

**MAINTAINING THE QUALITY INDICATORS OF THE PRODUCT DURING LOW
TEMPERATURE DRYING OF SPICES AND HERBS BY RESEARCHING THE
OPTIMAL VALUES OF HUMIDITY AND TEMPERATURE**

Djurayev Kh.F.

Doctor of Technical Sciences, professor, department of “Information-communication systems of
controlling technological processes” Bukhara engineering-technological institute, Bukhara city,
Uzbekistan, djuraev_xf@mail.ru

Mizomov M.S.

Postgraduate student, Bukhara engineering-technological institute, Bukhara
city, Uzbekistan muhammadmizomov@gmail.com

Ashurova U.D.

Assistant, department of “Higher mathematics”, Bukhara engineering-technological institute,
Uzbekistan

Duskarayev N. A.

Associate Professor of the Department of General Technical Sciences of the Bukhara Institute of
Natural resources management of National Research University of Tashkent Institute of
Irrigation and Agricultural Mechanization Engineers , 32, Gazli shokh ave., Bukhara, 105009,
Uzbekistan

Oripov I.O’.

Assistant of the Department of General Technical Sciences of the Bukhara Institute of Natural
resources management of National Research University of Tashkent Institute of Irrigation and
Agricultural Mechanization Engineers , 32, Gazli shokh ave., Bukhara, 105009, Uzbekistan

Annotation.: The scientific research presents that processing spices and herbs with the
technological system and the method, it is possible to preserve the quality indicators, biological
composition, level of nutrition and ingredients that are beneficial to human health. The main
purpose that conducting informations for development of processed products consisting of spices
and herbs that would be useful to people’s health on the basis of research and analyzing. Drying
is a great option, especially when winter is upon us and we do not want to waste any of our
beautiful summer herbs. Drying out your fresh herbs in a food dehydrator is an easy way to get
your herbs dried quickly. We find this method extremely useful especially when harvesting a
large number of herbs at once. Growing your own herbs is a complete game-changer. They

improve so many great dishes and are stored extremely well if you chose to dry them. If you find that, the nights are getting colder and you think it is time to harvest all of your herbs at the same time; this method is definitely the way to go. Consequently, drying should be executed carefully in the interest of retaining the taste, aroma, color, appearance, as well as nutritional value of the plants to maximum possible extent. Today, the interest in spices and herbs is increasing more and more, due to the global pandemic, people pay special attention to health, increasing awareness of health secrets, aging and chronically ill people prefer natural means to activate the immune system. Natural the absolute harmlessness and usefulness of the means caused a sharp increase for investments in scientific research in this field and the demand for spices and herbs plants in international markets.

Keywords: Product quality, process quality, nutritional value, amount of essential oils/aroma, constant drying rate, moisture content.

Introduction. A comprehensive review has presented covering the various methods used in agriculture to preserve herbal plants and the classification of solar-energy and hot air drying systems. Dehydration is the most common method used to lower moisture content and hence the water activity to a safe limit which prolongs shelf life. However, consumers' demand on processed products with most of the original characteristics of the fresh plants has increased. Spices and herbs are plants used for the treatment of humans and animals, for the prevention of diseases, as well as in the food, perfumery and cosmetic industries [1]. It has been determined that there are 10-12 thousand species of medicinal plants on earth. The chemical, pharmacological and functional properties of more than 1000 plant species have been investigated. There are more than 700 species of plants in Uzbekistan. Of these, about 120 species of plants grown in natural conditions and cultivated used in scientific and folk medicine. Currently, about 40-47% of medicines used in medicine obtained from raw plant materials. Plants are living natural chemical laboratories with complex structures and the ability to create complex organic substances or compounds from simple inorganic substances. Dried herbs, shoots, roots, rhizomes, buds, bulbs, barks, leaves, flowers, buds, fruits (seeds), seeds, juice, pulp, essential oil are used medicinally.

There are 2 different classifications of spices and herbs accepted: 1) depending on the composition of active substances - alkaloids, glycosides, essential oils, vitamins 2) depending on their pharmacological properties - sedative, analgesic, hypnotic, affecting the cardiovascular system, central nervous system stimulant, blood pressure reducer [2]. The active substances of herbs are alkaloids, various glycosides, flavonoids, coumarone, astringent and mucilaginous substances, essential oils, vitamins, dyes, enzymes, phytoncides, starch, proteins, polysaccharides, nitrogenous may contain substances, oil and fatty acids and other compounds.

