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ASTUDY OF DRYING SOME MEDICINAL AND AROMATIC PLANTS BY VACUUM OVEN

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ABSTRACT

The experiments were carried out in September 2019 in the laboratory of the Department of Agricultural Engineering at the Al-Bayda city is located in northeastern Libya, at the top of the Jabal Al-Akhdar summit at the confluence of latitude 21.44 north with longitude 32.76 east .

The aims Drying some medicinal and aromatic plants (Sage , Ment , Basil , Rut) so that studying moisture content , rate of drying and Calculates the heat energy useful for heating the air in the oven in order Calculates The thermal efficiency.

So the samples was prepared by Harvesting , Washing to removed dust and measured the weights of the samples before put in the drying oven . The results showed that the temperature of the Sage and Basil was relatively high, reaching 70 C^0, the temperature was Mint 60 C^0, but the mint took a while, due to the amount of water in a mint leaf, and it took 85 minutes.While the Rut used the lowest temperature (50 C^0) and the least time because the Rut leaf is weak and does not bear a high degree, the Drying rate of sage is bigger than basil and Ment ,Rut . The best Drying efficiency for the process of drying the Sage plant 69.4 % Then the Ment plant 50.7 % , subsequent by the basil plant 47.98 % , the least efficiency on the drying process of the Rut plant 36.57 %.

الملخص

اجريت التجارب في شهر سبتمبر 2019 بمعمل قسم الهندسة الزراعية بمدينة البيضاء الواقعة شمال شرق ليبيا على قمة الجبل الاخضر عند التقاء خطط عرض 21.44 شمالاً مع خط طول 32.76 شرقاً تهدف هذه الدراسة الى تجفيف بعض النباتات الطبية والعطرية (ميرمية ، النعناع ، الريحان ، الحبق) بحيث يتم دراسة الرطوبة النسبية ومعدل التجفيف وحساب الطاقة الحرارية المستفاد منها لتسخين الهواء في فرن كهربائي يعمل تحت ضغط تفريغ ولحساب الكفاءة الحرارية للتجفيف. لذلك تم تحضير العينات بالحصاد والغسيل لازالة الاتربة ووزنها ثم وضعها في فرن التجفيف. بينت النتائج ان درجة حرارة الميرمية والريحان (70 C^0) اعلى من النعناع (60 C^0) واستغرق زمن تجفيف النعناع 85 min لانه يحتوي كمية عاليه من الماء ، واقل درجة حرارة لنبات الفيجل (50 C^0) . وأعلى معدل تجفيف للريحان ومن ثم النعناع وافضل كفاءة للتجفيف للميرمية حيث بلغت 69.4 % ومن ثم النعناع 50.7 % والريحان 47.98 % واقل كفاءة للتجفيف للفيجل 36.5 % .

INTRODUCTION

Industrial drying of food for air previously heated by burning fuel, electricity, or others, and this is done in special ovens known as dryers, which are multiple shapes and colors, and these dryers may be air-drained to maintain the greatest possible value of your nutritional value. The drying industry considers it important to expel an appropriate amount of food moisture in order to prevent spoilage while preserving as much of its distinctive properties as possible. In industrial drying, the excess moisture is removed from the foodstuffs by means of industrial temperature, air velocity and relative humidity, and the drying time and the percentage of moisture in the food material is controlled after drying. The suitable temperature for drying ranges between 50 - 80 degrees Celsius, and the drying of plants appeared hundreds of years ago, so the pharaohs used it in the embalming processes inside the pyramids and as it was used in the middle ages for pigment and colors in some decorations and sculptures. Drying is used to remove water from food to prevent microorganism activity and to preserve food and reduce its weight and density to facilitate transportation and storage operations [16]

explained that the temperature required for drying is variable and depends on the type of dried food. If the temperature increases from 40-80 ° C, the time required for drying decreases by five times.[18]

Oven drying is the simplest way to dry food because there is no need for special equipment. It is also faster than sun drying or using a food dryer. But oven drying can be used only on a small scale. An ordinary kitchen oven can hold only 4 to 6 pounds of food at one time. The oven is set to the lowest possible setting and preheats to 60 C. Some gas ovens have a pilot right, which may keep the oven warm enough to dry the food. It is important to keep the oven temperature at 60˚C to 70˚C. An oven thermometer can be put on the top tray about half way back where it can be easily seen and the temperature checked half hourly [15].

