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Characterization of composite flour made from wheat flour and tubes flour fermentation

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Abstract
This study aims to obtain the characteristics of composite flour made from wheat flour and tuber flour from fermentation results and can be used to make bread products. Fermentation method used in this research is the process of fermentation using yeast (*Saccharomyces cerevisiae* on cassava tubers, purple sweet tubers, orange tubers, white tubers and taro tubers). This research has been carried out within 6 (six) months. The study design used completely randomized design (CRD) and the single factor treatment (*treatment)* were performed in the manufacture of composite flourin this study are as follows: T_0 = Wheat Flour (100%), T_1 = Wheat Flour (50%): Cassava Flour (50%), T_2 = Wheat Flour (50%): Purple Sweet Potato Flour (Purple 50%), T_3 = Wheat Flour (50%): Orange Sweet Potato Flour (50%), T_4 = Wheat Flour (50%): White Sweet Potato Flour (50%), T_5 = Wheat Flour (50%): Taro Tubes Flour (50%). The parameters analyzed were water content, ash content, protein content, fat content, carbohydrate content. The results showed that there were significant differences ($p < 0.5$) of the tubers flour and composite flour produced. Proximate composition shows that the protein content of taro tuber flour has a high protein of 5.62% and low cassava tuber protein that is 3.04%. The high carbohydrate content of cassava tubers is 90.20% and the carbohydrates in orange tubers is 85.60%. The composition of the proximate in the composite flour showed that the high protein content was in the T_1 treatment (6.25%) and the low T_3 (7.54%). High carbohydrate content in treatment T_1 (87.96%) and low T_3 (85.20%).

Keywords: characterization, composite, fermentation, characteristics

1. Introduction
Wheat contains gluten components which distinguish it from other starches. Gluten is a sticky and elastic protein that is useful for binding and making the dough elastic so it is easily formed. However, gluten in flour, making people with autism and celiac disease become allergic.
The Flour that does not contain gluten availability is greater than flour containing gluten, but its utilization has a disadvantage because the dough is less elastic. It is necessary to add additional ingredients such as egg whites, margarine, xanthan gum, gliadin and emulsifiers as binders and increase the volume of the dough to be elastic and soft-textured (Edema, et. al, 2005) [5].
Tubes utilization is still limited. The processing of these materials into flour or starch then formulated with a specific composition and the addition of extra material in the form of *hydrocolloids* will be able to produce bread that is slightly contain gluten but the shape and taste of her resembles bread made from wheat.
Cassava, purple sweet potatoes, orange sweet potatoes, white sweet potatoes, taro tubers are some of the types of tubers found in North Sumatra. The technology used to make flour is more with physical techniques while fermentation is almost rarely done. Flour made with fermentation techniques is also not so well known characters. Therefore it is necessary to characterize the chemical physical properties.
Flour can be classified into two namely single flour and composite flour. Composite flour is flour made from two or several types of food. The aim is to get the characteristics of suitable ingredients as processed products that are functional in nature. Other considerations are availability and price (Widowati, 2009) [22].
Composite flour can be used as a partial substitute for wheat flour in the manufacture of processed foods that are gluten-free or low-gluten bread, namely made from rice, corn, soybeans, tubers with the addition of hydrocolloids such as gum xanthan, gumguar, carrageenan, *carboxymethylcellulose* (CMC), or starches such as corn starch, potato starch etc. (Surono *et al.*, 2017) [13].
There are some weaknesses of the characteristics of tubers flour such as cassava, sweet potato tubers, where tubers starch has a low viscosity value, has a limited development pattern when heating, tends to be easily metrogradated and has low absorption capacity (Nusa and Alfiah. 2012; Widyasaputra and Yuwono, 2013; Pusparani and Yuwono, 2014) [9, 21, 2].
This resulted in tuber flour such as sweet potato tubers could not produce good product characteristics when applied to the manufacture of products such as baby *food*, *food powder*, *salad dressing*, *cake mixes* and *pudding* (Widyasasutra and Yuwono, 2013) [21]. Other disadvantages to sweet tubers are the color of the flour which is less attractive and the pleasant aroma (Syahputri *et al.*, 2017) [17]. In overcoming the weaknesses of the nature of the tubers flour, several studies have shown that pre-treatment of fresh tubers, such as fermentation, is soaking tubers in the marinade ingredients (Juliana *et.al*., 2017) [6].

