

## STUDIES AND RESEARCH ON THE DRYING PROCESS OF MEDICINAL PLANTS WITH HIGH THERAPEUTIC VALUES, CASE STUDY CHRYSANTHEMUM AND ALOE VERA

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**Abstract:** This paper aims at studying the technological process of dehydration of medicinal and aromatic crop plants and spontaneous flora, in order to determine the most suitable drying process and the technical-functional equipment. The artificial dehydration of food products medicinal and aromatic plants, although it is characterized by relatively high costs, is widely used because dried products have the weight and volume reduced and may be retain and use for a long time after harvest, maintaining food quality or the therapeutic quality (in the case of medicinal plants). At the same time can ensure the rigorous control of technological operations, so the final product complies with current food safety regulations.

**Keywords:** technological process, dehydration, medicinal plants

### 1. INTRODUCTION

Artificially drying of food products, medicinal and aromatic plants, is widely used because dried products have low weight and volume, can be easily stored and retains much better nutritional and therapeutic qualities. At the same time can assure a rigorous control of technological operations, so the final products comply with current food safety regulations [8,11].

Medicinal and aromatic plants are used as such in the form of vegetable products for preparing teas, decoctions, infusions and other preparations used for health care or nutritional purpose.

The teas constitute the most efficient way for extracting the active ingredients from the plant and, unlike the drugs do not cause unwanted side effects. But medicinal and aromatic plants are a source of raw materials for the extraction of active ingredients and oils, with particular value for many industries [3,4,8].

The main areas for use of the medicinal and aromatic plants as well as products and active ingredients extracted from them are: in food in the form of teas, food additives, spices, colorings, sweeteners, preservatives, alcoholic or non-alcoholic drinks, for flavoring food products (chewing gum, chocolate) or nonfood (detergents) and maintenance for medical treatments, including aromatherapy cosmetics and perfume industry, deodorants products, shampoos, bath lotions, toilet soaps, toothpaste, mouthwash and as natural pesticides for plant protection [3,8,11].

Convection drying was and is the most widespread method of removing moisture from the plants because of the simplicity of the technological process and the many variants applicable (including the possibility of association with another drying principle), in short time and with a relatively low cost [2,4,5,9,10].

Warm air constitutes the heating agent of the drying process, but he has the role of driving the processed material moisture evaporated. Heat and mass transfer during the drying process is conditioned by the drying agent parameters (speed, temperature and relative humidity of the warm air) and the linkage between the moisture and material [7,9].

Should be taken into account that the dehydration of vegetable products is influenced by a number of factors such as the variety of the plant, the plant that must be dried and its physical and chemical properties, the drying aerial parts of the plant high content of essential oils helps to rapid removal of water from the plant, humidity initial and final preparation mode (the crumbling degree), the drying process used, the limits imposed of temperature and speed of drying in order to not affect the therapeutic value of the active substances, weather conditions (temperature, the relative humidity of the air) in which the dehydration process is carried out.

The duration the dehydration process is chosen according to the physic and chemical characteristics of the plant so that after drying the moisture content not exceedingly generally

14%. For plants rich in oils (like peppermint, thyme, or basil) drying temperature should not exceed 35 °C [9].

Table 1. The parameters of drying technology for several species of medicinal and aromatic plants