Drying food in the oven of a kitchen range, on the other hand, can be very expensive. In an electric oven, drying food has been found to be nine to twelve times as costly as canning it. A commercial or homemade food dryer or convection oven provides automatically controlled heat and ventilation. Most households will not need a dryer unless they dry large quantities of food. A food dryer takes less electricity than drying the same

amount of food in an electric oven. However, the temperature is usually lower (about 120 degrees F. or 50 C.), so drying takes a little longer than in an oven [14]. Vacuum drying is especially effective for heat sensitive materials and allows for closed system benefits where solvent recovery is required[6].

Drying of agricultural products is still the most widespread preservation technique and it is becoming more and more an alternative to marketing fresh fruits since the demand of high quality dried fruits is permanently increasing all over the world [7] . The various vacuum drying processes are divided into two categories: the continuous vacuum drying process, in which the vacuum is maintained continuously throughout the drying process; and the discontinuous vacuum drying process, in which phases of convection heating at atmospheric pressure alternate with phases under vacuum. The continuous vacuum drying kilns include hot platen, superheated-steam, air-steam mixture and high frequency heated kilns. This article deals primarily with the continuous vacuum class of dry kilns [8]

The sample of sweet basil (one kg) which artificially dried was washed to remove the mud and dirt before entering into the drying unit The moisture content was found by the standard oven method i. e. drying the sample of 10 gram at 105 C^{o} for three hour (3h). Three samples each of 10 g were taken to determine the initial moisture content [3]

The study aims to diminish the period for drying some medicinal and aromatic plants by using industrial drying (electric dryer), while maintaining the quality and safety of the product during its drying, as well as the color of the final product including comparison of four types of mountain aromatic plants found in the study area.

METHODS AND MATERIALS

Medicinal and aromatic plant products are extensively used in traditional as well as modern systems of medicine. Global and national demand exists for the herbs. Excellent business opportunities also exist to economically utilize these plants and their products in traditional [5]

The Experimental laboratory of Agricultural Engineering, Faculty of Agriculture in white, as the Al-Bayda city is located in northeastern Libya, at the top of the Jabal Al-Akhdar summit at the confluence of latitude 21.44 north with longitude 32.76 east at an

altitude of about (624 meters) above sea level, as the sea is about 20 km away and surrounded by forests, which made it a tourist city that possesses the same elements. A high degree. Also, Jabal Al Akhdar has an excellent plant diversity, from which Jabal Al Akhdar got its name .

The process of drying plants is to decrease the percentage of moisture slowly in it while preserving the largest amount of the original shape additionally providing herbs throughout the year and maintain their taste and color. And the drying process was done with the following steps:

1- **Harvesting weeds:** We used scissors to cut the weeds grown in the Al-Faidiya town (الفائدية) area of AJabl AL- Akhdar.

2- **Washing :** wash it carefully if it is necessary to wash the dirty herbs with dirt and dust. It is better to sprinkle them with water lightly and then wipe or wave them. Allow it to dry from the water.

3- **electronic scale :** An electronic scale will used to measure the weights of the samples, it was **150 gm** after processing . the figures (2,3,4,5) views a samples before drying .

Fig. 1 view of Electronic Scale

Fig. 2 view a sample of Ment

Fig. 3 view a sample of Sage

Fig. 4 view a sample of Rut

Fig. 5 view a sample of Basil

4- The electric oven (vacuum oven):

The electric oven Model Jacket heating VT6060M (Japan) the capacity 0.053 m^3 having two Layers the Electrical input power 1.7 kW and it has fan defusing heat the air in the oven and we can change control of the temperature, pressure for gages on the oven, that it was also used to dry the samples, in addition, can control the vacuum pressure from the oven by a pump as shown in figure (6) . the specifications in the table (1).

