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## Evaluation of moisture content in drying of grated coconut meat using grain moisture meter

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**Abstract.** Drying the coconut meat is one of the process in the coconut oil industry. The objective of this research was to evaluate the moisture content that measured by grain moisture meter (GMM), and it was compared to gravimetric results. Grated coconut meat was put into the dryer that carried out at 80°, 85°, 90°, 95°, and 100°C. It needed 150 to 110 minutes until zero moisture content. Measuring the moisture content of grain particles (i.e. grated coconut meat) by Grain Moisture Meter (GMM) is one of a simple way to understand how much the real time moisture content, but it must be calibrated with gravimetric method.

### 1. Introduction

Most methods of measuring moisture content in solid particles using gravimetric methods. This is done by some researchers. The weakness of this way is not known the current water content. The measurement also takes a long time. Therefore, it is need to find a way to measure the water content in real time.

Aregbelosa *et al.* studied the thin layer drying characteristics of *dika* kernels and nuts. It was investigated four drying temperatures of 50°, 60°, 70° and 80°C and the data was fitted to drying models. The moisture content of the kernels and nuts was determined by gravimetric method. The samples were oven dried at 130°C until the mass didn't changes between two weighing succession. The sample's weight was taken quickly to obviate interference with the drying process. The final moisture content was specified by oven drying method [1].

Experiments of drying copra were conducted by Deepa *et al.* [2]. In the determination of water content, samples (10 g) were chopped from randomly selected 5 cups and kept in a convective electrical oven, maintained at 105° ± 1°C for 5 h. Initial and final mass at time t of samples were recorded using electronic balance and repeated every 1 h interval till end of drying.

Drying of grated coconut was investigated by Ginting *et al.* [3]. The research was aimed at testing the temperature drying (100°C, 110°C, 120°C and 130°C) on the quality of the desiccated coconut dried in desiccated coconut dryer. Water content was known by weighing the dried material in the oven at 105°C for 4 hours. The difference between initial and final mass is the water content. Pestano and Jose studied improvement coconut processing systems in the Philippines [4]. Samples of air-dried coconut meat was weighed using a precision balance with an accuracy of 0.01 g. Drying take place at 60°, 70° and 80°C.

Rosa *et al* investigate the kinetics of drying orange seed, waste products from juice processing, that was studied in the temperatures of 40°, 50°, 60° and 70 °C and drying velocities of 0.6, 1.0 and 4 m/s. The experiments were obtained using a convective air forced dryer. Drying was stopped when the



weight of the test sample reached a constant value. Moisture contents at each time interval was calculated in dry basis (d.b.) from both weight loss data and dry solid weight of the sample [5].

Grain moisture meter is used to measure the moisture content in solid granules and the water content is read directly on the screen. Is the result of the water content read from the grain moisture meter (GMM) equal to the water content of the gravimetric way? In this research, drying of fresh grated coconut is done. The purpose of this research was to evaluate the moisture content that indicated by grain moisture meter compared to the gravimetric results.

## 2. Materials and methods

Water equilibrium in solid phase (x) and in air (y) could be approximated by Henry Equation (1).

$$y = H.x \quad (1)$$

Experimentally, the coconut was de-husked, de-shelled, peeled, grated, and dried in the batch dryer. Drying was carried out in the batch dryer equipped with a motor, an agitator and a heater from a fire derived from LPG gas. The dryer was also equipped with oil bath to regulate its temperature. The area of the dryer was 29.5 cm x 40 cm. Grated coconut 3 kilograms was put into the dryer that operates from 80°C to 100°C, and every 10 minutes was measured its moisture content (y) using the Grain Moisture Meter - Hold Peak - HP-70326. The results were compared with the solid water content (x) which measured gravimetrically.

## 3. Results and discussion

This section explains and discusses the experiment results.

### 3.1. Evaluation of moisture content from GMM and gravimetrically method

The samples of  $30 \pm 0.01$  g of grated coconut meat were put into porcelain dish. The grated coconut was dried in the oven, and every ten minutes was measured the moisture using GMM and also measured by electrical balance. The moisture content of grated coconut from the grain moisture meter (y, g/g) was compared with water content from gravimetrically method (x, g water/g solid dry basis). The results can be seen at figure 1 and figure 2.