Materials and methods. The effect of spices and herbs on the body depends on the amount of chemical compounds in its composition. These compounds accumulate in various parts of the plant. The period of high effectiveness and quality of the drug corresponds to the time of the beginning of their flowering and seeding period. Spices are stored in the buds, leaves or stems of

some plants. Therefore, the part of plants with the most biologically active substances harvested. Roots, rhizomes, bulbs and tubers are usually prepared in late fall when the plant is dormant or in early spring before the plant wakes up. The fruits and seeds of the plant collected when they are ripe, because they are rich in medicinal substances at this time. Freshly harvested Spice plant product contains moisture (up to 85% in aboveground organs, up to 45% in roots). If this moisture has not removed (by drying), the plant will rot and the medicinal substances will break down and become unusable [3].

Wet basis moisture content (MCwb, also known as W) is mostcommon for farmers and producers and is defined as:

$$MCwb = \frac{h}{h + h}$$

Dry basis moisture content (MCdb, also known as X) is mostcommon for scientists and is defined as

$$MCdb = \frac{h}{h}$$

It is converted as follows

The drying time can be reduced for hours by artificial drying. During the work of drying the air is warmed, the moisture content is reduced. At drying with ambient air the controlled parameter is only the velocity of drying

air, the air temperature is around 15–25 °C. The airflow maintains mechanically by a ventilator. The ventilator should be operated only in dry, warm weather and can be produced a better quality of drug, if the drying with ambient air is carried out in a building [6]. Depending on the moisture content of the herbs and the absolute humidity of drying air, the drying time can be 8–10 days. There are analytical techniques available that can provide some information about the relative fractions of water in different molecular environments. The herbs to be dried must be placed in a closed system, where the preheated air is flowing, and to be placed out of the air duct. The temperature, absolute humidity and velocity of drying air can be adjusted. The drying time is only a few hours, because the temperature of the drying air is about 30–80 °C. Generally, at warm air-drying the medicinal plants and the drying air move in opposite direction.

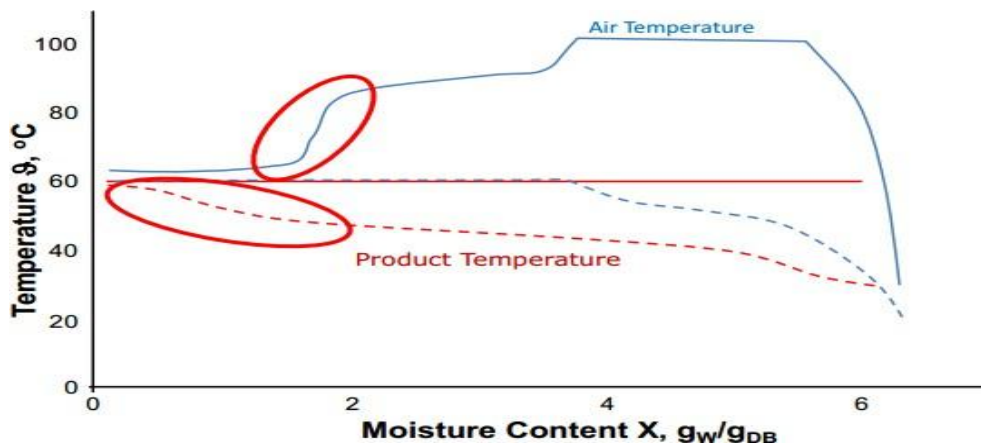


Figure1. Temperatures as functions of moisture content

Dehydrating without a dehydrator is something we still do here on the farm though we do much less, than we use to. Hang drying is a great way to dehydrate a bunch of herb at one time. We favor this method for our lavender. It is easy to hang with its extended cut stems and not so finicky with the temperature and moisture control of the room [10]. If our electric dehydrators are full, we go with hang drying to make sure to get the most out of our harvest when it is ready. Some other great ways to dehydrate without an electric dehydrating are oven drying, air- drying, and a dehydrator cabinet. We wrote more extensively about these options in our five Ways to Dehydrate without a Dehydrator post if you would like to dive into those options. The most efficient way to dry herbs and botanicals on a medium scale is by using electric dehydrators. If you have a whole field of herbs, this might not be the best option for you, and many larger farms will air dry in drying houses or hoop houses. Electric dehydrators work best in big batches for homesteads and super excited herbalists.