The objective of a dryer is supply the product with more heat than is available under ambient conditions , hereby increasing sufficiently the vapor pressure of the moisture held within the crop and decreasing significantly the relative humidity of the drying air and thereby increasing its moisture carrying capacity and ensuring sufficiently low equilibrium moisture content .[4]

Fig. 6 view of vacuum Oven

Standard model	Jacket heating VT6060 M
rated temperature C^0	(300-200) ± 4
Internal dims(h*w*l) mm	415*345*371
External dims(h*w*L)	744*576*570
NO. of shelnes	2
Electrical input Power (Kw)	1.7
Voltage (50/60 Hz)	230 ± 10%
Flow rat of Air (m^3/h)	10.2

Table (1) specifications of vacuum oven

5- **Use the Psychrometric** Analysis Chart to find the properties of air during the drying process as shown in figure (7)

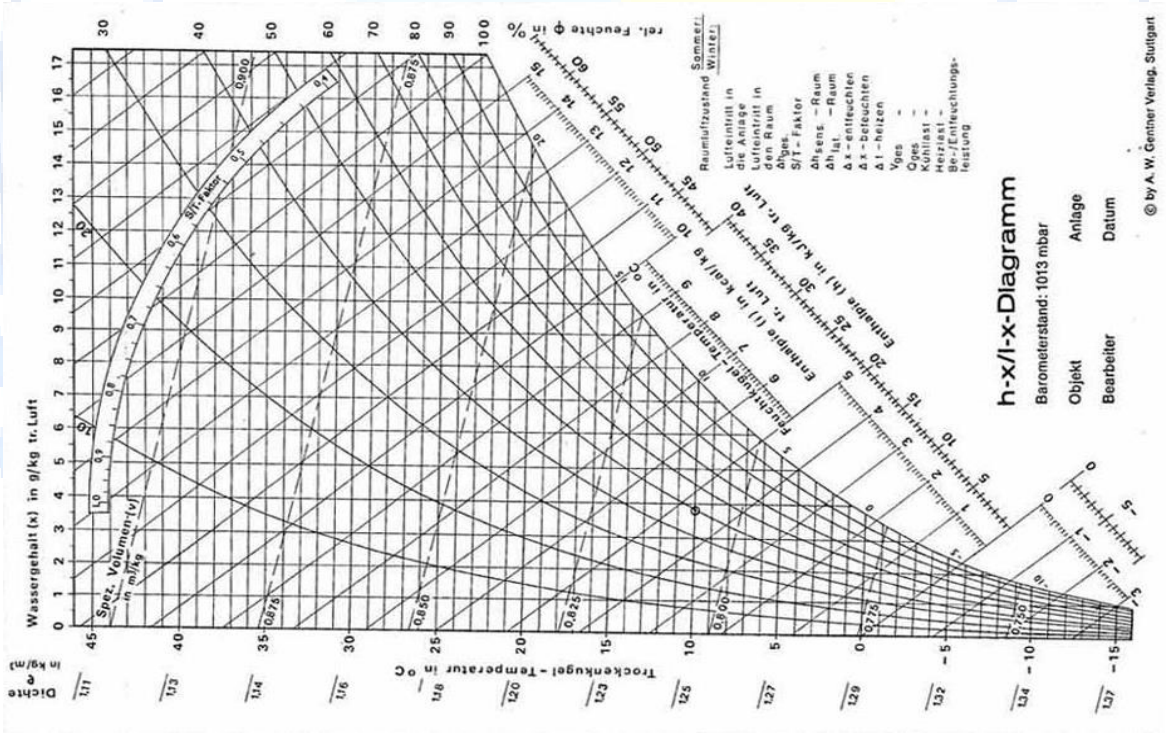

Fig. 7 view of Psychrometric Analysis Chart

6- The equations used in the study:

a)**Initial moisture content of the substance on a dry basis [1]**

The initial mass of fresh plants (Sage , Ment , Basil , Rut) (M_{wet}) and final mass of dried (M_{dry}) was measured with the help of weighing plants (Sage , Ment , Basil , Rut). Initial moisture content was calculated by following equation :

