Physical Characteristics of White Sweet Potato (*Ipomoea batatas* L.), Rice (*Oryza sativa* L.), and Tapioca (*Manihot esculenta*) Flours - Based Seasoning Composite Flour

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Abstract. The objective of this study was to determine the physical characteristics of seasoning composite flour that made from white sweet potato, rice, and tapioca flours, and determined the best formula of seasoning composite flour. A completely randomized design (CRD) with formula as the single factor was used. The data were analyzed by one-way ANOVA method and followed by Duncan Multiple Range Test (DMRT) at significance 5% if there was a significant difference. The best formula of seasoning composite flour was 30% tapioca flour, 30% rice flour, and 40% white sweet potato flour. The physical characteristics of the best formula were 5.689 ml/g of swelling power, 2.681 g/g of water absorption capacity, 0.887 ml/g of oil absorption capacity, and 22.03% cooking loss. Physical characteristics of the best seasoning composite flour were significantly different from the commercial seasoning flour and showed a better cooking loss, oil absorption capacity, and swelling power than commercial seasoning flour.

1. Introduction
Seasoning flour is a food material mixed from flour and seasoning with or without an addition of other food materials and permitted additives. It has a good market trend. This is because the seasoning flour simplifies and accelerates the preparation of fried products such as fried chicken, fried tempeh, peanut brittle, etc. Today’s seasoning flour is made from 50% wheat flour that contains gluten [1]. Gluten-free seasoning flour is a promising food material since gluten was associated with Autism Syndrome Disorder and Celiac Disease [2]. However, research on product development of gluten-free or wheat-free seasoning flour is still limited.

Tuber and cereal flour such as tapioca, rice flour, and white sweet potato flour are very potential to be used as raw material gluten-free seasoning flour, since the abundant availability. The world rice and cassava production always increases for last two decades. Rice production was more than 700 million tons and cassava production was more than 250 million tons in 2014. While, sweet potato production remains stable around 100 million tons for last eight years [3].

Tuber and cereal flour could be applied as composite flour. Composite flour is a mixture of several flours. Food product development based on composite flour has been applied on some products, such as composite flour of semolina durum with canna starch for spaghettini [4]; composite flour of canna starch, cassava starch, and modified cassava flour to substitute material on corn noodles instant product [5]; composite flour of arrowroot starch, cassava flour and gotu kola for flakes [6], composite flour of from red bean flour and canna starch for infants’ instant porridge [7], and composite flour of cassava starch waste, maize starch and mungbean flour for fettucine [8]. However, composite flour based on
tapioca, rice, and white sweet potato flours, and its application in the seasoning flour has not been studied yet. Thus, physical characteristics of formulation and physical characterization of seasoning composite flour from tapioca, rice, and white sweet potato flours was conducted in this study.

2. Experimental

Tapioca (Rose Brand), rice flour (Rose Brand) and white sweet potato flour (CV. KUSUKA UBIKU) were obtained from local market. Those three raw materials were sifted using a 100 mesh sieve and then mixed into composite flour. There were nine formulations of seasoning composite flour that are shown in table 1.

| Tapioca Flour (%) | Rice Flour (%) | White Sweet Potato Flour (%) |
|-------------------|----------------|-------------------------------|
| 30                | 70             | 0                             |
| 30                | 65             | 5                             |
| 30                | 60             | 10                            |
| 30                | 55             | 15                            |
| 30                | 50             | 20                            |
| 30                | 45             | 25                            |
| 30                | 40             | 30                            |
| 30                | 35             | 35                            |
| 30                | 30             | 40                            |

Composite flours were further mixed with blended spices consisting of refined salt, pepper powder, onion, garlic, and candle nut. Mixing is done using a mixer at medium speed for 20 minutes.

