Optimization of instant Pliek u (fermented coconut meat) production using Kinetic Dryer

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Abstract. Pliek u is a traditional food of Aceh, Indonesia, obtained traditionally by coconut meat fermentation and added into food or cuisines to enhance the food taste and flavour. This product commonly contains high water and fat causing rancidity and declining of quality over storage time. Therefore, further processes were required to preserve quality and to extend shelf life of pliek u. Moreover, in order to provide ready-to-eat product, instantpleik u was produced. This research aimed to optimize the production of instant pleik u through drying process using kinetic dryer. Pliek u contained 18.8% of water, 32.34% of fat and 4.63% of ash. In this research, pliek u was dried at 30, 40, 50 and 55 °C for 10 hours. The results showed that weight loss of pliek u increased over drying temperature and duration. In contrast, moisture content of pliek u decreased over drying temperature and duration. Moisture content of pliek u reached below 12% after kinetic drying at 30 °C for 5 hours, similarly after drying at 40 °C for 4 hours, 50 and 55 °C for 3 hours. In addition, drying rate of pliek u firstly rose over drying time and then remained constant.

1. Introduction

Plek u is one of fermented foods in Indonesia which has widely applied as spice in Aceh culinary[1]. It is pulp of coconut meat which is fermented, shredded, and then it is continued with drying the coconut meat under sunlight and separating the solid from oil by hydraulic pressure. It has specific flavor as almost rancid smell, strong scent, slight sour, and dark color. Nurliana[2] reported that pliek u contained 18.97% of water, 4.94% fat, 23.56% protein, 47.44% carbohydrate, 15.72% crude fibre, and 8.34% mineral. Moreover, its extract also contained several active compounds that potentially support its application as a spice.

Some areas in Aceh Province produced pliek u are Aceh Besar, Bireun, East Aceh, South Aceh and Pidie. Particularly in Bireun District, Jangka Alue village and Tanoh Anoe village are the center of manufacturing pliek u where most of people in those villages process coconuts into pliek u. In Jangka Sub district, Bireun District, there are more than 30 home-based pliek u industries, and the majority of the industries are led by housewives who do not have permanent jobs. They have formed farmer groups in order to develop the business and facilitate the group’s coordination easily.
Pliek u is sold about 15,000 – 25,000 Rupiahs depending on the quality of the product and price of raw materials. Generally, the appearance of pliek u is not attractive because it is sold as large chunks in sacks and only in traditional markets. Consequently, these businesses offer very low profits. The existence of pliek u as traditional products needs to be preserved through supplying chain planning and optimization of production, so that it can expand its distribution and marketing. The challenge today is a shift in people's appetite for modern food products with their hygiene, practicality and attractiveness. The production of instant pliek u is expected to increase its prestige and to expand its market. Possibility to reach the modern markets such as minimarkets and supermarkets can be achieved by its quality improvement and product innovation (instant products, attractive packaging, long-lasting durability, etc.).

In order to produce instant product, it requires to add more processing step in manufacturing pliek u. Pliek u contains high water, about 18% of moisture content [2] which is above critical moisture content. It leads to critical storage time, which is easily rancid and moldy. Thus, to produce instant pliek u with high quality, attractive and longer storage time, optimization of the production process is needed through drying to reduce the moisture content of pliek u. Therefore, this research aimed to optimize production of instant pliek u through drying process using kinetic dryer. In addition, temperature and time are crucial parameter in drying process, thus it is required to determine appropriate temperature and time for the kinetic dryer application in this production.

2. Materials and methods

2.1. Material
Sample of this research was pliek u from Desa Tanoh Anoe, Jangka Sub district, Bireun District, Aceh Province, showed in Figure 1.

![Figure 1. Pliek u](image)

2.2. Tools
The tools used in this study were analytical balance, glassware’s (IWAKI Japan), kinetic dryer (Tray Dryer), and basin.

2.3. Research Procedure

2.4. Drying method
Drying experiment was performed by tray dryer equipped by a tubular heater (1950 Watt), two stainless flat trays (700x400 mm), and four fans (Ø5 inch, 38 Watt). The dryer was also connected with an analytical balance (TORA). The sample was weighed, placed and spread evenly on a tray, and then it was dried at different temperatures of 30, 40, 50 and 55 °C for 1 to 10 hours. The weight of each samples was measured per hour.

2.5. Sample Analyses
All pliek u samples firstly were analysed its moisture (oven method), fat (soxhlet method), and ash content (dry ashing method) referred to AOAC official method[3]. Then, after drying, moisture content, weight loss and drying rate of samples were determined. Sample analyses were carried out in triplicate.
The weight loss and the drying rate calculation were based on weight changes of sample. The drying rate was calculated as following equation:

\[
DR = \left( \frac{W_t - W_{t+1}}{W_a} \right) \frac{1}{t_2 - t_1}
\]

Where \( W_t \) is initial weight of sample (gram), \( W_{t+1} \) is weight of sample at the \( t \) time (hour), \( W_a \) is constant weight of sample, \( t_1 \) and \( t_2 \) are the changing of the drying time (1 hour).

2.6. Data processing

The data obtained experimentally for the four different temperatures were plotted in linear regression.

3. Results and Discussion

The result provided in Table 1 showed that the pliek u contained high of water while the moisture content for spices to keep well during storages hold be 12% maximum. This result was almost similar to Nurliana [2] that the pliek u contained high of moisture and fat. It was caused by highly content of the moisture and fat of coconut meat as raw material.