$$M_{bd} = \frac{M_{wet} - M_{dry}}{M_{dry}} \qquad (1)$$

M_{Wet} : Weight before drying

M_{dry} : Weight after drying

b) **The initial moisture content of the substance is wet : [1] ,**

Initial moisture content of the substance is wet was calculated by following equation :

$$M_{wd} = \frac{M_{wet} - M_{dry}}{M_{wet}} \qquad (2)$$

c)**Drying rate [2]**

The drying rate , (Kg/h) was determined using the following equation :

$$\Delta X = \frac{(M_{t+\Delta t} - M_t)}{t_d} \qquad (3)$$

Where M_t and $M_{t+\Delta t}$ (kg water / kg dry matter) are the moisture content at time t (hours) and moisture content at $t+\Delta t$, respectively

d) **Calculates the heat energy useful for heating the air**

On order calculate the thermal efficiency for vacuum oven drying , must be calculate the useful heat energy using for drying. The useful heat energy was determined using the following equation :

$$Q_d = Cp\ (\dot{m})\ (\Delta h_i) \qquad (4)$$

Δh_i : The potential energy (enthalpy) of drying under the heat air behavior (inside the oven during the evaporation of water from the material to be dried) kJ / kg

$\dot{m}$: Mass flow rate kg / sec, which is the product of volumetric flow in density

Cp : Specific heat KJ/Kg.k^0

e) **Drying efficiency**

The Drying efficiency for vacuum oven drying (the Electrical input power 1.7 kw (table (1)) was calculated by Equation :

$$\eta_d = \frac{Q_d}{\text{Electrical input power}} \qquad (5)$$

RESULT AND DISCUSSION

The experiments were carried out in September 2019 in the laboratory of the Department of Agricultural Engineering and the crop to be dried mint, sage, basil, and Rut, because herbs are widespread in the Al-Jabal Al-Akhdar region available in the summer and the results are as follows:

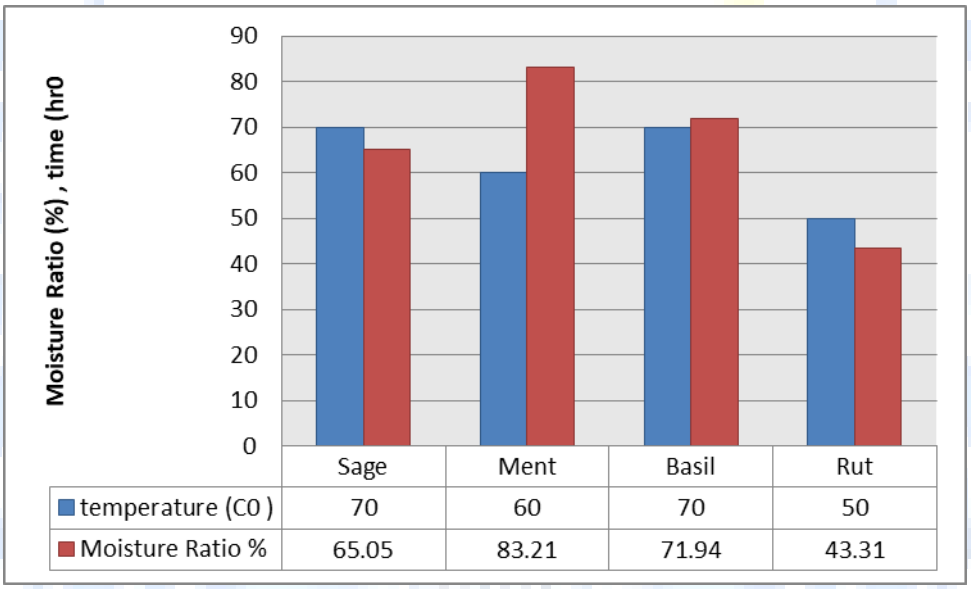

Fig. 3 view Moisture Ratio and temperature for each types of aromatic plants

The basic aim of this drying method is to shorten the drying time at a reduced temperature, which helps in retaining the basic quality of food products[6]

Fig. (3) view the temperature of the Sage was relatively high, reaching 70 C^0, the reason was due to the thickness of the leaf of sage, therefore it took 95 minutes and in addition to the very large amount of water in the Sage and taking care of the phenomenon of surface drying, which occurs if the temperature exceeds 80 C^0 while the temperature was Mint 60 C^0, but the mint took a while, due to the amount of water in a mint leaf, and it took 85 minutes.

