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# Study of Temperature Variation on Physicochemical Characteristics of Bidara Upas Tuber (*Merremia Mammosa* (Lour) Hall. F.) Flours

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**Abstract**. Bidara upas tubers contain flavonoids, tannins, and dietary fibers which potentially to be used as functional food. One of the way to extend the shelf life of bidara upas tubers is by turn the tube into flour. During processing, the drying temperature plays an important role in physicochemical changes of bidara upas tubers flour. This study aims to analyze the effect of drying temperature variations on physicochemical characteristics of bidara upas tubers flour. This study is used Complete Random Design (CRD) with 4 levels of drying temperature of 40°C, 50°C, 60°C, and 70°C, which each was repeated with 6 replications. The results of this study showed that drying temperature variations have a significant effect p < (0.05) on the color degree, water content, total flavonoids, tannins, dietary fiber, and starch digestibility. The best results were found at 40°C with characteristics of color, water content, total flavonoids, tannin, dietary soluble fiber, insoluble dietary fiber, and starch digestibility respectively 76.91%; 11.58%; 5.92%; 10.51%, 0.28%, 0.42%; 83.88%.

**Keywords:** Physicochemistry, bidara upas tubers flour

## 1. Introduction

Bidara upas (*Merremia mammosa* (Lour) Hall. F.) is an Indonesian native plant had been used for a century to reduce of blood glucose levels[1]. One of the plant parts of bidara upas which can be utilized is the tuber. Empirically, the bioactive compounds of bidara upas tuber believed as an anti-inflammatory, analgesic, laxative, swelling remover, neutralizing toxins, conditioning, stop bleeding, lowering blood sugar levels, fever, and cancer inhibitors. These bioactive compounds are alkaloids, tannins, flavonoids, and polyphenols[2]. In addition, bidara upas tubers contain macronutrients such as sucrose, maltose, crude fiber, fat, and protein[3]. Bidara upas tuber flour is easier in storages, it is more durable and easily processed into various food products.

Flavonoids in bidara upas tubers act as antidiabetic by inhibiting glucosidase and α-amylase enzymes which play a role in breaking down carbohydrates into monosaccharides. This causes a decrease in glucose uptake and resulting in low blood glucose levels[1]. Other bioactive components are tannins which help to reduce of blood glucose levels by inhibiting intestinal glucose absorption and preventing oxidative stress due to free radicals. Beside flavonoids and tannins, bidara upas tubers contain high dietary fiber. This dietary fiber prolongs absorption process in the digestion, so that blood glucose levels do not increase significantly[3]. This is evidenced by bidara upas tubers which has a glycemic index (IG) of 16.62 and known as low glycemic index food. Based on these various benefits, bidara upas tubers have the potential to be developed as a functional food.

All this time, extraction is the only way to make functional food. But extracts obtained from extraction tend to be unstable and volatile. One of the alternative solutions is by processing bidara upas tubers into flour to increase bioactive compounds stability, facilitate handling, and extend shelf life. One of the factors that plays an important role in compound changes during drying is temperature. Therefore, this study aims to analyze the effect of temperature variation on physicochemical characteristics of bidara upas tubers flour.

## 2. Materials and Method

### *2.1. Place and Time of Research*

This research was conducted at Food Engineering Laboratory of Food Technology Faculty, University of Semarang in November to December 2017.

### *2.2. Tools and Materials*

Tools for research: food dehydrators, blenders, sieves 80 mesh, trays, spoons, analytical scales, basins, cylinders, scales, cutting boards, and knives. Tools for analysis: Erlenmeyer, glass funnel, volume pipette, static, water bath, measuring flask, volume pipette, vortex, test tube, UV-Visible spectrophotometer, porcelain dish, incubator.

Materials for research: bidara upas tubers (±7 months old) harvest from Godean km 5 Yogyakarta, and 5% NaCl. Material for analysis: Indigo Sulfonic Acid LP, 40% Ferric Ammonium Sulfate Solution, Standard KMnO4 0.1 N Solution, standard quarantine solution, ethanol 96%, potassium acetate 1 M, aquabides, AlCl3, Maltose solution, dinitrosalicylic acid, aquades, aluminum foil, 0.1 M Na-phosphate buffer solution pH 7, α-amylase enzyme solution, 0.08 M Phosphate Buffer pH 6, thermophyl, protease, 95% ethanol, acetone, HCl 0.325 N. Reagents to analyze chemical and nutritional properties were obtained from Sigma or Merck.