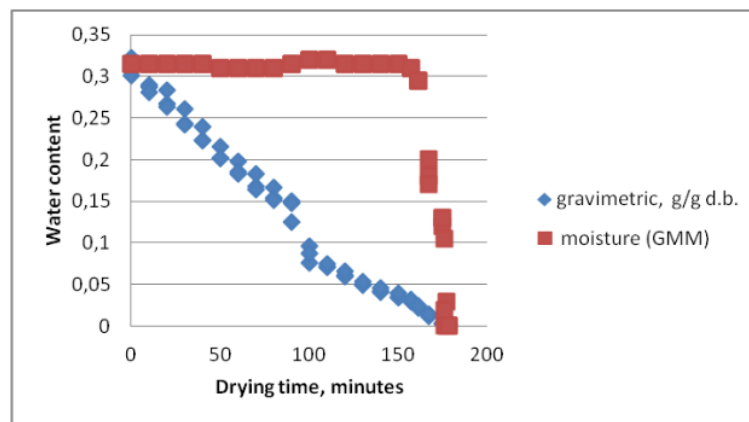
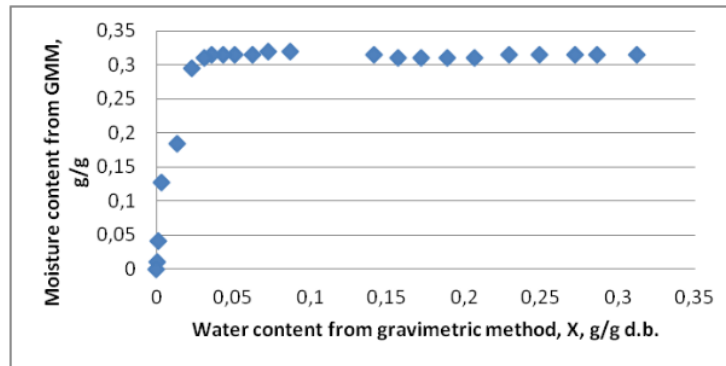
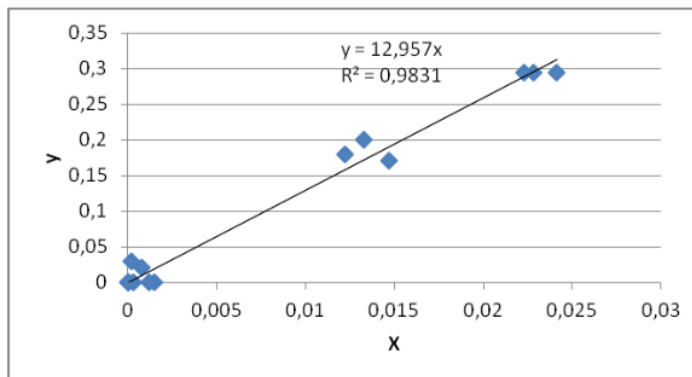


Figure 1. Measuring water content using Grain Moisture Meter (GMM) and Gravimetric Method.

There were two periods of drying, constant rate period (for  $x = 0.024 - 0.32$ ), and falling rate period ( $x = 0 - 0.024$ ). For constant drying period, the moisture content at the solid surface was 0.31 to 0.32, and it needed more than 150 minutes for oven drying. For the falling rate period, the relation between  $y$  and  $x$  was expressed on figure 3, and the Henry constant was 12.957.



**Figure 2.** The relation between moisture content from grain moisture meter ( $y$ ) and water content in solid gravimetrically ( $x$ ).



**Figure 3.** Relation between  $y$  and  $x$  in the falling rate period.

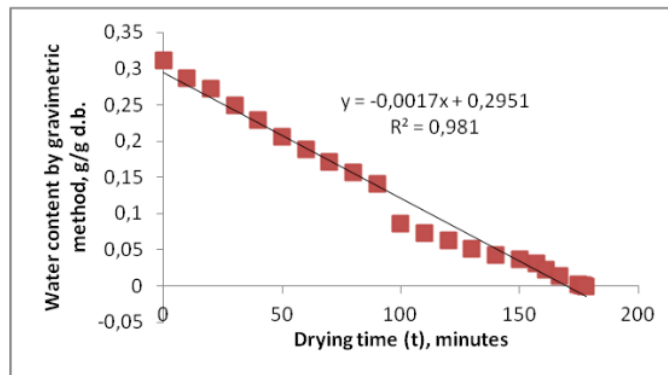
The measurement using grain moisture meter (GMM) is simple method, but need to compare with the gravimetric method. In the beginning of drying process, the water covers the solid surface, so that the moisture content that measured is constant, until critically  $x$ . After that, the moisture content ( $y$ ) is falling until zero. Grain moisture meter is a simple to understand how much the moisture content, but it must be checked with the gravimetric method to get a certain value of water content in the solid. Grain moisture meter only measure the moisture at the air near the surface of the solid. In the constant rate period, the measurement or moisture is not valid, but in the falling rate period, under 0.024 (g/g dry basis) it's almost valid. It is needed to make a relationship between drying time ( $t$ ) and water content in dry basis by gravimetric method ( $x$ ), and is shown as figure 4 and equation (2). It is needed to evaluate the true moisture content over 0.024 g/g d.b. So, for  $x > 0.024$  it is applied the equation (2) and for  $x \leq 0.02$  equation (3) is applied.

$$x = 0.2951 - 0.0017t \quad (2)$$

Where,  $x$  = water content, g/g solid dry basis and  $t$  = drying time, minutes.

$$x = y/1295.7 \tag{3}$$

Where,  $y$  = moisture content by grain moisture meter, %.