The name of the plant	The drying part of the plant	Drying temperature [°C]	Drying efficiency
Cornflower ( <i>Centaurea cyanus</i> )	Flowers	max. 35°C	3 ÷ 4.5 : 1
Artichokes ( <i>Cynara scolymus</i> )	Leaves	40 ÷ 45°C	6 ÷ 8 : 1
Basil ( <i>Ocimum basilicum</i> )	Aerial part	max. 35°C	6 : 1
Chicory ( <i>Cichorium intybus</i> )	Aerial part, Root	40 ÷ 50°C	5 ÷ 7 : 1 4 ÷ 5 : 1
Thyme ( <i>Thymus vulgaris</i> )	Aerial part	max. 35°C	4 ÷ 5 : 1
Milfoil ( <i>Achillea millefolium L.</i> )	Flowers	30 ... 35°C	3,5 ÷ 4 : 1
Hyssop ( <i>Hyssopi herba</i> )	Aerial part	max. 35°C	4 : 1
Lavender ( <i>Lavandula angustifolia</i> )	Flowers	max. 35°C	5 ÷ 7 : 1
Mint ( <i>Mentha piperita</i> )	Leaves	max. 35°C	4 ÷ 6 : 1
Chamomile ( <i>Matricaria camomilia</i> )	Flowers Aerial part	30 ÷ 35°C	5 : 1 3 ÷ 4 : 1
Plantago ( <i>Plantago lanceolata</i> )	Leaves	40 ÷ 50°C	6 ÷ 9 : 1
Lemon balm ( <i>Melissa officinalis L.</i> )	Leaves Aerial part	max. 30°C	4.5 ÷ 5.5 : 1 4 ÷ 5 : 1
Sage ( <i>Salvia officinalis</i> )	Leaves	30 ÷ 40°C	4 : 1
St John's wort ( <i>Hypericum perforatum L.</i> )	Flowers	30 ÷ 35°C	3 ÷ 4 : 1

## 2. MATERIALS AND METHODS

The installation for dehydrating of medicinal and aromatic plants on which have been made studies consists of a metal frame, trays placing the material to be dehydrated, enclosure walls and partitions, doors, and inspection cover, heat exchanger, a whole of the water supply, axial fan, valves for air control, electrical installation for command and control, measurement devices for the drying process parameters.

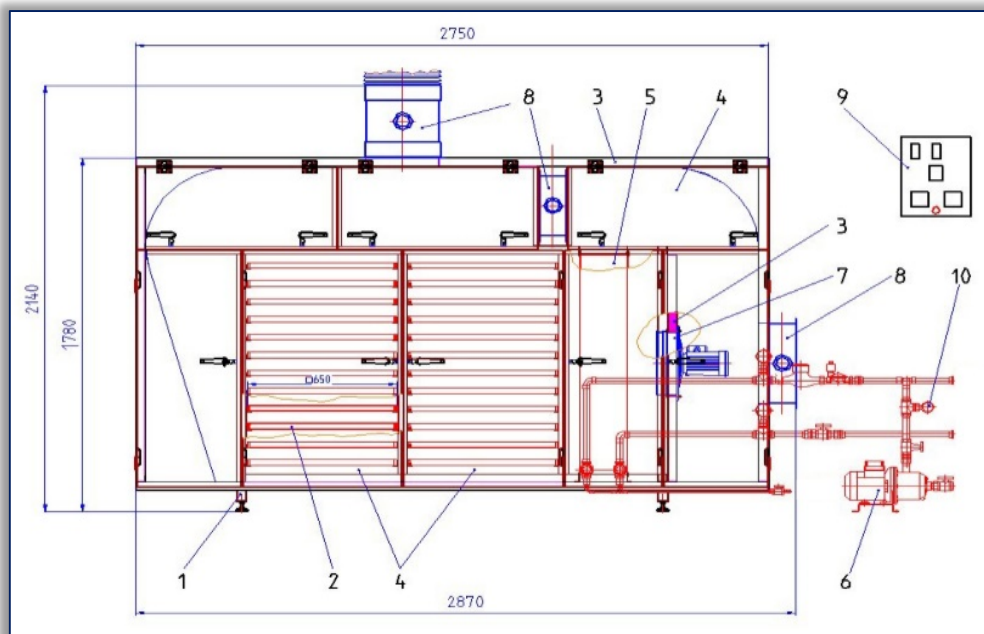


Figure 1. Technological scheme of dehydrating medicinal and aromatic plants installation

1. Metal frame; 2. Trays; 3. Walls; 4. Doors and covers; 5. Heat exchanger; 6. Whole of the water supply; 7. Axial fan; 8. Air dampers; 9. Electrical installation; 10. Measuring instruments

The functioning technological scheme of installation for dehydrating medicinal and aromatic plants is illustrated in figure 1.