2. Material and Methods
Research Location
This research was conducted at the Laboratory of Agricultural Technology, Faculty of Agriculture, University of Quality, Medan and the long of the study was conducted

for 7 months from May - November 2019.

Materials and Research Tools

The research materials used in this study were wheat flour, fresh tubers, cassava, purple sweet potatoes, orange sweet potatoes, white sweet potatoes, taro tubers, bread yeast (Fermipan), granulated sugar, water, salt, xanthan gum, corn starch.

The equipment used in this study are: Scales, Ovens, Fermenters, Mixers, Mixing, 80 mesh Sieves/ Sieves, Furnaces, Flour drying trays, Woodworking Spoons, Centrifuges, Hot Plates, Porcelain Cups, Aluminum Cups, Aluminum Glassware the other.

Design of experiments (experimental design)

Methods of design of experiments (*experimental design)* used in this study is completely randomized design (CRD) and Single Factor. As for treatment (*treatment)* done in composite flour is as follows: T_0 = Wheat Flour (100%), T_1 = Wheat Flour (50%): Cassava Flour (50%), T_2 = Wheat Flour (50%): Purple Sweet Potato Flour (Purple 50%), T_3 = Wheat Flour (50%): Orange Sweet Potato Flour (50%), T_4 = Wheat Flour (50%): White Sweet Potato Flour (50%), T_5 = Wheat Flour (50%)): Taro Tubes Flour (50%)

Model Analysis

The data analysis model in this study is using *Anaysis of Variance* (ANOVA). If the results obtained are significantly different and very real, then the data analysis is continued by testing the average difference using the LSR (*Least Significant Range) test*, namely the Duncan *Test* and testing is also performed on each treatment of the control using the *Dunnett Test* analysis method. Analysis statistics used in this study is the use *of software Statistical Product and Service Solutions* (SPSS) version 22.

Flour Physicochemical Analysis

The physicochemical analysis of flour includes the physical properties of flour, namely water content (AOAC, 2000), ash content (SNI-01-34511994), fat content of the Soxhlet method (AOAC, 1995), protein content (Kjeldahl method), AOAC, *2000)*, and content carbohydrates (*by different)* (AOAC, 2000).

Making Tubers Flour (Fermentation Method)

Making tubers flour is done by choosing a good tuber, namely: cassava, purple sweet potato, orange sweet potato, white sweet potato and taro tuber. All tubers that have been sorted are then washed and peeled, peeled using a slicer and fermented in a fermenter using bread yeast (Fermipan) for 18 hours with a range of temperature observations every 6 hours.

Fermentation using bread yeast (Fermipan): as much as 2 kg sawutan each tuber soaked in water as much as 6 liters that have been added bread yeast (Fermipan) as much as 0.5% (w/w) which has been dissolved in 1% sugar solution (b / b) as much as 1 liter. Fermentation is carried out in a fermenter that is designed with a temperature panel for 18 hours. Chips tuber that has been fermented and then drained and dried in the sun to dry (material easily broken finger). Chips tubers that have been dried and then mashed using a disc mill and sifted using 80 mesh sieves to produce cassava fermented flour, purple sweet potato, orange sweet potato, white sweet potato and taro tuber.

Making composite flour

Composite flour is flour made from a mixture of several single flour with a certain composition. In this study, the composition used was in accordance with the treatment. To each of the flour mixture is added xanthan gum as much as 1% (w / w) and mixed by using a *Food Processor*.

3. Result and Discussion

Tuber Flour Ingredients With Fermentation Method

The fermentation process using r agi / y east (*Saccharomyces cerevisiae)* to the root umbia material showed a positive response. The fermentation process works as shown by the temperature changes that occur. During the 18 hour fermentation process. These temperature changes can be seen in Table 1.

