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Effect of Hydrolysis Time and Acid Concentration on Yield and Quality of Glucose Syrup from Kepok Banana Starch (Musa *paradisiaca* L.)

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ABSTRACT

This reseach was done to know the effect of different hydrolyzing time and acid concentrate to the rendemen and quality of glucose syrup from kepok banana starch. This reseach used complete randomized design model (CRD) 4 x 4 consisted of 2 factors, factor number 1: hydrolyzing time consisted of 4 levels i.l; T1 = 2 hours, T2 = 2,5 hours, T3 = 3 hours and T4 = 3,5 hours., factor 2: acid concentration consisted of 4 levels i.l; K1 = 0,04 N, K2 = 0,06 N, K3 = 0,08 N and K4 = 0,10 N. Statistical analysis was done on rendemen, water content, glucose content, viscosity, TSS, sweetness and organoleptic values of taste and colour. The results showed that hydrolizing time gave highly significant difference effect on rendemen, water content, glucose content, viscosity, TSS, sweetness and organoleptic value of taste and colour. The acid concentration gave highly significant difference effect on rendemen, water content, glucose content, viscosity, TSS, sweetness and organoleptic value of taste and colour. The combination of hydrolyzing time and acid concentration gave highly sicnificant difference effect on rendemen and sweetnes but no difference on water content, glucose content, viscosity, TSS and organoleptic value of taste and colour. The best result from this reseach used hidrolizing time 3,5 hours and acid concentration 0,1 N.

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1. INTRODUCTION

The economic crisis in our country is still ongoing. The most negative impact that can be felt by the community from this situation is the continued increase in the prices of basic commodities.

Granulated sugar as one of the staple commodities has also experienced an increase in prices. Actually our country is already experiencing a shortage of sugar supply because the level of domestic production is still very low. This is due to the limited land area suitable for sugarcane cultivation coupled with the large amount of capital required to establish or rehabilitate sugar factories.

Under such circumstances, it is estimated that Indonesia will continue to face the problem of sugar shortages for decades to come. One solution that might be offered is to look for alternative materials for making sugar other than sugar cane, such as palm tree sap or starch. The raw material for starch is usually obtained from several types of food plants such as cassava or cassava, corn and others.

Apart from food crops such as cassava and corn, at this time bananas can also be extracted from the starch to be used as an ingredient for making sugar. Banana is one of the tropical fruits that is very easy to get, besides the price is cheap and can be reached by all levels of society, banana plants are easy to grow and the fruit is not seasoned.

Banana starch is obtained from unripe bananas, which are then crushed and extracted their juice. The juice from the banana pulp is added to water and precipitated and then the precipitate is dried, sieved and starch is obtained.

One way that can help supply sugar in Indonesia is to make glucose syrup (liquid sugar) from starch. Glucose syrup is the trade name of the product resulting from the hydrolysis of starch. The production of glucose syrup is expected to support the current and future sugar needs in Indonesia or at least to be useful as a substitute in certain circumstances. Glucose syrup can also be used as an additive in the processing of foodstuffs, for example in the manufacture of cakes, ice cream, candy and others. Glucose syrup can be used directly or consumed like regular sugar and glucose syrup can be used as a source of calories just like cane sugar, but is lower in sweetness than cane sugar.

Glucose syrup is a solution made from incompletely hydrolyzed starch, then neutralized and concentrated. Hydrolysis of starch can be carried out in 3 ways, namely hydrolysis with an acid catalyst, a combination of acid and enzymes, and a combination of enzymes and enzymes (Satuhu and Supriyadi, 1999).

Therefore, the supply of glucose syrup from banana starch can help provide sugar substitutes in Indonesia in the future or can be used as an alternative in certain circumstances, although the use of glucose syrup is not like cane sugar.

2. METHOD

2.1 Place and time of research

The research was conducted in May-June 2007 at the Microbiology Laboratory, Department of Agricultural Technology, Faculty of Agriculture, University of North Sumatra, Medan.

2.2 Materials and tools

The material used in the study was raw kepok bananas obtained from the Seikambing Tax, Captain Muslim, Medan.