There are two kinds of electric dehydrators. There are the most common ones that blow air vertically and then horizontal air blowing dehydrators. Most people will start out with a vertical air dehydrator. They are the easiest to find and most commonly found in local retail stores. These vertical air-blowing dehydrators send the heat up the center of the dryer from the bottom of the dehydrating trays. Some of these dehydrators will have fans that help to move the air circulation more evenly [4]. Depending on the price range, though, some of these dehydrators will not have a fan. Dehydrators with fans will give you a more consistent outcome with your herbs and botanicals that one without a fan. Another feature to look for is a dial that will adjust the dehydrating temperature. Some vertical air dehydrators would not have this feature, and the herbs and botanicals will have watched more closely. Vertical dehydrators often come in two different shapes. The most common ones are round, but there are some rectangular and square ones as well.

Discussion. In many branches of industry and agriculture, face the need to reduce the moisture content of various products, materials and raw materials. For agriculture, this is the general task of increasing the safety of fruit and vegetable and other agricultural

products, for which in recent decades there have been numerous technologies for drying various products have developed. The differences are due to thermodynamic, thermo physical, mass transfer and structural-mechanical characteristics, as well as energy costs for evaporation of 1 kg moisture, determining performance of most of the existing drying equipment. Energy costs for the whole evaporation of 1 kg of moisture, depending on the method drying and design of drying plants given in table 1.

Technological indicators of drying methods depending on the method and design installations.

Drying method	Specific energoz a spending kWh per 1kg isp. moisture	Ecologica l safety way	Quality indicators of the dried product		
			Flavoring	Restored occupancy	Ability to storage
IR radiation	0,9-1,2	Safe	High (taste,color, fragrancenatural product)	High 85- 90%	high (up to year or more)
Convective	1,6-2,5	Safe	Medium (taste fried)	Mediu m 60- 70%	Medium to 4-6 months
Conductive	1,5-1,7	Safe	Medium (taste fried)	Medium 60-70%	Medium to 4-6 months
Sublimation	3,5-3,3	dangerous (freons)	High (taste, color, fragrance natural product)	High 85-95% (Beside s turgor)	high (up to year or more)

Microwave currents	2-3	Dangerous (microwave)	High (taste, color, fragrance natural product)	High 85-95% (Beside s turgor)	Not studied there is negatives indicators
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The larger, thicker plant parts, especially roots are prepared for drying and other processing operations by chopping. The moisture content of harvested plants is generally very high, around 60–80%. If the moisture content is not significantly reduced, it enables maturation of harmful biological processes. Because of this, the valuable active agent of herbs can be destroyed and the external properties of the drugs can become unfavorable. The fundamental requirement to prevent the harmful processes is the reduction of moisture content as quickly as possible. The advantage of the method is that cheap and does not require plus thermal energy. During the drying process, the weight of samples measured using an electronic balance with a sensitivity of 0.01 g.



Figure2. Processing of spices and herbs with different methods

The samples were weighed every 15 min for the first 1 h, then every 30 min for 2 h, after 2 h of drying, the weighing was performed at 60 min intervals. The sample moisture content at time t (M_t) during drying process calculated according to the initial moisture content and initial weight, as well as the sample weight at time t. The moisture ratio (MR) of samples calculated using:

$$MR = M_t/M_0$$

Where, M_0 represents the primary moisture content of the raw material such fruit samples, g/g; M_t is the sample moisture content at time t , g/g.

The dehydration rate of material between time t_1 and t_2 of samples for different dehydration techniques: $DR = (M_{t1} - M_{t2}) / (t_2 - t_1)$

where; M_{t1} and M_{t2} are the moisture contents of fruits at the drying times t_1 and t_2 , respectively, g/g.

Specific energy consumption according to the energy value indicated on the ammeter, the removed moisture of the material, and the maximum load of each system

$$SEC = (1000 W * \eta) / (m_1 - m_0)$$

where, W is the energy difference before and after the experiment, kW.h; m_0 and m_i are the first and end masses of the materials, g; η is the utilization factor of equipment load [5].

