DRYING KINETICS OF *MORINGA OLEIFERA* LEAVES ON ANTIOXIDANT ACTIVITIES AND NUTRITION CONTENT

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Abstract. *Moringa* leaves are sensitive on heating process, using high temperature drying could damage nutrient contain, the aims of this study is determining of drying kinetic rate at 60°C level from *moringa* leaves. Preliminary study had been conducted in three treatments, first treatment was without boiled, second treatment was steam and last treatment was boiled treatment plus Na-metabisulfite 0.3%. After analysing, it could be determined that using second treatment gave better result in antioxidant level and vitamin C contain. The result was 60.62% antioxidant after processing which meant second treatment was better in decreasing antioxidant loss than other treatments. The same result showed in vitamin C. Vitamin C in second treatment was the highest with 31.93 mg / 100 gr. Based on that result, second treatment became basic research for next test. The drying rate kinetics with 60°C temperature reduced the moisture content of *moringa* leaves until 10% below for 60 minutes, based on the graph it could be seen that the drying trend was divided into 3 stages. Furthermore, drying was carried out at lower temperature to minimize nutrient damage but required longer drying time.

Keywords: antioxidant activities, kinetic drying, *moringa* leaves

1. Introduction

Moringa is scientifically proven to have a potential nutrient content to end malnutrition, hunger, and prevent and cure various diseases. According to the results of the study [1], *moringa* leaves contains vitamin A, vitamin C, Vitamin B, calcium, potassium, iron, and protein in very high quantities which are easily digested and assimilated by the human body. In fact, the number is many times that of food sources which have been used as a source of nutrition for improving nutrition in many parts of the country. Not only that, *moringa* is known to contains more than 40 antioxidants, especially in leaves [2]. The results of phytochemical test from [3] and [4] shows that it contains flavonoids, anthraquinones, alkaloids (0.42%), saponins (1.75%), terpenoids, anthocyanins, tannins (8.22%), phenols (0.19%) and carotenoids.

In the other hand antioxidants and micronutrient content such as vitamins and minerals are sensitive to light and heat, therefore handling must be good and avoided from various factors that can reduce its activity. Fresh raw *moringa* leaves has potential to produce high antioxidant activity but its continuity may be difficult to guarantee because it must always be held whenever needed. In addition, fresh raw materials are relatively faster to break than in dry form.

However, there are no related studies that examine the effect of drying methods at various temperatures on antioxidant activity and the content of micronutrients of *moringa* leaves. Drying *moringa* leaves is intended to reduce water content, so that it can extend its shelf life and can increase the usability of the *moringa* leaf. Dryers that can be used in addition to cabinet dryers can also use fluidized dryers, freeze dryers, vacuum dryers or dryers with sunlight. Based on this, research will be conducted on drying kinetics based on drying time at 60^0C to obtain *moringa* leaf flour which has the best antioxidant activity and nutrient content.

2. Method

2.1 Materials and Tools

The main material used in this study is fresh *moringa* leaves. The tools used in this study were cabinet dryer sets, thermometers, moisture level gauges, antioxidant activity measuring sets, and tool sets for testing nutrient content.

2.2 Stage of Research

The study was conducted in three stages, namely 1) preliminary treatment of the variation of blanching and drying of *moringa* leaves at 60°C, 2) determination of equilibrium water content and 3) making the model of drying rate equation (Lewis Model).

1. *Preliminary Treatment of Blanching Variations*

   The research activity begins with measuring the water content and vitamin C levels of the fresh *moringa* leaves. Next, fresh *moringa* leaves are carried out in 3 variations 1) without blanching, 2) blanching with steam, and 3) blanching with boiling in a solution of 0.3% sodium metabisulfite. Blanching was carried out at 100°C for 3 minutes then analyzed for vitamin C and antioxidant activity of *moringa* leaves.

   The next study was to dry the *moringa* leaves from the best research results using cabinet dryers at a drying temperature of 60°C. Sampling is carried out every 10 minutes until the weight loss results in ± 10% moisture content or drying is carried out until the sample weight no longer changes. All samples were then measured for water content. In addition to measuring water content, at the equilibrium point drying *moringa* leaves also measured ash, protein content, fat content, vitamin C levels, beta-carotene levels, and antioxidant activity.

2. *Determination of Equilibrium Water Content*

   The water content of equilibrium at 60°C of drying temperature is determined by dynamic methods. The sample is dried until no longer changes of weight. Water content when the sample weight no longer changes is the equilibrium moisture content.