The Installation for dehydration works in batches, the duration of dehydration of a batch depends on the type of vegetable material is vegetable it's being dried, being lower for larger herbaceous plants and fruit.

As shown in the technological scheme, the axial fan provides airflow through the radiator battery, which is heated by the hot water provided by boiler and then through plant material stacked in trays into the drying room. Because the bottom of the trays is provided with holes, some of the air flows vertically passing through the vegetable material placed on the trays, so that the drying process takes place in the entire volume of the product. The Register of adjustment with damper on the fan inlet allows manual adjustment of the flow of cold air (atmospheric air) and other valves are adjusted, all manually the flow rate of humidity laden air exhausted to atmosphere or recirculated warm air flow.

After prescribing drying parameters, automatic drying cycle was started. At the end of the process, the fan and the water pump was stopped.

The amount of air circulated through the installation can be adjusted, during operation of the installation in automatic mode, using inverter or handling dampers. Air velocity through trays product is an important parameter, especially for medicinal and aromatic plants drying, too high speed can lead to lighter fragments with high degree of dehydration.

The progress of the dehydration by using electric devices mounted on the cabinet door which indicates the temperature and humidity of the air leaving the drying room. Depending on the sizes of these parameters are made adjustments of ventilator sucked air flow and it was established the moment when starts the recirculation and the flow rate of recirculated air.

Recirculated air mode was obtained by the partial opening of the register control over the drying chamber and partial closing the admission register.



a)



b)

Figure 2. a) the medicinal plant dehydration facility that was used to conduct the research; b) drawers of the installation for dehydration of medicinal plants

### 3. RESULTS

In the first experiment, the plant called Chrysanthemum was used, which is well known for its medicinal properties. It has a detoxifying action and immune-stimulatory over the body [11].

The plant was placed in the drawers by 600g in each drawer, the initial sample weight being 9 kg. To keep the plant active principles, it was dried at 40 ° C.

The product was characterized by:

- The average initial moisture was  $a_{1m} = 67.34\%$  humidity  $a_{2m}$  final average was 7.93%;
- The 9 kg of plant load is the effective load at disposal for testing in following inputs conditions:
  - ≡ Initial mass of the sample:  $M_0 = 9$  kg;
  - ≡ Initial humidity:  $a_{1m} = 67.34\%$  ;
  - ≡ Total amount of water in the sample:  $M_{TA} = 6.06$  kg;
- The amount of dry substance:  $SU = 2.94$  kg;
- Final humidity:  $y_{a_{2m}} = 7.93\%$  ;
- The initial temperature:  $t_0 = 20$  ° C;
- The average drying temperature:  $t_m = 40$  ° C;

It was determined the specific energy consumption:  $q = 10.205$  kJ/kg evaporated water [1,6].

The values recorded in the first experiment (chrysanthemum) are shown in table no. 2 and figure no. 3.

Table 2. Values measured in the first experiment, Chrysanthemum

Den. no.	Drying time [min]		Power [% P <sub>n</sub> ]	Medium temperature [°C]	Measured sizes		Calculated sizes		Obs.
	Between measurements, Δt	Cumulated			Table sample, m [g]	Qty. of evaporated water in the measurement range, Δm [g]	Humidity [%]	Drying speed [%humid/min]	
0	0	0	0	20	100	0	67.34	0	
1	30	30	36	38	99.5	0.5	67.178	0.08	Preheating
2	30	60	36	40	94.63	4.87	60.34	0.3	
3	60	120	36	40.1	82.35	12.28	54.36	2.143	Constant speed drying
4	60	180	36	40	71.57	10.78	44.11	2.143	
5	60	240	36	39.9	58.44	13.13	35.4	2.143	
6	60	300	36	40.5	49.02	9.42	22.82	2.143	
7	60	360	36	40.3	42.32	6.7	20.48	0.81	Final drying
8	60	420	36	40	37.50	4.82	12.90	0.34	
9	60	480	36	29	35.47	2.03	7.93	0.06	Cooling