Chemicals: 0.04 N HCl; 0.06 N; 0.08 N and 0.10 N; Na_2CO_3 (Soda Ash) 0.2 N; $Al(OH)_3$; anhydrous Na_2CO_3; H_2SO_4 26.5%; Aquadest; Luff-Schoorl Solution; KI 20%; Na-thiosulfate 0.1 N; Starch Indicator

Tools: Blender; Scales; Oven; Mortar and Pestle; 80 mesh sieve; PH meter; Beaker glass; Erlenmeyer; Measuring cup; Scale Pipette; Drop pipette; Volumetric flask; thermometer; Magnetic stirrer; autoclave; Back cooling; Hand-refractometer; desiccator; Hot Plates.

2.3 Research methods

This research method uses a completely randomized design (CRD) which consists of 2 factors, namely: Factor I: Hydrolysis Time (T) T1 = 2 hours; T2 = 2.5 hours; T3 = 3 hours; T4 = 3.5 hours, Factor II: Acid Concentration (K) K1 = 0.04 N; K2 = 0.06 N; K3 = 0.08 N; K4 = 0.10 N. The treatment combination (Tc) is 4 x 4 = 16, so the number of replications (n) is 2.

2.4 Analysis Method

To analyze the results of observations, a factorial RAL variance analysis was carried out with the following model:

$$\mathbf{ijk = + j + (\alpha\beta)ij + ijk} \quad (1)$$

where :
ijk : Observation results from factor T at level I and factor K at level j with k-th replication
: Middle value effect
i : Effect of factor T at level i
j : Effect of factor K on j level
(αβ)ij : The interaction effect of factor T at level i and factor K at level j
ijk : Error effect of factor T at level i and factor K at level j in k test.

2.5 Research Implementation

Making Banana Starch, Making Starch Solution, Hydrolysis, Concentration, Performed Analysis.

2.6 Observation Parameter

Observation and measurement of data was carried out by analyzing the parameters: yield, moisture content, glucose content, viscosity test, determination of total soluble solid (TSS), sweetness and organoleptic tests of color and taste.

3. RESULTS AND DISCUSSION

3.1 Research result

In general, the results of the research conducted showed that the effect of hydrolysis time had an effect on yield, water content, glucose content, TSS, sweetness, viscosity and organoleptic values as shown in Table 1 below:

Table 1. Effect of Hydrolysis Time on Observed Parameters

Hydrolysis Time (Hours)	yield(%)	Water content (%)	Glucose Level (%)	TSS (oBrix)	Sweetness	Viscosity(Nm-2.s)	Organoleptic Value
T1 = 2	38.95	85.43	4.07	16.14	0.25	0.08	2.04
T2 = 2.5	53.58	84.58	8.21	17.48	0.33	0.09	2.55
T3 = 3	56.47	84.20	15.81	17.89	0.41	0.09	2.73
T4 = 3.5	57.48	83.40	17.78	18.39	0.44	0.10	2.99

From Table 1 it can be seen that the hydrolysis time has an effect on the analyzed parameters. From this table, it can be seen that the longer the hydrolysis time, the yield, glucose content, TSS, sweetness, viscosity and organoleptic values of color and taste increased, while the water content decreased. It can be seen that the highest yield is at T4 which is 57.48% and the lowest is at T1 which is 38.95%. The highest water content at T1 is 85.43% and the lowest at T4 is 83.40%. The highest glucose level at T4 was 17.78% and the lowest was at T1 at 4.07%. The highest TSS is at T4 which is 18.39 oBrix and the lowest is at T1 which is 16.14 oBrix. The highest sweetness at T4 is 0.44 and the lowest at T1 is 0.25. The highest viscosity at T4 is 0.10 and the lowest at T1 is 0.08.

Acid concentration affects the yield, water content, glucose content, TSS, sweetness, viscosity and organoleptic values as shown in Table 7 below;

Table 2. Effect of Acid Concentration on Observed Parameters

Acid Concentration (N)	yield(%)	Water content (%)	Glucose Level (%)	TSS (oBrix)	Sweetness	Viscosity (Nm-2.s)	Organoleptic Value
K1= 0.04	16.19	85.35	6.49	17.35	0.27	0.10	2.12
K2= 0.06	52.98	84.95	10.32	17.33	0.34	0.10	2.58
K3= 0.08	63.68	84.13	13.90	17.55	0.39	0.09	2.74
K4 = 0.10	73.64	83.18	15.17	17.66	0.43	0.08	2.88

From Table 2 it can be seen that the acid concentration has an effect on the analyzed parameters. From this table it can be seen that the higher the acid concentration, the yield, glucose content, sweetness, TSS and organoleptic values of color and taste increased, while water content and viscosity decreased. The highest yield is in K4 which is 73.64% and the lowest is in K1 which is 16.19%. The highest water content in K1 is 85.35% and the lowest in K4 is 83.18%. The highest glucose level in K4 is 15.17% and the lowest in K1 is 6.49%. The highest TSS is at K4 which is 17.66 oBrix and the lowest is at K1 which is 17.35 oBrix. The highest sweetness in K4 is 0.43 and the lowest in K1 is 0.27. The highest viscosity at K1 is 0.10 and the lowest at K4 is 0.08. The highest organoleptic value of color and taste at K4 is 2.