3. *Making Drying Rate Model Equations (Lewis Model)*

   Sample water content data and equilibrium moisture content are used to make the model of the drying rate equation. The water content used is dry water base content. The equation of the drying rate is made following the drying model according to Lewis. Lewis's model proposes that during drying of hygroscopic material, changes in the moisture content of the material in the period of the decreased rate are proportional to the difference between the moisture content and the equilibrium moisture content. This concept assumes that the material is thin enough or the air velocity is very high and the drying air conditions such as temperature and Rh are constant.

$$\frac{dM}{dt} = -k\,(M-M_e)\,. \quad \text{.....(1)}$$

The value of *k* is the drying rate constant which is a combination of the transfer properties in drying such as effective diffusion, moisture content, thermal conductivity, and mass coefficient. This equation is a differential equation because it expresses the relationship between functions and derivatives. By separating and placing variables that have water content to the left side of the equation and variables that have time to the right, then neutralized, the equation becomes:

$$\int \frac{dM}{(M-M_e)} = \int -k\ dt \quad \ln \frac{M_t - M_e}{M_i - M_e} = -kt. \qquad \text{.....(2)}$$

or

$$MR = \frac{M_t - M_e}{M_i - M_e} = \exp(-kt) \qquad \text{.....(3)}$$

With Mt is the water content (dry basis) at various times; Me is the equilibrium moisture content; Mi is the initial moisture content of the material; and k is the drying constant. (Mt-Me) / Mi-Me also called moisture content ratio or MR.

2.3 Research Parameters

The parameters analyzed in the preliminary treatment of *moringa* leaf were vitamin C an antioxidant activities. In the drying of *moringa* leaves the parameters analyzed were moisture content of wet bases and moisture content of dry bases. Furthermore, at the drying equilibrium point at a drying temperature of 60 ° C, vitamin C levels and antioxidant activity will be analyzed.

3. Results and Discussion

3.1 Preliminary Treatment of Blanching Variations and Drying of Moringa Leaves at Various Drying Temperatures

Blanching is an initial heating treatment that is usually carried out on fresh vegetable ingredients before the freezing, drying or canning process. Although in general it aims to improve product quality, the specific objectives of the process are vary and depend on the processing to be carried out. In the drying process, it is aimed to stop the activity of enzymes that damage the quality of *moringa* leaf products such as browning, some nutrient content which is reduced during drying and has the characteristics of unpleasant aroma and bitter taste.

Based on the results of analysis, blanching with steam for 3 minutes, had the highest value of antioxidant and vitamin C activity was 60.62% and 31.93 mg/ 100 gr. When compared with fresh *moringa* leaves, the content of vitamin C that is present is much reduced (220 mg / 100 gr, [5]). Vitamin C is one type of vitamin that is very sensitive to temperature changes so that in the future when making *Moringa* leaf flour it is necessary to do a restoration with the addition of vitamin C. Based on this, the main research used for blanching is using steam as well as providing the highest yield. And it considered more practical in application.

Table 1. Results of analysis of levels of antioxidants and vitamin C

No	Analysis	Unit	Method	Result					
				Without blanching 1	Without blanching 2	Steam 1	Steam 2	Boiled with Na-Metabisulfit 1	Boiled with Na-Metabisulfit 2
1	Antioxidant	%	DPPH	12.79	12.15	60.38	60.85	16.04	16.51
	Average			12.47		60.62		16.28	
2	Vitamin C	Gr/100gr	Titration	17.46	17.32	31.46	32.40	20.09	20.36
	Average			17.39		31.93		20.225	

3.2 Determination of Equilibrium Water Content

Drying is a way to evaporate water in food ingredients to balance water content or equivalent to the value of water activity (Aw) by using heat energy. This study uses a dryer with artificial heat energy using a cabinet dryer with 60°C temperature. Heat sourced from artificial drying has a good advantage, where the drying temperature can be measured so that the dried food is as expected [6].

The method used in determining the equilibrium moisture content is a dynamic method, because the static method requires several weeks before reaching equilibrium and at RH and high temperatures it is likely that *moringa* leaves will be damaged due to too moist or microbial contamination before reaching equilibrium.