Table 1: Fermentation Temperature Patterns (^{o} C)

Material	Fermentation Time			
	0 hours	6 hours	12 hours	18 hours
Cassava	27.8	28.7	29.9	30.1
Purple Sweet Potato	27.8	28.9	29.8	30.1
Orange Sweet Potato	27.6	28.5	29.5	29.9
White Sweet Potato	27.4	28.4	29.2	30.3
Taro Tubes	26.5	28.6	29.1	30.1

In the table above shows that the initial fermentation showed the fermenter temperature is at room temperature position (26.5^o C – 27.8^{o}C). After fermentation lasts for 6 hours, the temperature of the fermenter showed an increase to around 28.4^{o}C – 28.9^{o}C and continues to increase in fermentation for 12 hours at a temperature range between 29.1 $^\circ$C-29.9 ^{o} C. At the end fermentation or after fermentation lasts for 18 hours the fermenter temperature shows at 29.9^{0}C-30.3^{0}C.

The pattern of temperature rise during fermentation of tubers can be seen in Figure 1.

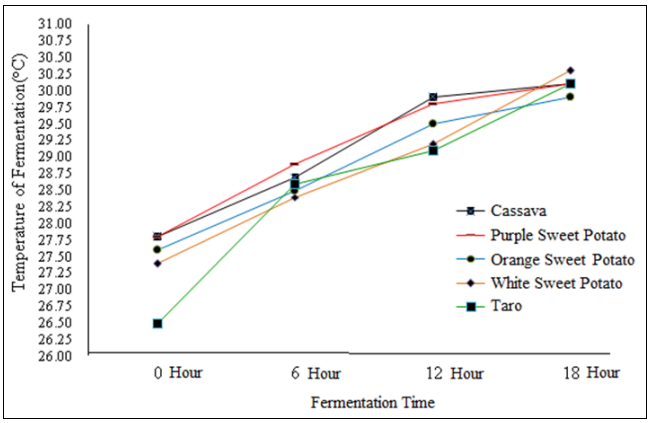


Fig 1: Graphic Pattern of Fermentation Temperature Increase in Tubers

Fermentation is a process that uses microorganisms that are catabolic (can break down complex components into substances that are simpler so it is easier to digest). The fermentation process can also break down enzymes that are present in materials that cannot be digested by humans, such as cellulose and hemicellulose. This fermentation is very suitable for use in sweet potatoes because it has a high nutritional content such as sugar content and soluble fiber components (Rahmawati, *et al*, 2015) [11]. Based on research by Anggraeni and Yuwono (2014) [2] natural fermentation

can have an influence on the physical properties of sweet potatoes such as increasing the color brightness and eliminating the unpleasant aroma of flour.

The hydrolytic activity of *Saccharomyces cerevisiae is* able to produce water and energy from its metabolic process (Tope, 2014) [18] so that during fermentation there is an increase in temperature.

Starch contained in the tubers down by enzymes pullulanase and amylopectin contained in the starch already started work to cut the chains of amylopectin branching α-1,6 glycosidic (Retnaningtyas and Daughter, 2014) [12] so that the number of straight-chain at au amylose increased (Arifin *et al.*, 2014) [3].

Characterization of Wheat Tubers Results Fermentation

The physicochemical character of the starch tuber - umbian fermentation results are shown in Table 2.

Table 2: Physical and Chemical Characteristics of Fermented Tubers Flour

Flour of	Water Content (%)				Ash Content (%)				Fat Content (%)				Protein Content (%)				Carbohydrate Content (%)			
Wheat	3.04	±	0.03	E	0.44	±	0.04	e	0.18	±	0.01	d	9.46	±	0.01	a	84.32	±	0.04	f
Cassava	6.07	±	0.04	B	2.38	±	0.01	c	0.16	±	0.01	d	3.04	±	0.01	f	90.20	±	0.01	a
Purple Sweet Potatoes	6.73	±	0.25	A	2.44	±	0.09	c	0.33	±	0.04	c	3.96	±	0.00	d	89.41	±	0.10	c
Orange Sweet Potatoes	6.72	±	0.05	A	4.69	±	0.01	a	0.89	±	0.02	a	4.42	±	0.01	c	85.60	±	0.03	e
White Sweet Potatoes	5.45	±	0.05	C	3.12	±	0.01	b	0.52	±	0.01	b	3.12	±	0.01	e	89.65	±	0.03	b
Talas Tubes	5.07	±	0.06	D	0.79	±	0.12	d	0.32	±	0.01	c	5.62	±	0.03	b	88.67	±	0.10	d