### *2.3. Experimental Design*

This research used an experimental research method with a completely randomized design with a single factor, i.e. drying temperature at four different levels, namely: P1 = Drying temperature of $40^oC$, P2 = Drying temperature of $50^oC$, P3 = Drying temperature of $60^oC$ and P4 = Drying temperature of $70^oC$. Experiments were repeated 6 times. Obtained data were tabulated with Microsoft Excel 2013. Statistical analysis was conducted to investigate the effect of variables on the measured parameter by using the SAS Software version 9.2 to perform General Linear Models (GLM) procedure; when a significant difference among levels was identified, the Duncan Multiple Range Test (DMRT) was carried out at the level of 5%.

### *2.4. Research Procedure*

Fresh bidara upas tubers that ±7 months old are harvested, sorted, washed, peeled, and cut. The bidara upas tuber is cut with a thickness of about 3 mm, then the tubers are soaked into 5% NaCl solution and washed again in running water. Then the tubers are dried at $40^oC$, $50^oC$, $60^oC$, $70^oC$ for 24 hours. After drying, the tubers are milled and sifted using 80 mesh sieve to obtain a uniform size of bidara tuber flour. Furthermore, bidara upas tuber flour was analyzed for its physicochemical characteristics which included color degree, water content, total flavonoids, tannins, dietary fiber, and starch digestibility.

## 3. Results and Discussion

### *3.1. Degree of Color*

Results of color degree analysis with several variations in drying temperatures can be seen in Table 1 below:

Table 1. Results of color degree analysis with variations in drying temperature

| Temperature (°C) | Results | | |
|---|---|---|---|
| | **Brightness (L*)** | **Redness (a*)** | **Yellowness (b*)** |
| 40 | $76.91^{d} \pm 0.16$ | $1.79^{b} \pm 0.00$ | $18.96^{c} \pm 0.47$ |
| 50 | $73.97^{c} \pm 0.02$ | $2.02^{d} \pm 0.04$ | $17.62^{b} \pm 0.16$ |
| 60 | $73.05^{b} \pm 0.10$ | $1.90^{c} \pm 0.01$ | $17.28^{b} \pm 0.35$ |
| 70 | $72.13^{a} \pm 0.15$ | $1.48^{a} \pm 0.01$ | $16.27^{a} \pm 0.19$ |

Note: Numbers are followed by different notations in the same column show significant differences (P <0.05).

Based on the results of ANOVA DMRT 5% in Table 1, showed that drying temperature has a significant effect (P <0.05) on color degree of bidara upas tuber flour. Table 1 shows that the color is at the temperature 40°C that is 76.91L and the lowest colour at the temperature 70°C that is 72.13L. The higher of drying temperature, the color degree will be lower because flour color gets darker. This is because drying at high temperatures leads to non-enzymatic browning of bidara upas tuber flour. Drying with high temperatures cause discoloration and quality deterioration[4].

Drying can cause Maillard reactions that occur between reducing sugars and amino acids that causing brightness deterioration of the flour color[5]. The Maillard reaction is a browning reaction that occurs between carbohydrates, especially reducing sugars with primary amine groups from amino acid[6]. The results of this browning reaction are generally undesirable or considered as an indication of deterioration.

### *3.2. Water Content*

The results of water content analysis with several variations in drying temperatures can be seen in Table 2.

Table 2. Results of water content analysis with variations in drying temperature

| **Temperature (°C)** | **Water Content (% b/b)** |
|---|---|
| 40 | $11.58^{d} \pm 0.08$ |
| 50 | $11.25^{c} \pm 0.05$ |
| 60 | $10.78^{b} \pm 0.42$ |
| 70 | $10.13^{a} \pm 0.56$ |

[a]Note: Numbers are followed by different notations in the same column show significant differences (P <0.05).

Based on the results of ANOVA DMRT 5% in Table 2, drying temperature has a significant effect (P <0.05) on water content of bidara upas tuber flour. The higher of drying temperature, the water content will be lower. This is because a high temperature can be increasing the speed of water evaporation from food material. In addition, heating during drying causes starch gelatinization, a process where starch granules especially amylopectin bind free water around it. Interestingly, this result shows that starch can bind water molecules through hydrogen bonds, thereby reducing the amount of free water in the food material[7].

### *3.3. Total Flavonoid*

The results of the analysis of total flavonoids with several variations in drying temperatures can be seen in Table 3 below:

Table 3. Results of total flavonoid analysis with variations in drying temperature[a]

| **Temperature (°C)** | **Total Flavonoid (% b/b)** |
|---|---|
| 40 | $5,92^{d} \pm 0.28$ |
| 50 | $4,69^{c} \pm 0.27$ |
| 60 | $3,16^{b} \pm 0.27$ |
| 70 | $1,24^{a} \pm 0.14$ |

[a]Note: Numbers followed by different notations in the same column show significant differences (P <0.05).

