain 0.15...0.5% volatile oil, 0.2...0.3% flavonozide, 0.7% polyphenolcarboxylic acids, 1% procyanidols, carotenoids, tannins, pentacyclic triterpenes. Underground organs are richer in volatile oil content (6.3% in rhizome and 3.7% in the roots), 12% inulin, tannins and organic acids [7].

Uses: The product is used as a tincture, infusion and oily extract. The infusion is recommended in the treatment of coronary insufficiencies, being considered the second vegetal product, as efficiency, after the hawthorn. The oil obtained by hot macerating of the flowers, mixed with other herbs, can be used to treat rheumatism, arthritis, neuralgia, for activating the metabolism and better irrigation of the skin. Internal administration should be undertaken cautiously, because it can become toxic in higher doses [1].

St. John's Wort (*Hypericum perforatum L.*) of the Hypericaceae (Figure 2) is a perennial herbaceous plant, 0.2 to 1 *m* high, with a cylindrical stem, two lateral branches and numerous branches growing from the base of the leaves. The leaves have an oval or elliptical form, having black dots on the edges and on the front. The flowers have five yellow petals with black dots and numerous stamens. It ranges from the plain and up to the subalpine area (more abundant in the hilly area), especially in meadows, at roadsides and forests. It supports a water mode that is poorer in precipitation and also an arid or high rainfall regime. It is resistant to both lower temperatures and summer heat. This plant is less influenced by soil reaction, supporting both acidic and basic soils, but generally more refined and with a higher content of nitrogen. The used plant product is the bud and flower terminal parts that range from 20 to 30 cm (*Herba Hyperici*) which have a characteristic odour and an aromatic, bitter taste.

Fig. 2. *St. John's Wort* (*Hypericum perforatum L.*)

Chemical Composition: Upper aerial parts contain 6.5...15% tannins, 2...5% flavonoids, 0.2% bioflavonoids, phloroglucinols, phenolic acids, derivatives of anthracene, 0.05...1% essential oil, vitamin C and A, minerals [7].

Uses: Due to hypericin, pseudohipericin, volatile oil and tannins, St. John's Wort has an antiseptic, astringent and healing action. Flavonoids are responsible for the vasodilatory and hypotensive action, while hypericin is used in the treatment of depressive states.

The product is used as an infusion and oily extract. The infusion is recommended in the treatment of colitis and cholecystopathies. Oil obtained by hot maceration of the vegetal product is internally used to treat liver and stomach ulcers diseases, and externally as a disinfectant for cicatrizing and healing wounds and burns.

Once harvested, the vegetal organs of arnica and St. John's wort plants can be kept fresh only a very limited time because of their high water content which favors bacterial (u = 45...90%) and fungi attacks (u = 15…20%).

Also, after harvest, enzymatic and some physical, chemical or photochemical processes produce the degradation of the plant's chemical composition. For a long-term storage without deterioration and loss of active principles to be assured, plant products must reach a humidity level below 15%, except for leaves and flowers, which require a moisture content below 5%, or some fruit, which may have a moisture level up to 20%. The humidity of different medicinal plant organs is shown in Figure 3 [2].

Given the fresh plants' moisture level it is found that by drying, considerable quantities of water should be removed, which vary depending on the plant's organ and on the harvesting moment.

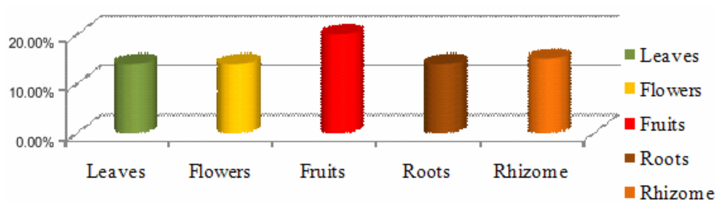

Fig. 3. *Humidity of the medicinal plant organs, %*

The drying efficiency is the ratio between the amount of fresh plant desiccated and the amount of dried plant resulted after the process of drying. It is expressed by the amount of necessary fresh plant to obtain one kilogram of dried product (specific consumption).

The efficiency and specific consumptions for the organs of the medicinal plants are presented in Table 1 [4].