Note: Different letters in the same column show significant differences at α = 0.05

Water content

ANOVA test results on the water content of flour from different types of tubers showed that there were significant differences ($p < 0.05$) between treatments. The water content of wheat flour shows the lowest number with an average water content of 3.04%. While the highest water content is found in purple sweet potato flour with an average water content of 6.73%. The water content contained in the tuber flour sweet violet and water content contained in the tuber flour sweet orange does not show a difference 's that real, but the moisture content wheat flour, cassava flour, starch tubers of sweet white and starchy tuber taro show a difference aan which real.

This difference is due to the nature of the origin of the flour material. The fermented flour water content still meets the water content standard stipulated in SNI 3751: 2009 for wheat flour, which is 14.5%. Whereas SNI for tapioca starch SNI 3451: 2011, maximum water content is 14%. The lower the water content, the better the quality of flour products because it can reduce the media for microbial growth that can reduce the quality of flour products. Water content of flour is less than 12% so that it can prevent mold growth (Winarno, 2004) [12].

Ash Content

ANOVA test results on the ash content of flour from different types of tubers showed that there were significant differences ($p < 0.05$) between treatments. The ash content of orange sweet potato flour showed the highest number with an average ash content of 4.69%. While the lowest ash content is found in wheat flour with an average ash content of 0.44%. Ash content in a food material, indicates the presence of mineral content in the form of inorganic minerals which have a high enough resistance to cooking temperatures. A bu is an inorganic residue from combustion of organic material. The main components commonly found in natural organic compounds are potassium, sodium, calcium, magnesium, manganese and iron. Ash content represents the total macro and micro mineral content of food.

The increase in ash content occurs because the longer the drying is done on the material, the amount of water that is evaporated from inside the dried material will be even greater. This is in accordance with the statement of Sudarmadji *et.al.*, (1989) in Lubis (2008), that ash content depends on the type of material, method of ash, time and temperature used when drying and the lower the non-mineral components contained in the material, the more Increase percent ash relative to material.

Fat Content

ANOVA test results on the levels of flour fat from different types of tubers showed that there were significant differences ($p < 0.05$) between treatments. Fat content of orange sweet potato flour showed the highest number with an average fat content of 0.89%. While the lowest fat content is found in cassava flour with an average fat content of 0.16%. Fat levels in flour and cassava flour showed no significant differences, but with high levels of fat flour tubers of purple sweet, sweet orange tuber flour, white flour and starchy tuber potato tuber taro showed significant differences. Fat content of purple sweet potato flour and taro tuber flour did not show any real difference. Starch fat content is not required in SNI.

Protein Content

ANOVA test results on different levels of flour protein from different types of tubers showed that there were significant differences ($p < 0.05$) between treatments. The protein content of wheat flour showed the highest number with an average protein content of 9.46%. While the lowest protein content is found in cassava flour with an average protein content of 3.04%.

The average protein content of flour fermented from tubers is low when compared to the classification of wheat flour. Protein content below 9% in flour, suitable for *cake* making so that the resulting *cake* has lower developmental power (Wheat associates, 1983).

Carbohydrate Content

ANOVA test results on starch carbohydrate content from different types of tubers showed that there were significant differences ($p < 0.05$) between treatments. Carbohydrate content of cassava flour showed the highest number with an average carbohydrate content of 90.20 %. While the lowest carbohydrate content is found in wheat flour with

an average carbohydrate content of 84.32 %. Fermented starch carbohydrate levels show different numbers.
This difference is due to the nature of the origin of the flour material. Flour carbohydrate content required in SNI 3751: 2009. The results of the analysis of wheat flour showed that the carbohydrate content of wheat flour used as a comparison was 84.32 %. The color of fermented flour from tubers is shown in Figure 2.

Note: 1) Wheat Flour, 2) Cassava Fermented Flour, 3) Fermented Purple Sweet Potato Flour, 4) Orange Sweet Potato Fermented Flour, 5) White Sweet Potato Fermented Flour, 6) Taro Fermented Flour.