The temperature of basil is high, reaching 70 C^{O} . The reason is the amount of water to be removed and it took a interval 75 minutes. While the Rut used the lowest temperature and the least time, as it used the temperature of 50 C^{0} because the Rut leaf is weak and does not bear a high degree and took advantage of time 65 minutes. We find that the Rut of plants that does not bear a high temperature inside the drying oven, divergent mint, Sage and basil, which are the thickness of their leaf well and effect temperature High.

The relative humidity of mint was the highest value compared to the rest of the plants, and the Rut plant contains the lowest value of relative humidity compared to the rest of the previous plants, so it was faster drying. It is known that the drying takes place faster, the relative humidity is low, taking into account the phenomenon of surface drought, and from this principle, the relative humidity of mint was the highest value compared to the rest of the all plants, and a Rut plant contains the lowest value of relative humidity compared to the rest of the previous plants, so it was faster drying.

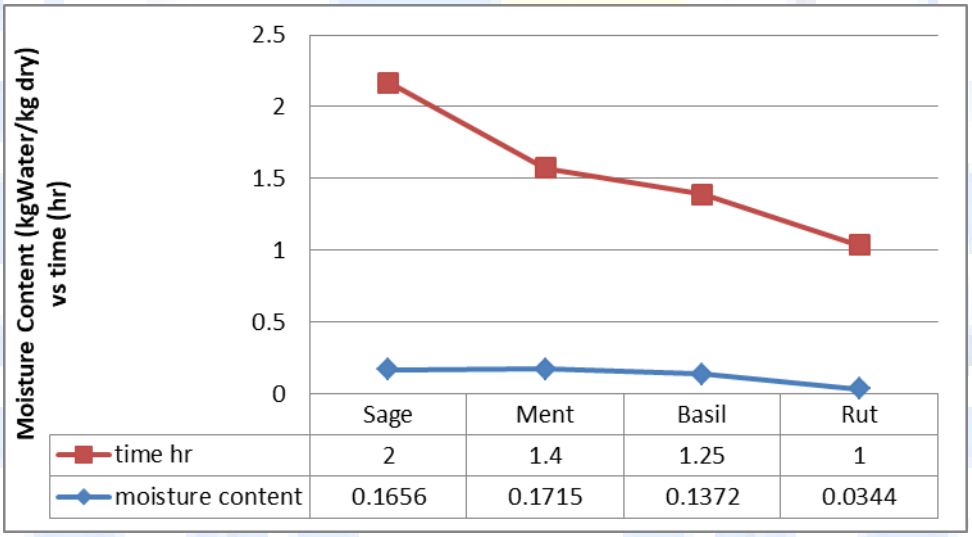

Fig. 4 view Moisture content and time for each types of aromatic plants

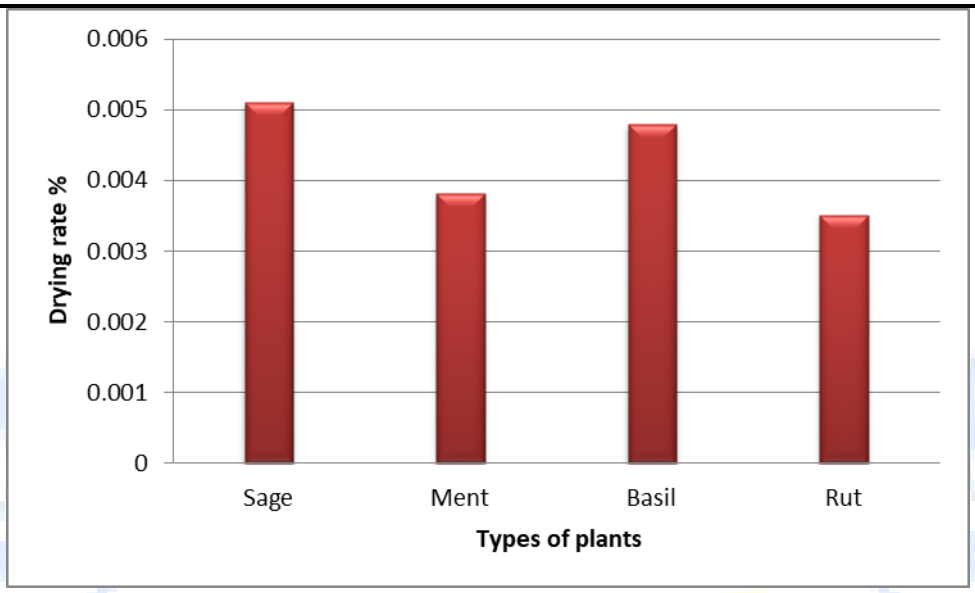

Fig. 5 view Drying rate for each types of aromatic plants

The drying rate curve is of great benefit in determining the time required to dry larger quantities under the same drying conditions, in Fig. (5) the Drying rate of sage is bigger than basil and Ment ,Rut .