Table 1. Chemical content of pliek u

| Composition | Content (%) |
|-------------|-------------|
| Water       | 18.80       |
| Fat         | 33.34       |
| Ash         | 4.63        |

3.1. Moisture content

Moisture content is the amount of water contained in an ingredient per unit of material weight and expressed in percent. It is crucial characteristic of product in determining food shelf life. Figure 2 showed that the moisture content of pliek u obtained before and after drying were from 8.7% to 18.8%. At the beginning of the drying process, the percentage of moisture content decreased sharply, but after drying for 7 hour it decreased slowly and remained constant. Overall, the longer drying time, the more moisture content decreased. This is caused by transferring water from the material to dried air. The heat produced from the dryer cause evaporation of the water content in the material. The longer the drying time, the less moisture content in the material because the water is bound by the dried air in the dryer [4]. On the other hand, the higher drying temperature for the longer time can lead to decomposition of other food component, mainly heat-sensitive components, such as fat oxidation and evaporation of volatile compounds. In consequent, it caused a great change in the mass of the pliek u and too low moisture content reaching zero percent of moisture content for the pliek u dried at 55°C for over 7 hours.

The percentage of moisture content of pliek u sample dried at 30°C for 7 hours was 12%, while its moisture content dried at 55°C for 7 hours was 0.23%. The higher temperature and the longer the drying time, the lower is the water content. According to Amanto [5], higher temperature provide higher heat energy given to the material, so that the drying rate become faster. Taufik [6] also stated that the higher air temperature of the dryer, the higher heat energy carried by the air. As a result, the greater amount of liquid mass can be evaporated from surface of the material. Increasing air temperature can raise the temperature of the material, hence the water vapor pressure in the material becomes higher than its pressure in the air resulting mass transfer of the vapor from material to air. Therefore, the moisture content of pliek u dried at 55°C for 10 hours has the lowest value.
Figure 2. Moisture content of pliek u samples across drying period

Water content is also one of the important characteristics of foodstuffs, because it will affect the storability, texture, appearance and taste of foodstuffs. From the results of the study, the average water content is low (below 12%), so it is expected that you can have a longer shelf life, not easily rancid and moldy. The water content in food contributes to determining the durability of these foodstuffs, the high-water content results in the ease of bacteria, mold and yeast to grow, so it causes food deterioration.

3.2. Weight loss
Weight loss is one indicator to measure the amount of evaporated water. Figure 3 presented that generally the higher drying temperature and the drying period led to greater loss of weight. Commonly, in drying process, the greatest loss is mass of liquid. The biggest weight loss is 25% from the treatment temperature of 55°C for 10 hours, while the lowest weight loss is 3% dried at 30°C and for 1 hour.

Drying is intended to remove some water from materials that are dried by evaporation. The drying method basically aims to extend the shelf life of foodstuffs and retain the components in food. Weight loss is the loss of water from the material caused by the process of transpiration or evaporation of the material. However, Nielsen [7] stated that most weight changes are weight losses due to volatilization or decomposition. The content of water that evaporates through the surface of the material causes loss of weight on the material.

The lower the water content, the greater the weight loss or vice versa. This is due to the lack of water in the material which is a result of the evaporation of the liquid mass. If a lot of large water evaporates, it means that the weight of the loss gets bigger, causing less water that stays in the material to be characterized by low water content.

Figure 3. Weight loss of pliek u samples across drying period

3.3. Drying rate
The rate of drying carried out at the different temperature and drying time resulted in changes in different moisture content. Some equations can be generated in the calculation of the drying rate of pliek u and calculated using various formulas from the weight values after and before the material dried and then divided by the drying time [8].

Figure 4 showed that the drying rate of pliek u had similar trend to weight loss of pliek u. The drying rate that occurred at every unit of time seen at 40°C was more stable than the temperature above 40°C.
Generally, the higher the temperature used in drying process, the higher the drying rate of pliek u over the drying time. The drying rate at 30 °C resulted more uniform value, specifically after for 4 hours, than others. The drying changes occurred at the first 5 hours of drying time, thus it was ideal to dry pliek u for 5 hours, but the value of water movement in the material occurred at the first 4 hours drying, thus drying for 4 to 5 hours at 40 – 55 °C is still appropriate for pliek furthermore, after 5 hours the phenomena was changed because water content in food decreased and the less water content in the material began to dry out. In the result, the drying rate became slower and then it remained constant. The drying at constant drying rate occurs at the second to the third hour, and then the drying rate decreases at the fourth hour and further it is limited by critical moisture content[9, 10] The drying rate includes two processes, namely the transfer of water from the material surface and the transfer of water vapor from the surface to the surrounding air. The critical moisture content of the pliek u occurs when the drying rate of free water from the material moves into the surface. This provides the maximum value from changing the drying rate to a different level [11].

![Figure 4. Drying rates of pliek u samples across drying period](image)

**Figure 4.** Drying rates of pliek u samples across drying period

### 4. Conclusions

In conclusion, higher temperature of drying process would lead to shorter the drying time. The result suggested that drying pliek u at 50 and 55 °C for 3 hours obtained the percentage of moisture content under critical moisture content, and it declined from 18.80% to around 10.67%. At those temperature, the weight loss showed that only the amount of water evaporated from pliek u, it was about 8.2 % of moisture content. Moreover, the drying rate illustrated water movement in the material to the air under 4 hours the drying period.

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