Fig 2: Appearance of Fermented Flours

Characterization of Flour Formulation / Composite
The physical and chemical characteristics of composite flour are shown in Table 3.

Table 3: Physical and Chemical Characteristics of Composite Flour

Composite Flour	Water Content (%)				Ash Content (%)				Fat Content (%)				Protein Content (%)				Carbohydrate Content (%)			
T0	5.58	±	0.03	a	0.44	±	0.04	c	0.18	±	0.01	d	9.46	±	0.01	a	84.32	±	0.04	C
T1	4.22	±	0.02	d	1.41	±	0.02	b	0.17	±	0.01	d	6.25	±	0.00	f	87.95	±	0.00	Ab
T2	3.86	±	0.05	e	1.44	±	0.02	b	0.26	±	0.01	c	6.71	±	0.01	d	87.73	±	0.07	A
T3	4.40	±	0.01	c	2.57	±	0.02	b	0.54	±	0.01	a	6.94	±	0.00	c	85.55	±	0.03	Bc
T4	3.59	±	0.01	f	1.78	±	0.02	ab	0.35	±	0.00	b	6.29	±	0.00	e	87.98	±	0.03	Ab
T5	4.60	±	0.02	b	1.27	±	1.12	b	0.25	±	0.01	c	7.54	±	0.01	b	86.34	±	1.11	a

Note: Different letters in the same column show significant differences at $\alpha = 0.05$

Water content
ANOVA test results on the moisture content of composite flour between wheat flour and fermented tubers showed that there were significant differences ($p<0.05$) between treatments. Composite flour moisture content between white flour and white sweet potato flour showed the lowest number with an average water content of 3.59%. While the highest water content isfound in 100% wheat flour with an average water content of 5.58%.
In general, the moisture content of composite flour is lower than the water content of wheat flour and fermented flour from tubers as shown in Table 3. According to Kusnandar (2011) [7], the nature of water molecules can bind to other polar molecules, namely carbohydrates and proteins. The T 0 treatment, which is 100% flour, has the highest water content, which is 5.58 %. Water content requirements based on flour quality standards are 14% (Astawan and Widowati, 2005) [4]. The lower the water content, the better the quality because low water content does not accelerate the damage to flour.

Ash Content
ANOVA test results on the ash content of composite flour flour and fermented tubers showed that there were significant differences ($p <0.05$) between treatments. Ash composite flour flour and orange sweet potato flour (T3) levels showed the highest numbers with an average ash content of 2.57 %. While the lowest ash content is found in wheat flour with an average ash content of 0.44%.
In general the ash content of composite flour is higher than wheat flour. The levels of ash obtained flour wheat 0.44%, composite flour wheat and cassava flour (T1) of 1.41%, wheat composite flour and flour purple sweet tuber (T2) of 1.44%, wheat composite flour and starch tubers sweet orange (T3) 2.57%, flour composite flour and white sweet potato flour (T4) 1.78% and flour composite flour and taro tuber flour (T5) 1.27%.
Flour fermented tubers that are added will increase the ash content of flour composites. Low ash content indicates that starch is relatively free of hydrated fine fibers originating

from starch granule cell walls (Zhou, *et. Al.,* 2004) [23].

Fat Content

ANOVA test results on the composite fat content of starch between wheat flour and fermented tuber flour showed that there were significant differences ($p < 0.05$) between treatments. The fat content of composite flour and orange sweet potato flour (T3) showed the highest number with an average fat content of 0.54 %. While the lowest fat content is in the composite flour and cassava (T1) with an average fat content of 0.17 %. Fat content in flour and composite flour and cassava flour (T0) did not show any real difference. Likewise, the fat content in flour composite flour and purple sweet potato flour (T2) with flour composite flour and taro tuber flour (T5) did not show any significant difference.

Protein Content

ANOVA test results on the protein content of composite flour between wheat flour and fermented tuber flour showed that there were significant differences ($p < 0.05$) between treatments. The protein content of wheat flour showed the highest number with an average protein content of 9.46%. While the protein content was lowest for the flour composite flour wheat and cassava (T1) with high levels of protein on average 6.25 %.