3.1.1 Yield (%)

The duration of hydrolysis gave a very significant effect ($P<0.01$) on the yield of glucose syrup produced. The results of the test with LSR show that the effect of hydrolysis time on the yield of each treatment can be seen in Table 3 below:

Table 3. LSR Test Main Effects Effect of Hydrolysis Time on Yield (%)

Distance	LS		Hydrolysis Time	Average	Notation	

	0.05	0.01	(O'clock)		0.05	0.01
-	-	-	T1 = 2.0	38.95	c	C
2	1,622	2.233	T2 = 2.5	53.58	b	B
3	1,703	2,347	T3 = 3.0	56.47	a	A
4	1,747	2.406	T4 = 3.5	57.48	a	A

Notes: Different letter notations show significantly different effects at the 5% level and very significant differences at the 1% level.

The longer the hydrolysis time, the yield will increase. This is because the longer the hydrolysis time, the more starch molecules are broken down, the more reducing sugars will be produced. This is in accordance with Judoamidjojo, et al., (1992) which states that the longer the hydrolysis, the acid will break down starch molecules randomly and the resulting reducing sugar will also be greater.

The concentration of acid gave a very significant effect ($P<0.01$) on the yield of glucose syrup produced. The test results with LSR show that the effect of acid concentration on the yield of each treatment can be seen in Table 4 below:

Table 4. LSR Test Main Effect Effect of Acid Concentration on Yield (%)

Distance	LSR		Concentration	Average	Notation	
	0.05	0.01	Acid (N)		0.05	0.01
-	-	-	K1 = 0.04	16.19	D	D
2	1,622	2.233	K2 = 0.06	52.98	C	C
3	1,703	2,347	K3 = 0.08	63.68	B	B
4	1,747	2.406	K4 = 0.10	73.64	A	A

Notes: Different letter notations show significantly different effects at the 5% level and very significant differences at the 1% level.

The higher the concentration of acid given, the yield of the syrup produced will increase. According to Stout and Ryberg, (1989) the higher the concentration of acid used, the shorter the time required for the hydrolysis process. The higher the concentration of acid used, the starch molecules will split randomly so that the reducing sugar produced increases, this is also in accordance with Judoamidjojo, et al., (1992) which states that the longer the hydrolysis, the acid will break down the starch molecules randomly and Reducing sugar produced is also getting bigger.

The duration of hydrolysis and the concentration of acid had a very significant effect on the yield of glucose syrup produced. The test results with LSR show the effect of the interaction between hydrolysis time and acid concentration on the yield in each treatment can be seen in Table 5:

Table 5. LSR Test Main Effect of Interaction Effect of Hydrolysis Time and Acid Concentration on Yield

Distance	LSR		Treatment	Average	Notation	
	0.05	0.01			0.05	0.01
-	-	-	T1K1	13.53	i	H
2	3,244	4.466	T1K2	39.48	g	G
3	3.407	4.694	T1K3	47.93	f	F
4	3,493	4,813	T1K4	54.87	e	DE
5	3.569	4.910	T2K1	15.83	hi	H
6	3,612	4.975	T2K2	53.35	e	E
7	3.645	5.050	T2K3	67.66	c	C
8	3.666	5.105	T2K4	77.50	ab	A
9	3.688	5.148	T3K1	17.17	hi	H
10	3.709	5.180	T3K2	59.40	d	D
11	3.709	5,213	T3K3	68.30	c	B
12	3,720	5.234	T3K4	81.03	a	A
13	3,720	5.256	T4K1	18.23	h	H
14	3,731	5.278	T4K2	59.70	d	D
15	3,731	5,299	T4K3	70.83	bc	B
16	3,742	5.310	T4K4	81.15	a	A

The longer the hydrolysis time and the higher the acid concentration, the higher the yield of glucose syrup produced. This indicates that the higher the concentration of acid used, the higher the catalyst work process so that the hydrolysis time is faster and produces high reducing sugars.

