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Experiment and Evaluation the Properties of Dragon Fruit Drying With Thickness of 30mm

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----------***ABSTRACT***----------
Drying the dragon fruit by the oven-dryer was investigated at thickness level of 30mm during to determine the water content, the drying rate and the shrinkage of dragon fruit during microwave. The mass of the sample during drying was measured to calculate the water content, the drying rate and the shrinkage of the dragon fruit. This is an experimental result for the dragon fruit, which our team has experimented, to understand the properties of this fruit for the purpose of industrial drying. To support the diversification of dragon fruits products, supply to the market.
KEYWORDS *– Fruit drying, dragon fruit drying, drying rate, water content, shrinkage*.

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I. INTRODUCTION

Drying is defined as the application of heat under controlled conditions to remove the majority of the water normally present in a food by evaporation. Drying in fruit is a solution for fruit preservation and inhibits the growth of bacteria, yeasts, and mold through the removal of water. And with the complexity of the composition chemical (sugars, proteins, lipids, minerals, vitamins, flavors, etc.), the fruits need to be observed and controlled during drying to have positive effects and avoid negative impacts on the final product. There are many different methods for drying, and selecting the drying method depended on the type and quantity of product to be dried and of water to be evaporated, the desired final quality, or functionality sought for the dried product.

In this time, we have chosen a dragon fruit which is one of the most significant fruits grown throughout the tropical countries, especially in Vietnam for the experiment of drying fruits. The objective of this experiment is to study on the changes of shape, size and moisture content in drying process of the dragon fruit.

II. MATERIALS AND METHODS

1. Sample preparation

As above mention, the experimental material is a fresh dragon fruit. This dragon fruit is a red dragon fruit with red skin and white flesh and have the flesh filled with lots of tiny black seeds which are edible with the fruit.

Fig 1: A sample before drying

The dragon fruit was purchased from a local market and cut into a small piece with a thickness of 30 mm, an initial mass of 121,54g, and an average cylinder diameter of 73.98 mm. And the sample is put on an aluminum support with a mass of 2,17g during experiment.

During drying process, the sample is always at 80^{o}C inside the oven-dryer, and only takes out to measure the values. After measuring, the collected values is calculated and treated to determine the values of the moisture content, the drying rate and the shrinkage of the sample.

2. Equipments

+ The oven-dryer Memmert VO200: for generating a hot air that is used as the heating medium and is in direct contact with the sample. Memmert VO200 is a dryer of 29 l volume and the maximum capacity of 1.2 kW, shown in Figure 8 below. The dryer can be electrically heated from 20^{o}C to 200^{o}C with short warming up times, high-precision temperature control and turbo-drying. The heat transferred from the hot air to the sample causes evaporation of the water content.

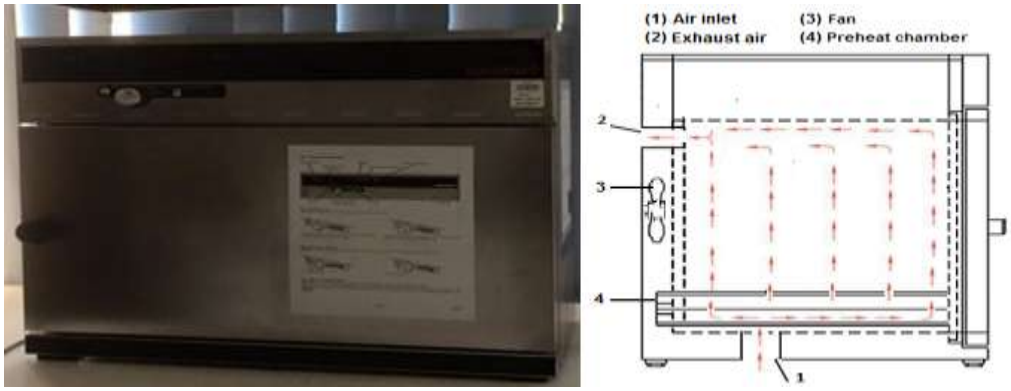

Fig 2: The oven-dryer Memmert VO200

+ The scale Sartorius Quintix124-1S: for measuring the mass of a sample. Sartorius Quintix124-1S is a precise digital scale with the readability of 0.0001g, the capacity up to 120g, internal calibration, and pan diameter 90mm.

Fig 3: The precise digital scale Sartorius Quintix 124-1S

+ The digital electronic caliper: for measuring a thickness and a diameter of a sample with the accuracy up to 10^{-2} mm during drying.

Fig 4: The digital electronic caliper

3. Date treatment

Treating the measuring data is to get the values of the water content, the drying rate and the shrinkage of the sample, and to understand about the way that the sample change during drying process.