Based on the results of ANOVA DMRT 5% in Table 3, showed that drying temperature has a significant effect (P <0.05) on total flavonoids of bidara upas tuber flour. The higher of drying temperature, so the total flavonoid of bidara upas tuber flour. This is because the higher the heating temperature, total flavonoids of bidara upas tuber flour are getting lower. This is because the higher of heating temperature, the higher of flavonoid damage. The result of this study is in accordance with research results another, where the higher drying temperature used, the lower the nutritional value of the products obtained[8]. The other studies are also shown that drying with high temperatures will damage the heat-sensitive components[9].

### 3.4. *Tannin Content*

The results of tannin content analysis with several variations in drying temperature can be seen in Table 4 below:

Table 4. Results of tannin analysis with variations in drying temperature[a]

| Temperature ($^oC$) | Tannin Content (% b/b) |
|---|---|
| 40 | $10{,}51^d \pm 0.31$ |
| 50 | $7{,}67^c \pm 0.31$ |
| 60 | $4{,}77^b \pm 0.27$ |
| 70 | $1{,}84^a \pm 0.17$ |

[a]Note: Numbers followed by different notations in the same column show significant differences (P <0.05).

Based on the results of ANOVA DMRT 5% in Table 4, showed that drying temperature has a significant effect (P <0.05) on tannin content of bidara upas tuber flour. The higher of drying temperature, tannin content of bidara upas tuber flour will be lower. Decreasing of tannin content during drying process, due to tannins hydrolyzing to glucose and tannic acid due to continuous heating[10].The results of the other studies shows the opposite, where the higher the temperature the more tannins extracted come out and the temperature is not more than 80$^o$ , because the tannin is not resistant to the heating process[11]

### 3.5. *Dietary Fiber Content*

The results of the analysis dietary fiber, both soluble dietary fiber and insoluble dietary fiber with several variations in drying temperatures can be seen in Table 5.

Table 5. Results of analysis of dietary fiber content with variations in drying temperatures[a]

| Temperature ($^oC$) | Content (% b/b) | |
|---|---|---|
| | Insoluble Fiber | Soluble Fiber |
| 40 | $0{,}42^a \pm 0.03$ | $0{,}28^a \pm 0.02$ |
| 50 | $0{,}59^b \pm 0.02$ | $0{,}44^b \pm 0.02$ |
| 60 | $0{,}79^c \pm 0.02$ | $0{,}53^c \pm 0.02$ |
| 70 | $0{,}93^d \pm 0.02$ | $0{,}66^d \pm 0.02$ |

[a]Note: Numbers are followed by different notations in the same column show significant differences (P <0.05).

Based on the results of ANOVA DMRT 5% in Table 5, showed that drying temperature has a significant effect (P <0.05) on the fiber content of bidara upas tuber flour. The higher of drying temperature, so the fiber content of food, both soluble dietary fiber and insoluble dietary fiber are higher the level as well. This is due to a decrease in water content during heating, increasing the ratio of other macromolecules such as carbohydrate, fat, and protein. Increases the ratio of carbohydrates also increasing dietary fiber content. Decreasing in water content can increase the content of other compounds such as carbohydrates, proteins, and minerals[12]. At 40°C, dietary fiber content is lowest, because at this temperature the water content is higher than other temperature treatments.

### 3.6. Starch Digestibility

The results of the analysis of starch digestibility with several variations in drying temperatures can be seen in Table 6.

Table 6. Results of starch digestibility analysis with variations in drying temperature[a]

| Temperature ($^oC$) | Starch Digestibility (% b/b) |
|---|---|
| 40 | $83{,}88^d \pm 0.47$ |
| 50 | $74{,}36^c \pm 0.16$ |
| 60 | $60{,}75^b \pm 0.35$ |
| 70 | $35{,}13^a \pm 0.19$ |

[a]Note: Numbers are followed by different notations in the same column show significant differences (P <0.05).

Based on the results of ANOVA DMRT 5% in Table 6, showed that drying temperature has a significant effect (P <0.05) on starch digestibility of bidara upas tuber flour. The higher of drying temperature, the starch digestibility of bidara upas tuber flour will be lower. This is because the higher of drying temperature, food fiber levels are getting higher. The increasing of dietary fiber levels is inversely proportional with starch digestibility because the accumulation of dietary fiber levels are slower starch digestibility[13]. This is because food fibers increase the viscosity of starch in the intestine thus inhibiting enzyme interactions with starch[14].

## 4. Conclusions

Temperature has a significant effect (p <0.05) on color degree, water content, total flavonoids, tannin content, dietary fiber content, and starch digestibility.

The best physicochemical characteristics of bidara upas tuber flour are the treatment of drying temperature 40$^o$C with the characteristics of color degrees 76.91%, water content 11.58%, total flavonoids 5.92%, tannin content 10.51%, soluble food fiber 0.28%, insoluble food fiber 0.42%, and starch digestibility 83.88%.

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