Competitive Advantage of Purse Liquid

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Competitive Advantage of Purse Liquid Sugar as Natural Sweeteners Materials

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Abstract

Sugar is one of the basic needs of society, particularly its role as a sweetener. It is necessary to find an alternative sweetener other than sugar cane, which include developing a glucose syrup (liquid sugar) from the starch. Purse (*Xanthosoma sagitifolium*) as one type of root crops has a great opportunity to be developed because it has high carbohydrate content (34.2 g/100 g). The purpose of this research was to determine the best enzymatic hydrolysis process in the production of purse liquid sugar.

Research design was a randomized block design (RBD) factorial pattern with 3 times repeated. The first factor is the volume of the enzyme (E) with three levels, namely: E1 = 1 ml, E2 = 2 ml, and E3 = 3 ml. The second factor is the hydrolysis temperature (S) with four levels, namely: S1 = 70^0C, S2 = 80^0C, S3 = 90^0C and S4 = 100^0C. The parameters tested were ^{o}Brix, water content, ash content, reducing sugar, and organoleptic test on taste, color and aroma. The best process is the process which has highest expected value based on Expected Value Method. Furthermore, the products produced from the selected process were calculated on the caloric value and the Glycemic Index (GI).

The results of this research showed that: (1) Treatment interaction of enzyme volume and hydrolysis temperature causes a significant differences in parameters of ^{o}Brix, moisture content, and reducing sugar, but did not cause significant differences in the parameter of ash content; and (2) Based on the expected value method, the best process is hydrolysis process by adding 3 ml enzyme and hydrolysis temperature of 100^0C (E3S4), which produces liquid sugar of purse with 73.73% water content, 0.24% ash content, 25.17 ^{o}Brix, 23.43 % reducing sugar, 106 calories and value IG is 80.63.

Keywords: Enzymatic, hydrolysis, liquid sugar, purse

Introduction

Sugar is one of the basic needs of society, particularly its role as a sweetener. Along with the increase in per capita income and population, the needs for sugar have also increased. The increased of sugar production in the country is not able to compensate for the increase in sugar consumption, so imports of sugar become reasonable choice. To reduce the import of sugar, the sugar production in the country should be encouraged. While also seeking other alternative sweeteners as sugar substitutes, including by developing glucose syrup (liquid sugar) from the starch. Glucose syrup is defined as a clear liquid and viscous whose main components are glucose derived from the hydrolysis of starch. Glucose syrup is the result of starch hydrolysis process, which is derived from a variety of carbohydrate sources such as cassava, sweet potato, sago and corn (Hidayat, 2006).

Purse (*Xanthosoma sagitifolium*) as one kind of plant tubers have a great opportunity to be developed because it has many benefits and can be cultivated easily.Purse can be developed as a source of non-rice carbohydrate (Azwar, 2010). The price of purse is very cheap. Meanwhile, underutilization and high carbohydrate content (34.2 g/100g), make the opportunity for purse to be developed as a raw material for making of glucose syrup.

Hydrolysis method is a method to get glucose syrup from tubers starch.Hydrolysis method can be done by acid hydrolysis, enzymatic hydrolysis and a combination of both. Acid hydrolysis has a

fundamental difference with enzymatic hydrolysis. Acid hydrolysis which typically use a strong acid (HCl), will break the chain of starch at random, while the enzymatic hydrolysis will decide of starch chains specifically on certain branching. Enzymes that can be used in the hydrolysis of starch to produce glucose syrup is α-amylase and glucoamylase (Februadi, 2011). α -amylase enzyme playing a key role in the hydrolysis of starch, glycogen and α-1, 4-glucan. Glucoamylase enzym capable of hydrolyzing the α-1,4 bond in the chain amylose, amylopectin, glycogen, and pullulan. This enzyme can also attack the bond α-16 at the branching point. This means that the starch can be decomposed completely into glucose. Hydrolysis using a strong acid would only produce glucose syrup with a dextrose equivalent (DE) value of 55, while the enzymatic hydrolysis will produce higher DE value.