Efficiency and specific consumptions for medicinal plant organs Table 1

Vegetal organ	Efficiency, [%]	Specific consumption: $\frac{\text{green kilo}}{\text{dried kilo}}$
Leaves	15…20	3…9:1
Flowers	20…25	5…9:1
Fruits	45…50	2:1
Roots	25…45	3…6:1
Rhizome	25…40	3…5:1

The fresh harvested material must undergo a stabilization operation which inactivates the enzyme before being industrially processed or dried.

In order to obtain high quality plant material, freshly harvested product containing about 45...95% water, undergoes a drying operation during which water is removed and the fermentation processes of the plant are stopped.

By drying, the action of enzymes and fungi is blocked, the colour is retained, the size and weight are reduced resulting in a better preservation of plant material.

Drying methods used on herbs are natural and artificial drying.

For the arnica (*Arnica montana L.*), framework technologies for medicinal and aromatic plants recommend a rapid drying to stop the shift process in the fruit, which continues with a slow drying. Drying can be done in a natural way, at shade, in well aired rooms, in a thin layer. Artificial drying is indicated at 40...50 °C, which can destroy the pests which degrade the product. A yield of 5...6:1 is obtained.

The same technology framework recommends for St. John's wort (*Hypericum perforatum L.*) a natural drying, at shade, in thin layers, in well aired places, while being turned from time to time, with caution because of the defoliation of the strains. It can be dried and tied in bouquets and tied using rope, but the method is cumbersome and can cause rotting at the place where the plants are tied. Artificial drying is done at about 35 °C, the drying efficiency being 3...4:1.

Starting from these assumptions, the design and implementation of equipment for inactivating the enzyme process of the plant product, by the use of ozone produced by the Corona discharge is proposed. The scheme of the equipment used for stabilizing the medicinal plants, by ozonation is shown in Figure 4.

The efficiency increase of the equipment is due to the principle of producing ozone, at the surface of the metal conveyor belt, close to the herbs that are treated.

By providing optimal distance between the Corona discharge space and the moving conveyor surface on which the herbs will be treated using this new technology, an increase in the electric field strength and with it an increase in the electrical power that generates ozone will be obtained.

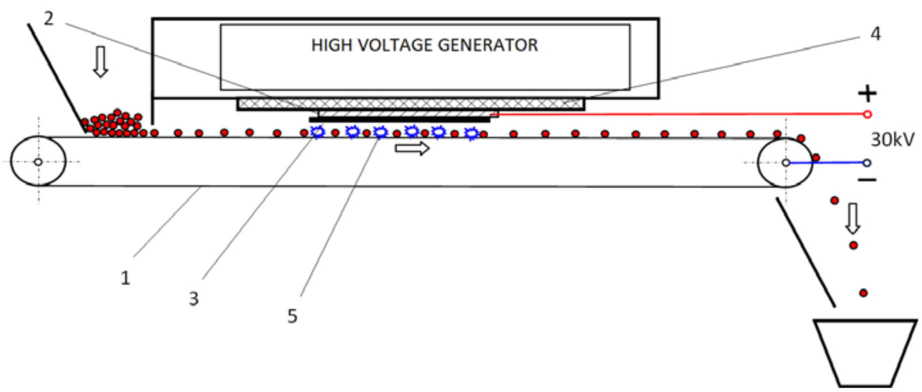

Fig. 4. *The scheme of the equipment used for stabilizing medicinal plants, by ozonation*

The vegetal products situated on the metal link chain conveyor 1 are uniformly distributed in a single layer over its surface. They are led to the metal plate 2 that is coupled to the plus of the high voltage generator (30 kV). Since the conveyor is coupled to the minus of the source, ozone will be generated on its surface due to the Corona effect 5. The metal plate 2 is fixed to the chassis through the insulation board 4. The dielectric 3 does not allow direct discharges from the anode to the cathode, but only to produce the Corona effect.

3. Conclusions

- Due to high water content and enzymatic processes caused by temperature and moisture, the storage period can be increased by treating the herbs with ozone.

- Maintaining the qualitative value of medicinal plants from harvesting to industrial processing is linked to their biological nature and the conditions under which they are stored. Based on these preliminary data we propose to study the effect of stabilizing the enzymatic process in plants by using the ozone produced by Corona discharge.
- The constructive version of this equipment is economical in terms of electricity consumption and can be easily included in the chain of industrial processing technology.

Acknowledgement

This paper is supported by the Sectorial Operational Programme Human Resources Development (SOP HRD), financed from the European Social Fund and by the Romanian Government under the contract number POSDRU/107/1.5/S/76945.

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