The protein found in flour (gluten) contains prolamin can cause digestive disorders for people who are intolerant. Disease caused by intolerance of people to wheat protein is called cutaneous disease, which from year to year it turns out the number is increasing. Celiac disease (*celiac disease)* is a disease associated with inflammation of the small intestine resulting in impaired absorption of nutrients, and even can cause damage to the intestinal mucosa (Lazarido *et al.*, 2007) [8].

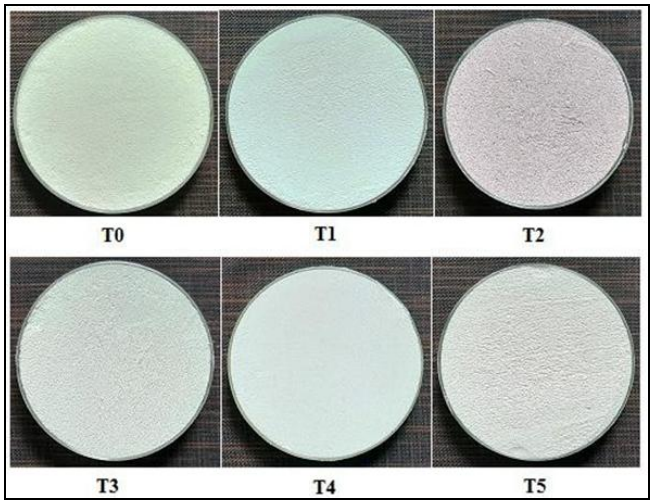
Carbohydrate Content

ANOVA test results on carbohydrate content of composite flour between wheat flour and fermented tubers showed that there were significant differences ($p < 0.05$) between treatments. Carbohydrate content of composite flour and white sweet potato flour (T4) showed the highest number with an average carbohydrate content of 87.98 %. While the lowest carbohydrate content is found in wheat flour (T0) with an average carbohydrate content of 84.32%.

Carbohydrates are classified as components of nutrients which are the main source of energy supply for the body. The average carbohydrate content of local tubers is above 48%. And most of the carbohydrate content of the tubers is in the range of 82-88%. The form of processed tubers in the form of flour with high carbohydrate content provides an opportunity for diversification of processed food raw materials for carbohydrate sources, which can be processed into processed forms according to the physical and physiochemical characteristics of each flour (Octavianti and Mulwinda, 2012) [10].

Color

The color of flour produced through the fermentation process varies based on the color of the origin of the fermentation flour. The color of cassava flour shows a clean white color. While the color of the composite flour and cassava flour (T1) is white but not as white as cassava flour. The colors of the composite flour and purple sweet potato flour (T2) are light purple. Purple sweet tubers are dominated by purple. The color of the flour composite flour and orange (T3) tuber flour is yellowish white. The color of the orange tuber flour is expressed in yellowish white. The color of the white flour and white tuber flour (T4) flour is expressed as not bright white. flour composite flour and taro tuber flour (T5) are expressed as white to light brown. The color of the composite flour produced between flour and tuber fermented flour is shown in Figure 3.



Note: T 0) Wheat Flour 100%, T1) Wheat flour: Cassava flour = 50%: 50%, T2) Wheat flour: Purple Sweet Flour = 50%: 50%, T3) Wheat Flour: Orange Sweet Potatoes Flour = 50%: 50%, T4) Wheat Flour: White Sweet Potatoes Flour = 50%: 50%, T5) Wheat Flour: Talas Tubes Flour = 50%: 50%.

Fig 3: Appearance of Wheat Composite: Tubers

4. Conclusion

1. Cassava, purple sweet potato, orange sweet potato, white sweet potato and taro tuber can be made into flour through fermentation method by using yeast / yeast *Saccharomyces cerevisiae*.
2. Characteristics of the physicochemical properties of fermented flour even though it is different from wheat flour as a comparison, but in general meet the quality requirements according to SNI flour with water content <14% and ash content <3%.
3. Making composite flour with a ratio of 50%: 50% between wheat flour with each cassava flour, purple sweet potato flour, orange sweet potato flour, white sweet potato flour and fermented taro tuber flour can be done by mixing with xanthan gum.
4. Characteristics of physicochemical properties of composite flour even though it is different from wheat flour as a comparison, but in general it meets the quality requirements according to SNI flour.

Glossary

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