DPPH radical scavenging capacity measured following with a slight adjustment. Briefly, 10 μ l of extract solution added to 200 μ l of DPPH solution (0.16 mmol/L). After reaction at room temperature for 30 minutes away from light, the absorbance of the mixture detected at 517 nm. DPPH radical scavenging capacity was expressed as inhibition percentage (I %) and calculated

$$I\% = (A_{control} - A_{sample}) / A_{control} * 100\%$$

Phase drying: higher temperatures in the beginning until the surface is dry, further drying at quality saving temperatures, quality parameters have defined and critical temperature has known [7]. There is a minimum air velocity, which is not worthy to go below, because it would reach the same result if the herbs dry with ambient air at natural convection. In addition, there is a maximum air velocity, which is not worthy to go above, because it does not cause significant improving during drying and occurs pneumatic transport of the medicinal plants. Coriander leaves contain 200-400 mg% vitamin C [8].



The presence of organic acids, especially apple, lemon, and aromatic substances in cilantro improves appetite and improves food absorption. It contains phytoncides, substances with antibacterial properties, which detoxify the gastrointestinal tract and increase the body's resistance to infectious diseases.

Figure3. Preparing for drying process of spices and herbs

While the square and rectangular trays work better for long thin herbs and broad leaves. While the vertical airflow food dryers work great and are certainly better than air-drying small batches, this version of the dehydrator has downsides. While the air naturally flows through the middle of the machine, some dehydrators come with fans. The heat still usually tapers off near the top of the dehydrator [9]. Depending on how many trays high, you have stacked the top racks may not dry at the same time as the bottom trays closer to the heat source. This creates the need continually rotate the trays to get the right consistency throughout your herbal material.

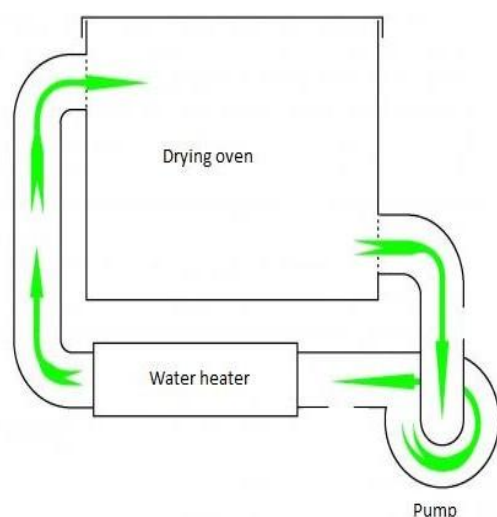


Figure4. Processing of the spices and herbs

Research results. Conventional drying equipment can have high-energy consumption. Commercial food dehydrator dryer uses the reverse Carnot principle, uses free air to absorb the surrounding heat and transfer the heat to the material to be dried. The heat pump dryer controlled by touch screen with adjustable temperature and low power consumption, and its heating efficiency is higher than similar equipment. This dryer has many advantages, such as energy saving, environmental protection, 24-hour intelligent operation, wide drying range and good effect. The drying materials would be improved in several varieties, such as clean, appearance and taste.