According to Stout and Ryberg (1989) the higher the concentration of acid (HCl) used, the shorter the time required for the hydrolysis process at the same pressure.

3.1.2 Water content (%)

The duration of hydrolysis had a very significant effect (P<0.01) on the water content of the glucose syrup produced. The test results with LSR show that the effect of hydrolysis time on the water content of each treatment can be seen in Table 6 below:

Table 6. LSR Test Main Effect Effect of Hydrolysis Time on Water Content (%)

Distance	LSR		Hydrolysis Time (O'clock)	Average	Notation	
	0.05	0.01			0.05	0.01
-	-	-	T1 = 2.0	85.43	a	A
2	0.480	0.661	T2 = 2.5	84.58	b	B
3	0.504	0.695	T3 = 3.0	84.20	b	B
4	0.517	0.712	T4 = 3.5	83.40	c	C

Notes: Different letter notations show significantly different effects at the 5% level and very significant differences at the 1% level.

The longer the hydrolysis time the water content decreases. This is because the water contained in the syrup evaporates and is used by the acid during the hydrolysis process.

The concentration of acid gave a very significant effect (P<0.01) on the water content of the glucose syrup produced. The test results with LSR show that the effect of acid concentration on the water content of each treatment can be seen in Table 7 below.

Table 7. LSR Test Main Effects Effect of Acid Concentration on Water Content (%)

Distance	LSR		Concentration Acid (N)	Average	Notation	
	0.05	0.01			0.05	0.01
-	-	-	K1 = 0.04	85.35	a	A
2	0.480	0.661	K2 = 0.06	84.95	a	A
3	0.504	0.695	K3 = 0.08	84.13	b	B
4	0.517	0.712	K4 = 0.10	83.18	c	C

Notes: Different letter notations show significantly different effects at the 5% level and very significant differences at the 1% level.

The higher the acid concentration, the lower the water content. This is because the water in the syrup is used by the acid to break down starch during the hydrolysis process. At the time of hydrolysis water is bound by HCl.

3.1.3 Glucose Level (%)

The duration of hydrolysis gave a very significant effect (P<0.01) on the glucose level of the glucose syrup produced. The results of the LSR test show that the effect of hydrolysis time on glucose levels in each treatment can be seen in Table 8 below:

Table 8. LSR Test Main Effects Effect of Hydrolysis Time on Glucose Levels (%)

Distance	LSR		Hydrolysis Time (O'clock)	Average	Notation	
	0.05	0.01			0.05	0.01
-	-	-	T1 = 2.0	4.07	c	C
2	2,579	3.551	T2 = 2.5	8.21	b	B
3	2,708	3,731	T3 = 3.0	15.81	a	A
4	2,777	3.826	T4 = 3.5	17.78	a	A

Notes: Different letter notations show significantly different effects at the 5% level and very significant differences at the 1% level.

The longer the hydrolysis time, the higher the glucose level. This is in accordance with the statement of Polling and Harsono (1981) that the degree of conversion of starch into dextrin, maltose and glucose depends on the concentration of acid, time, temperature and pressure during the hydrolysis process. Thus, when starch hydrolysis is carried out at a constant temperature, acid concentration and pressure, the longer the hydrolysis time, the higher the glucose level produced.

The concentration of acid gave a very significant effect (P<0.01) on the glucose level of the resulting glucose syrup. The test results with LSR show that the effect of acid concentration on glucose levels in each treatment can be seen in Table 9 below:

Table 9. LSR Test Main Effects Effect of Acid Concentration on Glucose Levels (%)

Distance	LSR		Concentration Acid (N)	Average	Notation	
	0.05	0.01			0.05	0.01
-	-	-	K1 = 0.04	6.49	c	C
2	2,579	3.551	K2 = 0.06	10.32	b	B

3	2,708	3,731	K3 = 0.08	13.90	a	AB
4	2,777	3.826	K4 = 0.10	15.17	a	A

Notes: Different letter notations show significantly different effects at the 5% level and very significant differences at the 1% level.

The higher the concentration of acid used, the higher the glucose level. Balam (1972) said that glucose syrup with a DE (Dextrose Equivalent) value of up to 55 can be produced from a good acid hydrolysis method. Usually using dilute hydrochloric acid (HCl) with different concentrations produces different DE.