Research of Budiyanto *et al*. (2005) showed that the enzymatic hydrolysis of cassava using the α-amylase enzyme is done at enzym concentrations of 0.6-1.2 ml/kg of starch, temperature of 90-100^{o}C during 20-60 minutes,while the enzyme amiloglukosidase performed at enzyme concentrations of 0.8-1.2 ml/kg of starch, the temperature of 60^{o}C, pH of 4.0-4.6 during 72 hours.Risnoyatiningsih (2011) showed that the enzymatic hydrolysis of yellow sweet potato starch at a temperature of 60^{o}C using the amylase enzym 2 ml and glucoamylase 0.1 ml produce glucose content with a conversion of 66.08%.

The purpose of this research was to determine the best enzymatic hydrolysis process in the production of purse liquid sugar.

Materials and Methods

Materials and Tools

The materials used are purse tubers, α-amylase and glucosidase enzymes, NaOH 1%, and materials for chemical analysis. The tools used are erlenmeyer, measure instruments, and tools for chemical analysis

Research Design

The design of researchwas a randomized block design (RBD) factorial pattern with 3 times repeated. The first factor is the volume of the enzyme (E) with three levels, namely: E1 = 1 ml, E2 = 2 ml, and E3 = 3 ml. The second factor is the hydrolysis temperature (S) with four levels, namely: S1 = 70^{0}C, S2 = 80^{0}C, S3 = 90^{0}C and S4 = 100^{0}C.

Observation Parameters

The parameters tested were ^{o}Brix, moisture content, ash content, reducing sugar, and organoleptic test on taste, color and aroma. The selected process will then be calculated caloric value and the Glycemic Index (GI).

Alternative Selection

Alternative selection was done to determine the best treatment in the manufacturing process of purse liquid sugar by enzymatic hydrolysis. The best process is the alternative process which has highest expectated value based on Expected Value Method. For product of purse liquid sugar, quality parameters used for selecting the best alternative is water content, ash content, reducing sugar content, as well as organoleptic on taste, aroma, and color.

Data Analysis

Analysis of organoleptic data which is ordinal data using Friedman test, whereas analysis of the chemical test data performed by analysis of variance, if there is significant continued with Duncan test with 95% confidence level.

Results and Discussion

1. Purse Starch Processing

Purse starch is produced from the purse tubers with the stages of the process, namely sorting, stripping, downsizing, soaking in a saturated salt solution, washing, milling, extortion, filtration, sedimentation, drying, flouring and packaging. The yield generated is 20.33% as shown in Table 1.

Table 1. Yield of Purse Starch

No	Purse Tubers	Purse Starch	Yield (%)
1	35	7,2	20,57
2	35	6,8	19.43
3	30	6,3	21,00
Average			**20,33**

Taste

Based on the result of Frequency Analysis, the percentage of score gained for taste parameter are shown in Table 2 and Figure 1.

Table 2.Score Gained Percentage for Taste Parameter of Purse Liquid Sugar

	Score Gained (%)											
Score	E1S1	E1S2	E1S3	E1S4	E2S1	E2S2	E2S3	E2S4	E3S1	E3S2	E3S3	E3S4
1	13,3	10,0	6,7	3,3	3,3	6,7	0,0	0,0	0,0	0,0	0,0	0,0
2	50,0	50,0	50,0	50,0	53,3	50,0	53,3	56,7	43,3	56,7	50,0	50,0
3	36,7	36,7	43,3	46,7	43,3	43,3	40,0	36,7	46,7	40,0	40,0	40,0
4	0,0	3,3	0,0	0,0	0,0	0,0	6,7	6,7	10,0	3,3	10,0	10,0
5	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0

Based on the results of Friedman test for score ofpurse liquid sugar taste shows that there are no significant differences among treatments, with a calculated F value of 12.669.

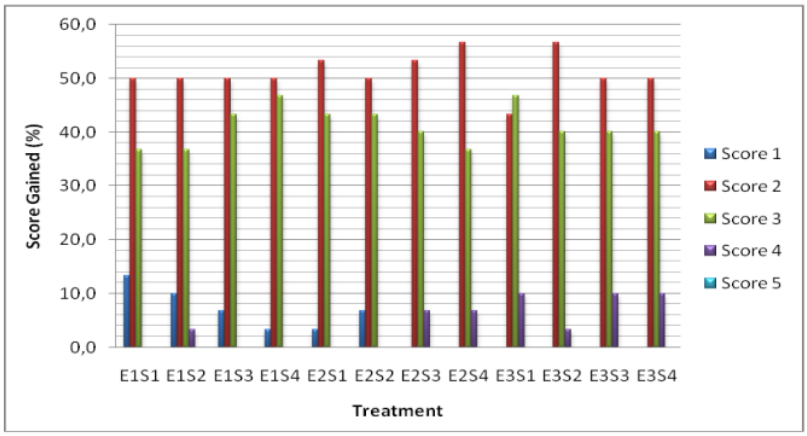

Figure 1. Graph ofScore Gained Percentage for Taste Parameter of

Purse Liquid Sugar

Aroma

Based on the result of Frequency Analysis, the percentage of score gained for aroma parameter are shown in Table 3 and Figure 2.