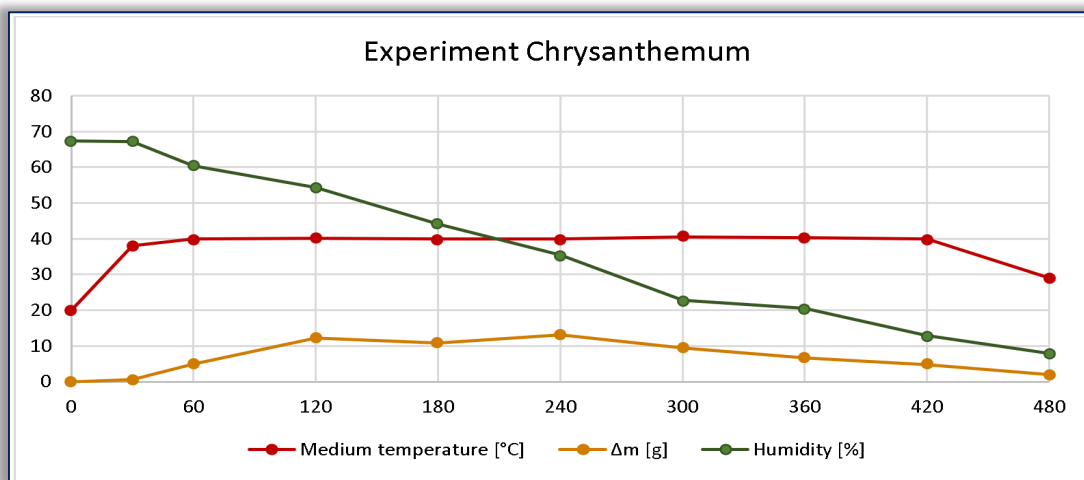


Figure 3. Values measured in the first experiment, Chrysanthemum

The values recorded in the second experiment (Aloe Vera) are shown in table no. 3 and figure 4.

Table 3. Sizes measured while performing the second experiment

Den. no.	Drying time [min]		Power [% P <sub>n</sub> ]	Medium temperature [°C]	Measured sizes		Calculated sizes		Obs.
	Between measurements, Δt	Cumulated			Table sample m [g]	Qty. of evaporated water in the measurement range, Δm [g]	Humidity [%]	Drying speed [%humid/min]	
0	0	0	0	25	100	0	77.08	0	
1	20	20	36	39	99.58	0.42	76.98	0.07	Preheating
2	30	50	36	40	95.71	2.87	76.05	0.27	
3	60	110	36	42	85.45	10.26	73.17	2.67	Constant speed drying
4	60	170	36	41.8	76.58	8.87	70.07	2.67	
5	60	230	36	42.1	63.08	13.50	63.66	2.67	
6	60	290	36	41.9	52.46	10.62	56.30	2.67	
7	60	350	36	41.6	44.78	7.68	48.81	2.67	
8	60	410	36	42	35.85	8.93	36.03	2.67	
9	60	470	36	41.7	30.58	5.27	24.05	0.9	Final drying
10	60	530	36	40	26.96	3.62	14.98	0.34	
11	60	590	36	30	25.04	1.93	8.42	0.06	Cooling

During the second experiment has been use a different type medicinal plant Aloe Vera (Aloe Barbadensis) these herbs are used for its antiseptic and anti-inflammatory properties [11]. The total amount of plant introduced into the dryer was 10.8 kg. The plant has been distributed in the dryer drawers each 720 g / drawer.