3.1.4 Viscosity

The duration of hydrolysis gave a very significant effect (P<0.01) on the viscosity of the glucose syrup produced. The test results with LSR show that the effect of hydrolysis time on the viscosity of each treatment can be seen in Table 10 below:

Table 10. LSR Test Main Effects Effect of Hydrolysis Time on Viscosity

Distance	LSR		Hydrolysis Time (O'clock)	Average	Notation	
	0.05	0.01			0.05	0.01
-	-	-	T1 = 2.0	0.08	c	C
2	0.005	0.007	T2 = 2.5	0.09	b	B
3	0.005	0.007	T3 = 3.0	0.09	b	B
4	0.005	0.007	T4 = 3.5	0.10	a	A

Notes: Different letter notations show significantly different effects at the 5% level and very significant differences at the 1% level.

The longer the hydrolysis time, the higher the viscosity. Howling (1978) reported that the viscosity of glucose syrup was influenced by the mean BM of dissolved solids and the DE value or glucose content was also influenced by the hydrolysis method used. So glucose levels are directly proportional to viscosity, where the longer the hydrolysis time, the higher the glucose levels and the viscosity of glucose syrup.

The concentration of acid gave a very significant effect (P<0.01) on the viscosity of the glucose syrup produced. The test results with LSR show that the effect of acid concentration on the viscosity of each treatment can be seen in Table 11 below:

Table 11. LSR Test Main Effects of Acid Concentration on Viscosity

Distance	LSR		Concentration Acid (N)	Average	Notation	
	0.05	0.01			0.05	0.01
-	-	-	K1 = 0.04	0.10	A	A
2	0.005	0.008	K2 = 0.06	0.10	A	A
3	0.006	0.008	K3 = 0.08	0.09	B	B
4	0.006	0.008	K4 = 0.10	0.08	C	C

Notes: Different letter notations show significantly different effects at the 5% level and very significant differences at the 1% level.

The higher the concentration of acid used, the lower the viscosity. Howling, (1978) stated that the viscosity of glucose syrup is not only influenced by the mean BM of dissolved solids and the distribution of DE value, it is also influenced by the hydrolysis method used in the production of the glucose syrup. The acid hydrolysis method is influenced by the concentration of acid and the amount of acid used.

3.1.5 TSS (oBrix)

The duration of hydrolysis gave a very significant effect (P<0.01) on the TSS of glucose syrup produced. The test results with LSR show that the effect of hydrolysis time on TSS for each treatment can be seen in Table 12 below:

Table 12. LSR Test Main Effect Effect of Hydrolysis Time on TSS

Distance	LSR		Hydrolysis Time (O'clock)	Average	Notation	
	0.05	0.01			0.05	0.01
-	-	-	T1 = 2.0	16.14	d	D
2	0.082	0.113	T2 = 2.5	17.48	c	C
3	0.086	0.118	T3 = 3.0	17.89	b	B
4	0.088	0.121	T4 = 3.5	18.39	a	A

Notes: Different letter notations show significantly different effects at the 5% level and very significant differences at the 1% level.

The longer the hydrolysis time, the higher the TSS. The longer the starch molecule breakdown reaction takes place, the greater the number of reducing sugars formed, so that the TSS will increase. This is in accordance with the statement of Judoamidjojo, et al., (1992) the longer the hydrolysis, the acid will break down starch molecules randomly and the resulting reducing sugar will also be greater.

The concentration of acid gave a very significant effect (P<0.01) on the TSS of glucose syrup produced. The test results with LSR show that the effect of acid concentration on TSS for each treatment can be seen in Table 13 below:

Table 13. LSR Test Main Effects Effect of Acid Concentration on TSS

Distance	**LSR**		**Concentration Acid (N)**	**Average**	**Notation**	
	0.05	**0.01**			**0.05**	**0.01**
-	-	-	K1 = 0.04	17.35	b	B
2	0.082	0.113	K2 = 0.06	17.33	b	B
3	0.086	0.118	K3 = 0.08	17.55	a	A
4	0.088	0.121	K4 = 0.10	17.66	a	A

Notes: Different letter notations show significantly different effects at the 5% level and very significant differences at the 1% level.

The higher the concentration of acid used, the higher the TSS, except for K2 (0.06 N). The increase in TSS was not always consistent between increases in acid concentration. This shows evidence of acid hydrolysis working randomly as mentioned by Whistler and Paschall, (1965) in Widjanarko, (2000) that random hydrolysis of polysaccharide molecules by acid, where the results of acid hydrolysis tend to vary greatly in the total dissolved solids content.