Table 3. Score Gained Percentage for Aroma Parameter of Purse Liquid Sugar

Score	Score Gained (%)											
	E1S1	E1S2	E1S3	E1S4	E2S1	E2S2	E2S3	E2S4	E3S1	E3S2	E3S3	E3S4
1	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0
2	40,0	43,3	33,3	40,0	46,7	43,3	53,3	56,7	50,0	43,3	63,3	66,7
3	50,0	43,3	56,7	53,3	50,0	50,0	40,0	36,7	36,7	56,7	36,7	33,3
4	10,0	13,3	10,0	6,7	3,3	6,7	6,7	6,7	13,3	0,0	0,0	0,0
5	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0

Based on the results of Friedman test for score of purse liquid sugar aroma shows that there are no significant differences among treatments, with a calculated F value of 14.039.

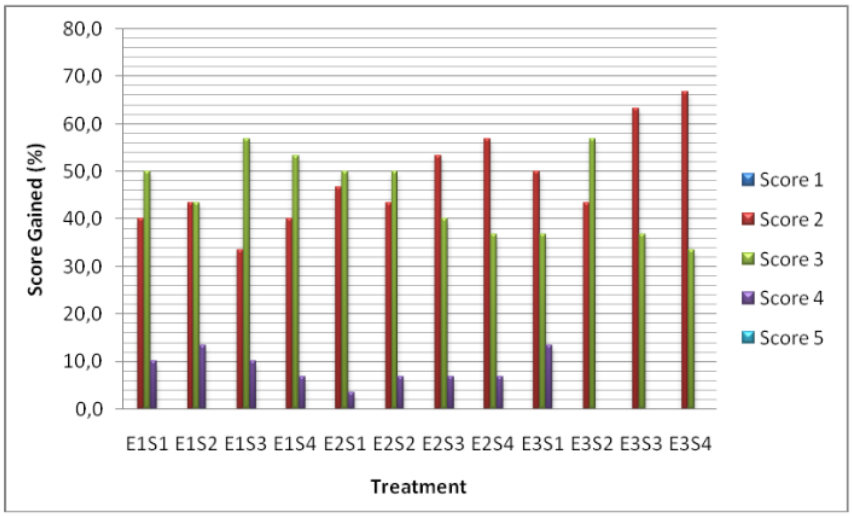

Figure 2. Graph of Score Gained Percentage for Aroma Parameter of Purse Liquid Sugar

Color

Based on the result of Frequency Analysis, the percentage of score gained for color parameter are shown in Table 4 and Figure 3.

3. Chemistry Contents

°Brix

°Brix measurement is performed to determine the degree of sweetness of purse liquid sugar from enzymehydrolysis.Data and graph of °Brix purse liquid sugar from enzyme hydrolysis is shown in Table 5 and Figure 4.

Table 4. Score Gained Percentage for Color Parameter of Purse Liquid Sugar

Score	Score Gained (%)											
	E1S1	E1S2	E1S3	E1S4	E2S1	E2S2	E2S3	E2S4	E3S1	E3S2	E3S3	E3S4
1	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0
2	20,0	20,0	10,0	10,0	16,7	13,3	16,7	20,0	20,0	13,3	16,7	10,0
3	56,7	53,3	70,0	66,7	66,7	70,0	60,0	60,0	56,7	63,3	50,0	53,3
4	23,3	26,7	20,0	23,3	16,7	16,7	23,3	20,0	23,3	23,3	33,3	36,7
5	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0

Based on the results of Friedman test for score ofpurse liquid sugar color shows that there are no significant differences among treatments, with a calculated F value of 5.215.