The water content of a sample was determined by the following equation [1]:

$$X(t) = \frac{m_w(t)}{m_{dm}} = \frac{m(t) - m_{dm}}{m_{dm}} \quad (1)$$

where: $m_w(t)$: the evaporated water mass of a sample, [g]
$m(t)$: the initial mass of a sample at t, [g]
m_{dm}: the dry mass of a sample, [g]
$X(t)$: the water content of a sample at t, [g/g]

The drying rate of a sample was determined by the following equation [1]:

$$-\frac{dX}{dt} = \frac{X_{(ti-1)} - X_{ti}}{t_i - t_{i-1}} \; x \; \frac{S_i}{S(t)} \quad (2)$$

where: X_{ti-1}: the water content at t_{i-1}, [g/g]
Xti: the water content at t_i, [g/g]
t: the time for measuring the values of the sample, [min]
S_i: the initial exchange surface, [mm]
S(t): the exchange surface at t_{th} time, [mm]
dX/dt: the drying rate of a sample, [g/g.min]

The shrinkage of the sample was determined by the following equation [1]:

$$S_b = \frac{V(t)}{V_i} = \frac{\pi R^2(t) \times e(t)}{\pi R_i^2 \times e_i} \quad (3)$$

where: V(t): the volume of a sample at the time of t, [mm^3]
V_i: the initial volume of a sample, [mm^3]
R(t), e(t): the radius and thickness of a sample at t, [mm]
R_i, e_i: the initial radius and thickness of a sample, [mm]
S_b: the shrinkage of the sample, [mm^3/mm^3]

Based on the collected data and the equations, we got the values of the water content, the drying rate and the shrinkage of the sample as follows.

III. RESULTS

1. Measured results

At each measured time, the values of a mass, a diameter, a thickness of the product is collected by tools such as a precise digital scale and a ruler.

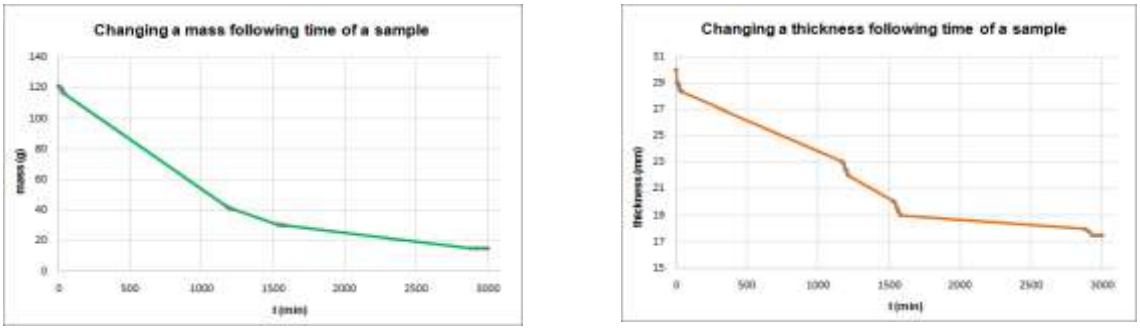

Fig 5: Charts on the changes in mass and thickness of a sample during drying

Fig 6: Some pictures of the sample after drying process

2. Discussing

The first, the changes in the moisture content of a sample during drying are presented in figures 3. The moisture content decreases gradually with increases in drying time, exhibiting a gentle downward curve. The data also indicates that the time is required to reduce the moisture content from 7.029g to less 1g at around 1570 minute. And the curve of the dry basis water content of a sample in this experiment took place in accordance with the theoretical basis of drying in the field of food and fruit.