3.1.6 Sweetness

The duration of hydrolysis gave a very significant effect (P<0.01) on the sweetness of the glucose syrup produced. The test results with LSR show that the effect of hydrolysis time on the sweetness of each treatment can be seen in Table 14 below:

Table 14. LSR Test Main Effects Effect of Hydrolysis Time on Sweetness

Distance	LSR		Hydrolysis Time (O'clock)	Average	Notation	
	0.05	0.01			0.05	0.01
-	-	-	T1 = 2.0	0.25	d	D
2	0.016	0.022	T2 = 2.5	0.33	c	C
3	0.017	0.023	T3 = 3.0	0.41	b	B
4	0.017	0.024	T4 = 3.5	0.44	a	A

Notes: Different letter notations show significantly different effects at the 5% level and very significant differences at the 1% level.

The longer the hydrolysis time, the higher the sweetness level. Sweetness is directly proportional to glucose levels. in syrup, the higher the glucose level contained in the glucose syrup, the sweeter the taste of glucose syrup. Polling and Harsono (1981) stated that the degree of conversion of starch into dextrin, maltose and glucose depends on acid concentration, time, temperature and pressure during the hydrolysis process. Thus, when starch hydrolysis is carried out at a constant temperature, acid concentration and pressure, the longer the hydrolysis time, the higher the glucose level produced.

The concentration of acid gave a very significant effect (P<0.01) on the sweetness of the glucose syrup produced. The test results with LSR show that the effect of acid concentration on the sweetness of each treatment can be seen in Table 15 below:

Table 15. LSR Test Main Effects Effect of Acid Concentration on Sweetness

Distance	LSR		Concentration Acid (N)	Average	Notation	
	0.05	0.01			0.05	0.01
-	-	-	K1 = 0.04	0.27	d	D
2	0.016	0.022	K2 = 0.06	0.34	c	C
3	0.017	0.023	K3 = 0.08	0.39	b	B
4	0.017	0.024	K4 = 0.10	0.43	a	A

The higher the concentration of acid used, the higher the level of sweetness. The level of sweetness is directly proportional to the levels of glucose and TSS in glucose syrup, so the higher the levels of glucose and TSS in glucose syrup, the higher the level of sweetness. Howling, (1978) reported that the relationship between the sweetness of glucose syrup was influenced by the concentration of soluble solids, where the percentage of soluble solids increased indicating a higher level of sweetness.

3.2 Discussion

The longer the hydrolysis time, the organoleptic value increases. The color of the resulting glucose syrup is pale to yellowish in color. Glucose syrup in the T1 treatment was pale so the panelists didn't like it, the longer the hydrolysis time the color of the syrup got yellower so the panelists liked it. Meyer, (1970) stated that when glucose syrup is heated in an acidic environment and the hydrolysis time is longer, it will form 5 hydroxyl-methyl-fulfural which causes a yellowish color in glucose syrup. The taste of glucose syrup is influenced by glucose levels and the level of sweetness of glucose syrup. the longer the hydrolysis time, the higher the glucose level and the sweetness so that the taste is sweeter.

The higher the acid concentration used, the higher the organoleptic value of the color and taste of the glucose syrup. The taste of glucose syrup is influenced by glucose levels and the level of sweetness of glucose syrup. the higher the acid concentration, the higher the glucose level and the sweeter the taste, the sweeter the taste. Widjanarko, (2000) said that the acid hydrolysis method will produce syrup with a low DE value, because this acid hydrolysis takes place randomly in hydrolyzing the molecular structure of flour into monosaccharide and other oligosaccharide molecules. Besides, the resulting syrup will tend to be yellow.

4. CONCLUSION

From the results of the study the effect of hydrolysis time and acid concentration on the yield and quality of glucose syrup from banana starch can be concluded as follows: The duration of hydrolysis gave a very significant effect on the yield, water content, glucose content, viscosity, TSS, sweetness and organoleptic values of color and taste in glucose syrup; The concentration of acid gave a very significant effect on the yield, water content, glucose content, viscosity, TSS, sweetness and organoleptic values of color and taste in glucose syrup; The interaction duration of hydrolysis and acid concentration had a very significant effect on yield and sweetness and had no effect on water content, glucose content, sweetness viscosity and organoleptic values of color and taste; The best glucose syrup produced in this study was the hydrolysis time of 3.5 hours with an acid concentration of 0.1 N.

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For further research, a vacuum evaporator should be used in order to obtain maximum viscosity and blanched to produce a better color of glucose syrup.

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