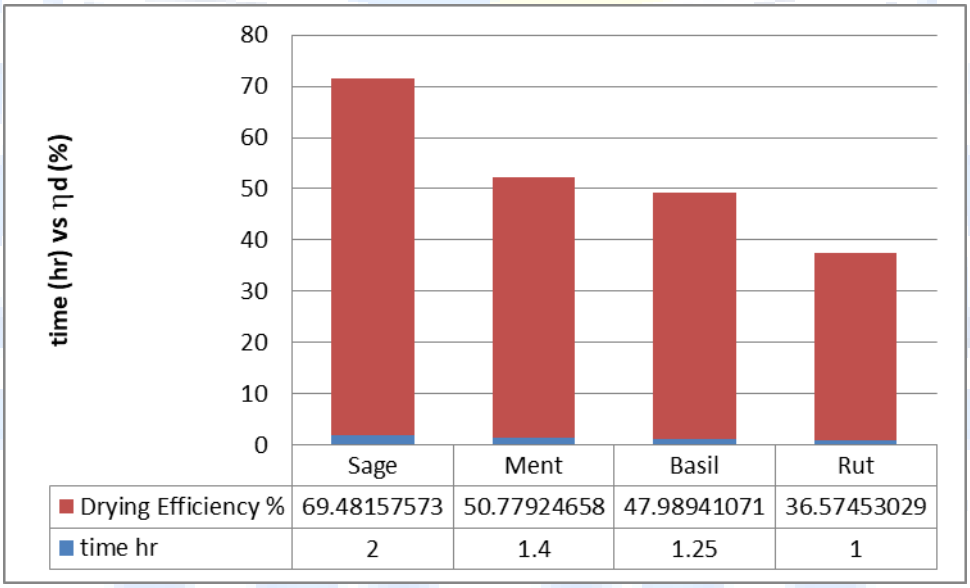

Fig. 6 view Drying Efficiency and time for each types of aromatic plants

Fig. (6) Drying efficiency that notices a correlation between the rate of discharge of hot air and the type of plant with the passage of time, as we found the average amount of hot air required to dry the Sage plant needs more time compared to the rest of the plants. The energy

required for the drying process of the Sage plant is the highest value, reaching 12 KW, while the lowest value for the drying process of the Rut plant was 6.2 KW, they are more than a few factors that affect the energy, including the specific temperature and the rate of mass discharge of hot air in addition to the temperature difference between the oven temperature And his surroundings. When we used industrial drying, the heating system (vacuum oven) used had data indicating the amount of electrical energy consumption over time, that it by calculating the energy used for drying for each type of plant, we can find out the drying efficiency of each type of plant under the conditions of drying, that, Fig.(6) Drying Efficiency and time for each types of aromatic plants the best efficiency for the process of drying the Sage plant 69.4 % Then the Ment plant 50.7 % , subsequent by the basil plant 47.98 % , the least efficiency on the drying process of the Rut plant 36.57 %.

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