The load of 10.8 kg of the plant was the actual load and was considered productivity due to the following inputs:

- Initial sample mass:  $M_0 = 10.8$  kg;
- Initial humidity:  $a_{1m} = 77.08$  %;
- Total amount of water in the sample:  $M_{TA} = 8.32$  kg;
- The amount of dry substance:  $SU = 2.48$  kg;
- Final humidity:  $ya_{2m} = 8.42$  %;
- The initial temperature:  $t_0 = 25$  °C;
- The average drying temperature:  $t_m = 42$  °C

It was determined the specific energy consumption:  $q = 9.113$  kJ/kg evaporated water [1,6]

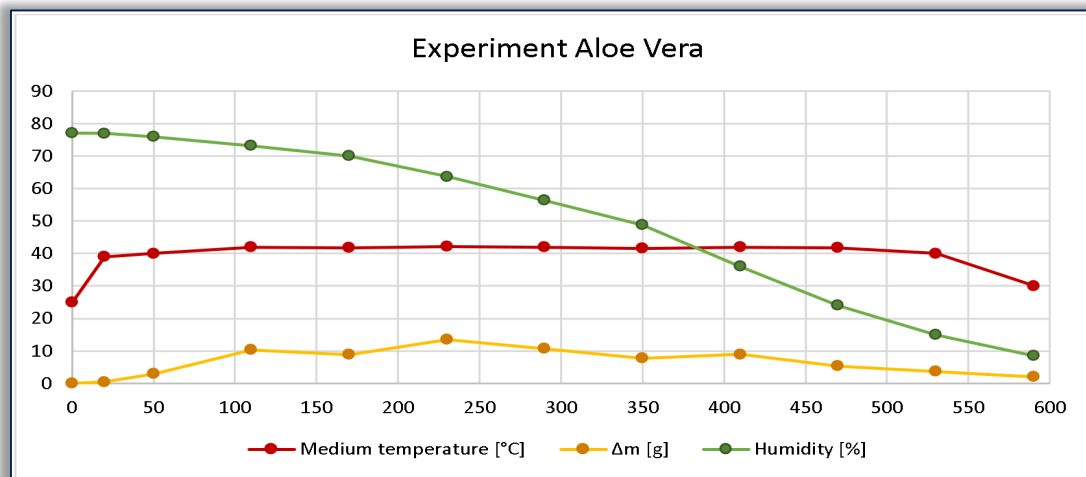


Figure 4. Values measured in the second experiment, Aloe Vera

#### 4. DISCUSSIONS

To obtain medicinal plant products, no special investments are required, especially if local resources are used. The parameters of the thermal agent (hot water) ensure temperatures of the drying agent high enough to dry both plants with higher humidity and plants with lower humidity, as well as those plants that have a woody structure. At the same time, there are sufficient reserves, in terms of temperature and heat flow, to dehydrate properly prepared fruits or vegetables, if necessary, even by slicing. Partial recirculation of hot air in the final phase of the dehydration cycle, by adjusting the flaps provided on the air circuit, contributes to drying products with reduced energy consumption, and the automation of the drying process and the provision of measuring devices on the water and air circuits allow the establishment and control of temperatures, levels and duration of the drying cycle for each individual product.

#### 5. CONCLUSION

The products from medicinal and aromatic plants represent a high economic value on both domestic and foreign markets because they have a wide range of use.

Advantages of using dried plants:

- Concentration of active principles: The dried plant retains almost all its active principles intact, losing only water. In certain cases, through dehydration, the concentration of substances per gram of product increases, providing a stable therapeutic effect.
- Extended shelf life: Drying allows the plants to be stored for long periods. In general, the aerial parts (leaves, flowers) are valid for approximately 1 year, while the woody parts (roots, bark) retain their effectiveness for 2-3 years.
- Permanent availability: Since most plants have a short harvest period, drying is the "invention" that allows us to benefit from them even out of season.
- Versatility in preparation: Dried plants are the basis for most natural pharmaceutical forms.
- Infusions and decoctions: They are quickly prepared by pouring boiling water over dried flowers or leaves.
- Powders: Dried plants can be finely ground to be consumed as is or added to capsules.

Drying medicinal plants is the main preservation method that allows the use of natural remedies throughout the year, while maintaining most of the therapeutic properties. By removing water, the degradation processes are stopped and the active substances are concentrated.

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