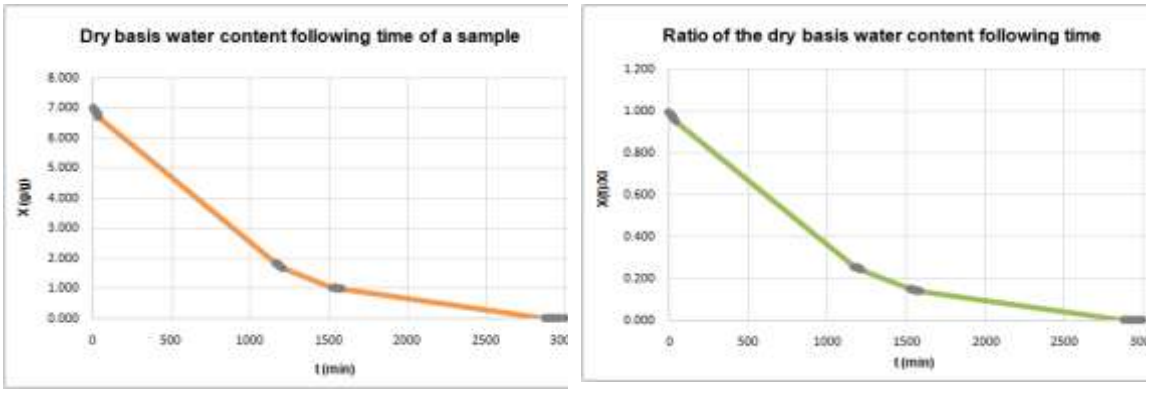

Fig 7: Changes in moisture content of a sample during drying

The second, the changes in the thickness and shrinkage of a sample during drying are shown in figures 4. The shrinkage of a sample was 80% at 250 min, 60% at 700 min, and 21% at 1600 min, but the data of thickness indicates that the change of a thickness is less than of the shrinkage with 80% at 750 min, and finally 60% at 2000min. However, all processes of shrinkage and thickness followed the typical drying curves with high shrinkage and thickness initially and gradual leveling off towards the end of drying so that the final size and shape of sample was fixed before drying was completed.

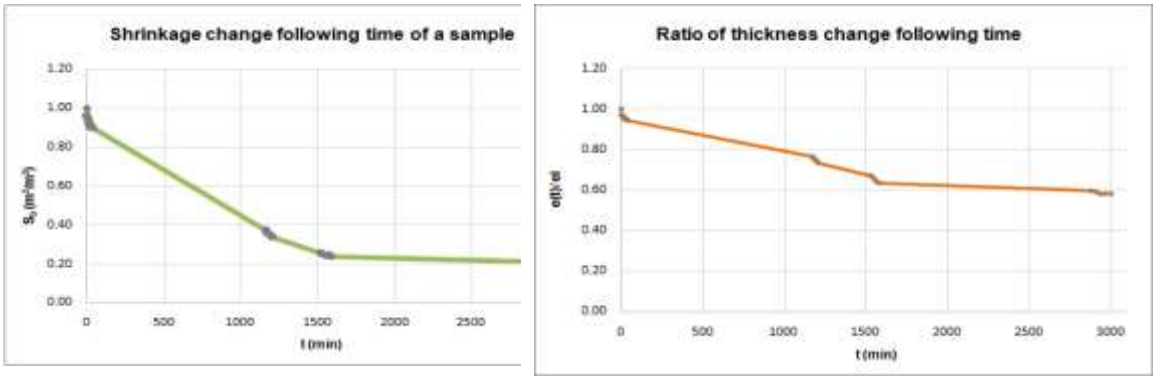

Fig 8: Changes in shrinkage and thickness of a sample during drying

The third, the drying rates of sample were calculated using the data describing the changes in moisture content, and presented in figures 5. In both drying rate and corrected drying rate curves, the drying rate increased in range of 0 to 400 min, and then the drying process of sample took place only in the falling rate period with decreasing moisture content. However, the values of the corrected drying rate are higher than of the drying rate due to the effect of the available surface for the heat and mass exchange. And finally, these results concur with the theory drying curves of fruits and vegetables.

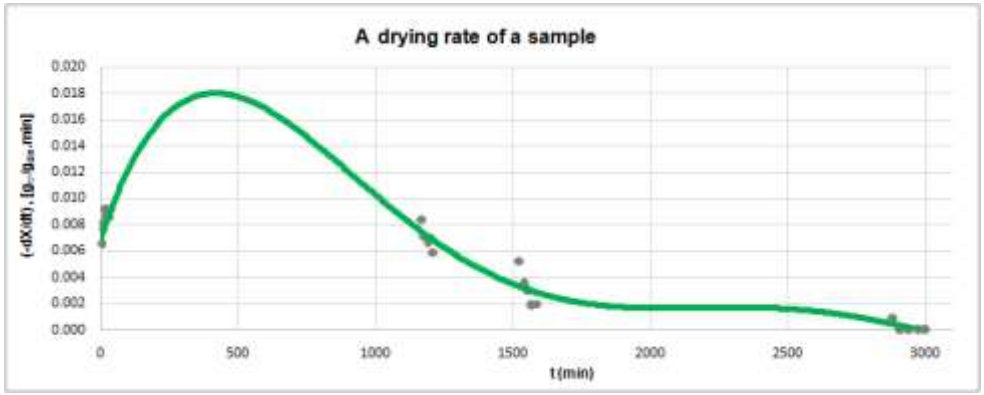

Fig 9: Variation of drying rate with drying time of sample

IV. CONCLUSION

Oven-dryer is an appropriate tool for fruit drying in general and dragon-fruit in particular. The changes in the moisture content, shrinkage and shape of a sample during drying took place in accordance with the theoretical basis of drying. And although the drying rate of a sample is not high (less 0.020 kg water/kg dry mass min) due to its fairly large thickness (30 mm), but the drying rate curve of a sample is entirely consistent with the basic drying theory of fruits and vegetables. Finally, by this experiment, our team has got a view to understand more clearly about the theory drying processes as well as information useful on drying process of dragon-fruit.

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