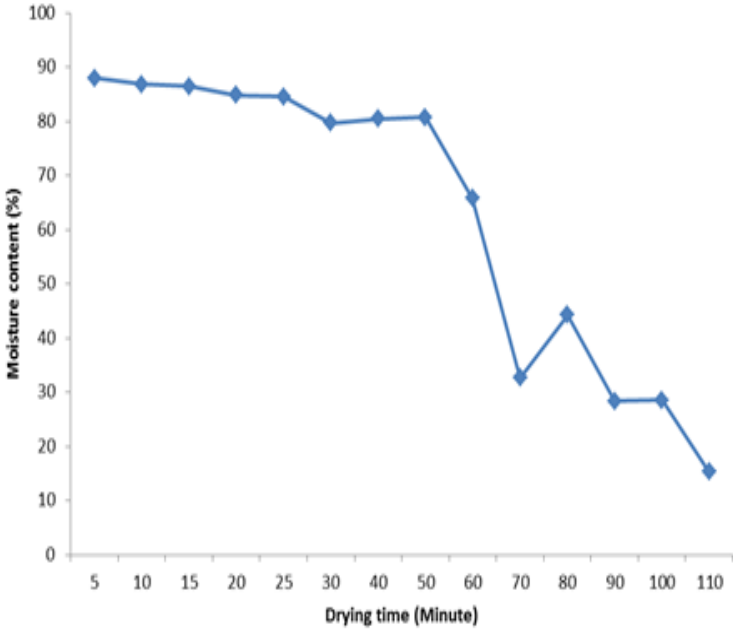

Figure 1. Moisture Content Vs Drying Time

The characteristics of the decrease in moisture content of *moringa* leaves during the drying process can be seen in figure 2. The decrease in the moisture content of *moringa* leaves at the first stage is greater than the final stage of drying. All curves tend not to be linear where the water content has a tendency to be near constant for a very long drying period.

Based on the curve of the relationship between the rate of drying vs. moisture content as shown in figure 2, the drying process of *moringa* leaves will experience several stages, namely: The initial adjustment stage (I) is drying from the evaporation of water on the surface of the leaves of *moringa* into the air the speed decreases drastically as the water decreases on the surface of the *moringa* leaf. After the adjustment stage, a constant rate stage (II) is formed, at this stage a constant rate occurs because the equilibrium temperature has been reached where the rate of evaporation of water from the *moringa* leaf to the surface and the rate of evaporation of water from the surface of the *moringa* leaf to the air are the same. The constant rate of drying of *moringa* leaves occurs in a short time. Decreasing stage (III).

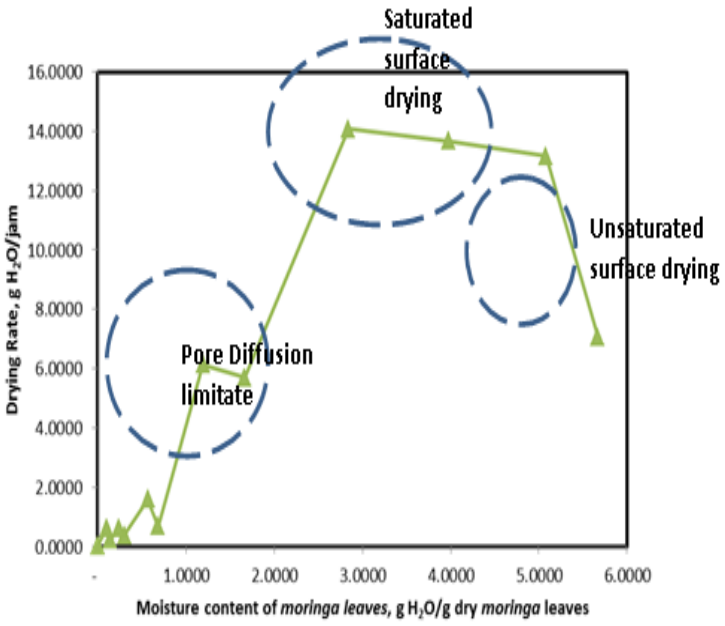

Figure 2. Graph drying rate vs moisture content

Finally, after achieving balance, the drying rate drops linearly. It happens because of the surface layer of the liquid has been reduced due to evaporation, so that subsequent drying will cause the area to dry out.

4. Conclusion

Based on the results of the study it was found that the best preliminary treatment was with boiled blanches for 3 minutes at 100^0C resulting in the highest antioxidant and vitamin C values of 60.62% and vitamin C 3.24%. The drying curve of *moringa* leaves using cabinet dryer shows the trend of the higher temperature, the faster the drying process is carried out and the more the faster the damage to nutrients and antioxidant activity of the *moringa* leaves produced. *Moringa* leaf drying has three periods: initial adjustment, constant rate and decreased rate, where at high temperatures the rate of decline is very drastic in a short time compared to lower temperatures.

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