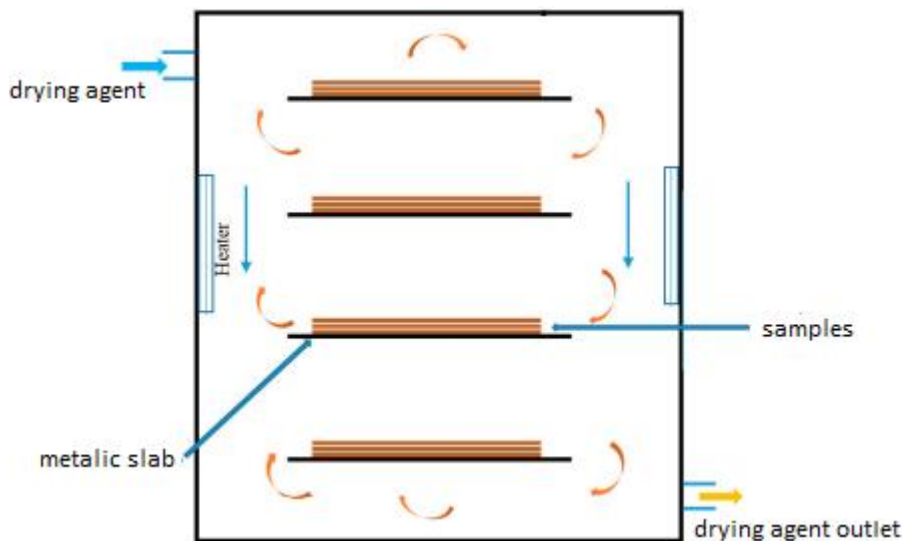


Figure 5. Scheme of the laboratory hot-air convective drying system

There is also the risk that if the racks are not rotated that the top trays will mold. The bottom trays may even burn. The best way to solve the issue of rotating dehydrating trays is to go with a horizontal air dehydrator. These dehydrators blow air from the back of the dehydrator and often send the hot air from a larger area. The disadvantage is that depends on the weather (sudden rain, storm). While round is more easily found, the square and rectangular ones provide much more space on the dehydrator tray for placing your fresh herbs and botanicals. Their round counterparts can make it challenging to fit your abundance, mainly depending on the shape and size of the herb. Trays of fresh oregano drying in the oven. Previous studies have shown that the suitable drying temperature range was between 50 and 60 °C for herbal medicines rich in volatile oil components. Therefore, in the current study, five drying temperatures of 50, 55, 60, 65, and 70 °C applied to evaluate their influence on drying characteristics and sample quality to obtain the optimal drying temperature of each drying technology accordingly.

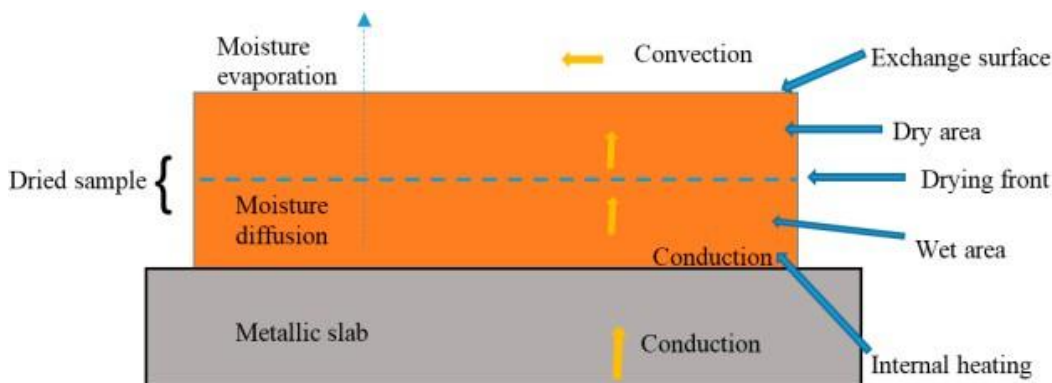


Figure 6. Demonstrating the mechanism of heat and mass transfer through the sample. Using a heat pump evaporator, this dryer absorbs hot air from outside air. During the drying process, waste gas waste heat is recycled. Because of the operation of the compressor, the supply of energy to the drying box, the drying box of hot air [11]. Repeated cyclic heating, absorbing moisture in the material, its cooling damp, wet through the hot air film or condensation process, the water takes the moisture from the material, and finally realizes the continuous drying of the materials.

Conclusion. The herbs have dried place in a closed system, where the preheated air is flowing, and placed out of the air duct. Adjust the temperature, absolute humidity and velocity of drying air. The drying time is only a few hours, because the temperature of the drying air is about 30–70 °C. Generally, at warm air-drying the medicinal plants and the drying air move in opposite direction. During drying the moisture content decreasing investigated at constant air velocity and from this an average-drying rate was determined that related to the volume of the material. The air velocity how influences the moisture content decreasing was also investigated. The analysis of the drying processes assists in validating appropriate operating conditions. Hence, understanding the temperature and moisture behavioral characteristics for the product is anecessity, especially for handling practices and quality control. Kinetic modelling is a useful approach to design and optimize thermal processes in order to maximize quality. Several mathematical models have employed for the purpose of moisture diffusion process in food products. Moisture diffusivity in solid food would be obtained in different forms, which changes in accordance with the geometry of the sample and the experimental conditions. These methods have been used to estimate moisture diffusivity and rely on drying kinetics, sorption, or desorption kinetics, as well as moisture profile analysis.

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