**Figure 4.** Relationship between water content by gravimetric method against drying time ( $t$ ).

### 3.2. Application on a batch modified screw mixed dryer

Grated coconut as much as 3 kg was put into the modified screw mixed dryer, and batch operation. The dryer was operated at 80°C and atmospheric pressure. Every ten minutes the water content of grated coconut was measured using GMM. The drying operation was continued until zero moisture content. The same operation was carried out at 85°, 90°, 95°, and 100°C. The results of measurement of water content using grain moisture meter and applied calculation of equation (2) and equation (3) is shown in table 1.

**Table 1.** The average moisture content of grated coconut meat at different temperature operation observed by grain moisture meter.

t, min	Average Moisture Content, g water/g solid dry basis									
	T=80°C		T=85°C		T=90°C		T=95°C		T=100°C	
	GMM	x	GMM	x	GMM	x	GMM	x	GMM	x
0	0.320	0.295	0.320	0.295	0.320	0.295	0.320	0.295	0.320	0.295
10	0.320	0.278	0.320	0.278	0.320	0.278	0.320	0.278	0.315	0.278
20	0.320	0.261	0.320	0.261	0.315	0.261	0.315	0.261	0.315	0.261
30	0.320	0.244	0.315	0.244	0.315	0.244	0.315	0.244	0.315	0.244
40	0.320	0.227	0.315	0.227	0.315	0.227	0.315	0.227	0.315	0.227
50	0.320	0.210	0.315	0.210	0.315	0.210	0.315	0.210	0.315	0.210
60	0.315	0.193	0.315	0.193	0.315	0.193	0.315	0.193	0.315	0.193
70	0.315	0.176	0.315	0.176	0.315	0.176	0.315	0.176	0.215	0.017
80	0.315	0.159	0.315	0.159	0.193	0.015	0.213	0.016	0.120	0.009
90	0.315	0.142	0.220	0.017	0.120	0.009	0.120	0.009	0.067	0.005
100	0.315	0.125	0.130	0.010	0.047	0.004	0.078	0.006	0.027	0.002
110	0.172	0.013	0.087	0.007	0.022	0.002	0.037	0.003	0.000	0.000
120	0.120	0.009	0.037	0.003	0.000	0.000	0.000	0.000		
130	0.050	0.004	0.000	0.000						
140	0.020	0.002								
150	0.000	0.000								

It can be seen from the table 1 that the higher operating temperature will reduce the drying time. The drying temperature of 100°C took only 110 minutes to reach zero moisture content, whereas the drying time 120 minutes at 90°C and 95°C. At 85°C and 80°C it needed 130 minutes and 150 minutes, respectively. The higher operating temperature will reduce the humidity of air surrounding the dryer, and eventually will increase the driving force. This will increase the rate of mass transfer of water from solid surface to the air. Finally, it reduces the drying time.

The results of this research is better than the Wijose Process, because the Wijose Process needs more time, 188.3 minutes for the same temperature [4]. This results also better than another researcher which used cabinet dryer [2], that needs 24 hours.

Grain moisture meter is not suitable for measuring water content in drying operation of grated coconut meat, so it must be corrected by equation (2) and (3) to get the current water content gravimetrically. It is shown as  $x$  (gram of water/gram of solid dry basis) in table 1 and figure 5. The calibration of GMM results can be seen at figure 5.

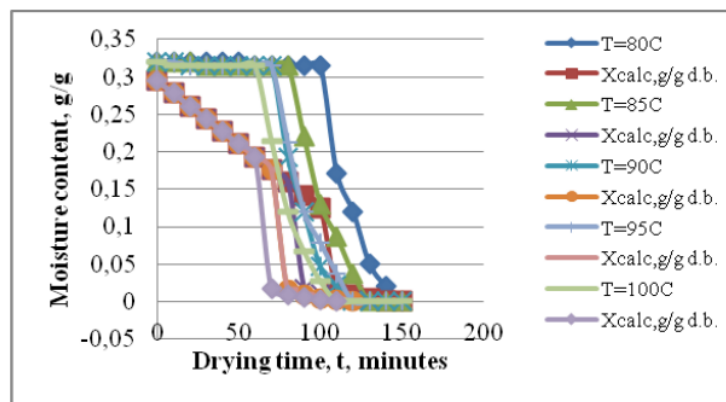


Figure 5. The calibrated results of GMM that applied in batch modified screw mixed dryer.

## 2 Conclusion

Measuring the moisture content of grain particles (i.e. grated coconut meat) by Grain Moisture Meter (GMM) is one of a simple way to understand how much the real time moisture content, but it must be calibrated with gravimetric method.

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