2.1. Characterization of Seasoning Composite Flour

Determination of swelling power, 0.1 gram sample was mixed with 10 ml of distilled water in a centrifuge tube and heated at 60°C for 30 minutes. The mixture was being shaken during the heating process. When the heating was done, the suspension was centrifuged at 3000 rpm for 30 minutes.

\[
\text{Swelling power} = \frac{\text{sediment weight}}{\text{dry sample weight}}
\]  

Determination of water absorption capacity (WAC), 3 grams sample was placed on a filter paper, and then it was added with warm water (in 40°C) by 13 grams and allowed for 3 minutes. The dripped water was collected and pondered.

\[
\text{WAC} = \frac{\text{Water weight at the onset-dipped water weight}}{\text{sample weight}}
\]  

Determination of oil absorption capacity (OAC), 1 gram sample was added by 10 ml of vegetable oil into a 25 ml centrifuge tube. The mixture was centrifuged for 30 minutes at 2000 rpm.

\[
\text{OAC} (%) = \frac{\text{supernatant weight-sample weight}}{\text{sample weight}}
\]  

Determination of cooking loss, Fillet-chicken breast was coated with sample batter followed by sample flour, and then it was fried until its color changed into golden brown using deep frying method at the temperatures of 175 - 180°C. Sample batter was prepared by mixing 1 portion water to 1 portion sample.

\[
\text{Cooking loss} (%) = \frac{\text{raw coated meat weight-fried meat weight}}{\text{raw uncoated meat weight}}
\]  

The best formulation was determined by de Garmo analysis with a modification. The best formulation is determined from the highest value of the results value (RV). RV calculation was started by determined Variable Score (VS), followed by Normal Score (NS) calculation, Effectiveness Value (EV) calculation and ended by Result Value (RV) calculation. Variable Scores (VS) are sorted by priority of physical characteristic that give higher contribution to the sample quality. VS of sample were determined as
follows: swelling power 0.5; WAC 0.5; OAC 0.5; cooking loss 1.0. Then Normal Score (NS), Effectiveness Value (EV), and Results Value (RV) were calculated using the formula:

\[ \text{NS} = \frac{\sum \text{VS}}{\text{EV} = \frac{\text{parameter value - worst value}}{\text{best value - worst value}}}; \text{RV} = \text{NS} \times \text{EV} \quad (5) \]

3. Results and Discussion

3.1. Swelling power

The ratio of rice and white sweet potato flour had a significant effect on the swelling power of the seasoning composite flour. White sweet potato flour portion had a positive correlation with the swelling power of the seasoning composite. The seasoning composite flour with the lowest swelling power was the seasoning composite flour of 30% tapioca flour; 70% rice flour; 0% white sweet potato flour. The seasoning composite flour with the highest swelling power was the seasoning composite flour of 30% tapioca flour; 30% rice flour; 40% white sweet potato flour. Seasoning composite flour with 0-35% white sweet potato flour had a lower swelling power than the commercial seasoning flour (controls = K1 and K2) while the seasoning composite flour with 40% white sweet potato flour had not significant different with controls.

![Figure 1. Sweeling Power of Seasoning Composite Flour](image)

3.2. Water Absorption Capacity

The ratio of rice and white sweet potato flour affected the water absorption capacity of the seasoning composite flour significantly. The greater the ratio of white sweet potato flour was, the higher the water absorption capacity of the seasoning composite flour would be. The water absorption capacity of seasoning composite flour with the portion of 0-10% white sweet potato flour was not significantly different from the controls’ while the water absorption capacity of the seasoning composite flour with the portion of 15-40% white sweet potato flour was greater than that of the controls.
3.3. Oil Absorption Capacity

The oil absorption capacity of the seasoning composite flour was affected significantly by the ratio of rice flour and white sweet potato flour. Sweet potato flour portion gave inverse proportion to the oil absorption power of the seasoning composite flour. The portion of 0-35% white sweet potato flour had a higher oil absorption capacity than that of the controls while the portion of 40% white sweet potato flour had not significant different with controls.

3.4. Cooking Loss

The result showed that the cooking loss of the seasoning composite flour decreased as the increase of white sweet potato portion. The controls’ cooking loss was not significant different with the seasoning composite flour’s using 0-20% white sweet potato flour portion. The factor which affected the cooking loss was viscosity of the used flour. The higher the viscosity value of the used flour was, the lower the cooking loss value would be [12].
3.5. Determination the best formula

Based on the de Garmo analysis result (table 2), formula that is composed by 30% tapioca flour, 30% rice flour and 40% white sweet potato flour was determined as best formula. Compared to controls, seasoning composite flour had Result Value (RV) higher than control.

### Table 2. Determination the best formula of seasoning composite flour

| Sample        | Result Value (RV) |
|---------------|-------------------|
|               | CL (%) | WAC (g/g) | OAC (ml/g) | SP (ml/g) | Total     |
| K1            | 0.0235  | 0.1748    | 0.1917     | 0.1929    | 0.1233    |
| K2            | 0.1306  | 0.1163    | 0.1773     | 0.1791    | 0.6034    |
| 30 : 70 : 0   | 0.0000  | 0.1157    | 0.0070     | 0.0006    | 0.1233    |
| 30 : 65 : 5   | 0.0746  | 0.1156    | 0.0000     | 0.0000    | 0.1902    |
| 30 : 60 : 10  | 0.1400  | 0.1409    | 0.0091     | 0.0285    | 0.3185    |
| 30 : 55 : 15  | 0.2029  | 0.1532    | 0.0029     | 0.0441    | 0.4030    |
| 30 : 50 : 20  | 0.2338  | 0.1584    | 0.0422     | 0.0507    | 0.4851    |
| 30 : 45 : 25  | 0.2128  | 0.1716    | 0.0642     | 0.0535    | 0.5039    |
| 30 : 40 : 30  | 0.2987  | 0.1748    | 0.0751     | 0.0668    | 0.6154    |
| 30 : 35 : 35  | 0.3397  | 0.2000    | 0.1372     | 0.1071    | 0.7841    |
| 30 : 30 : 40  | 0.4000  | 0.0000    | 0.2000     | 0.2000    | 0.8000    |

4. Conclusion

The physical characteristics of seasoning composite flour include the following: swelling power ranged from 3.4385 ml/g to 5.6895 ml/g; the water absorption capacity ranged from 2.3402 ml/g to 2.4480 ml/g; the oil absorption capacity ranged from 0.8867 ml/g to 1.2210 ml/g; and the cooking loss ranged from 22.03% to 35.25%. The best formula of seasoning composite flour were made from 30% tapioca flour, 30% rice flour, and 40% white sweet potato flour. The physical characteristics of the best formula were swelling power 5.689 ml/g, water absorption capacity 2.681 g/g, oil absorption capacity 0.887 ml/g, and cooking loss 22.03%. The physical characteristics of the seasoning composite flour significantly different from the commercial
seasoning flour. Seasoning composite flour was better than commercial seasoning flour for parameters cooking loss, oil absorption capacity, and swelling power.

References
[1] Bagja JS, Yuwono SS and Widyaningtyas D 2015 J. Food and Agroindustry 3 1627–36
[2] Lau N M, Peter H R, Green, Annette K, Taylor, Hellberg D, Mary A, Caroline Z.T, Barry E. Kosofsky, Joseph J H, Anjali M, Rajadhyaksha, Armin A 2013 J. Ploss One 8 1–6
[3] FAO (2017, January 24) http://www.fao.org/faostat/en/#data/QC/visualize
[4] Harmani SA, Haryadi, Cahyanto MN and Yudi P 2016 AGRITECH 36
[5] Indrianti, N, Rima K, Riyanti E and Doddy A D 2013 AGRITECH 33
[6] Sianturi DP and Marliyati SA 2014 JGP 9 (1) 15-21
[7] Yustiyani and Setiawan B 2013 JGP 8 (2) 95-102
[8] Sunyoto, M, Tati N, Rima R K, Deddy M 2016 J. Food 25 43–50
[9] Ocloo, FCK, Bansa D, Boatin R, Adom T and Agbemavor WS 2010 Agric. Biol. J.N. Am. 1 (5) 903–8
[10] Lidiasari, E, Merynda I S and Friska 2006 J. AGRIPLUS 16 1–7
[11] Beuchat LR 1977 J. Agric.Food Chem. 25 111–120
[12] Mukprasirt A, Herald TJ, Boyle DL, and Boyle EAE 2001 Poultry Science Journal 96 1–9