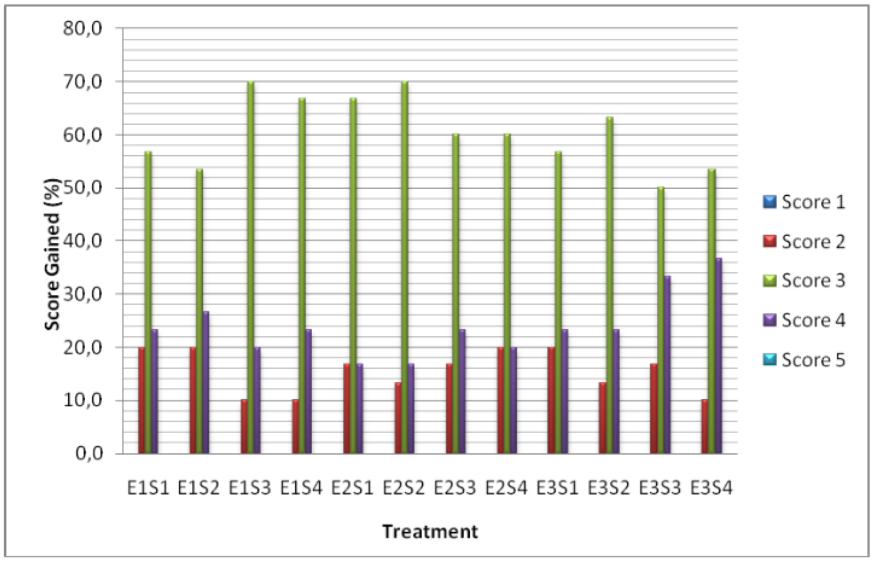

Figure 3. Graph of Score Gained Percentage for Color Parameter of Purse Liquid Sugar

Table 5.°Brixof Purse Liquid Sugar

Treatments	S1	S2	S3	S4	Average
E1	21,83 c	23,83 bc	21,83 c	26,67 a	23,54
E2	23,83 bc	23,33 bc	24,67 a	25,33 ab	24,29
E3	22,00 c	24,33 b	24,50 b	25,17 ab	24,00
Average	22,56	23,83	23,67	25,72	23,94

In Figure 4 it appears that the same enzyme concentration, the higher the hydrolysis temperature showed that °Brix tends to increase.This is in accordance with the opinion of Suhartono (1989) that the α-amylase enzyme works in the temperature range 90-100°C.Added by Hartiati and Yoga (2014), that the taro potato starch hydrolysis by the enzyme concentration of 1.0 ml/kg at a temperature of 95°C to produce dextrose equivalence (DE), the highest 34.26%.

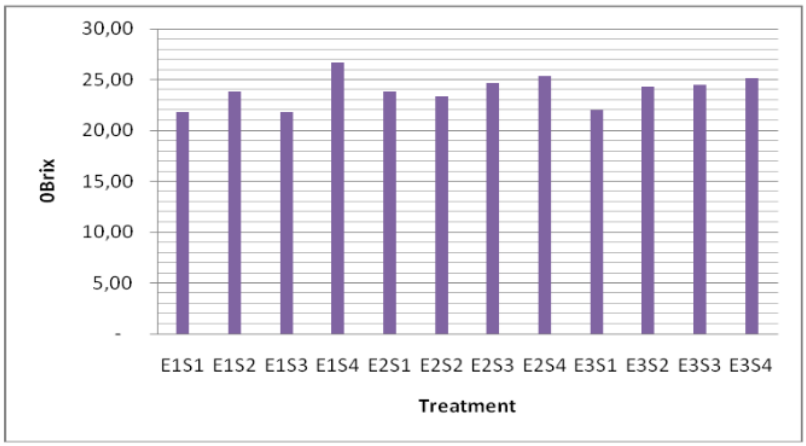

Figure 4. Graph of °Brix of Purse Liquid Sugar

Results of analysis of variance showed that there were significant differences in the treatments interaction to°Brix of purse liquid sugar is generated, as shown in Table 6.

Table 6.Notation of Duncan Test for Treatments Interactions

Treatments	°Brix
E1S1	21,83 c
E1S2	23,83 bc
E1S3	21,83 c
E1S4	26,67 a
E2S1	23,83 bc
E2S2	23,33 bc
E2S3	24,67 b
E2S4	25,33 ab
E3S1	22,00 c
E3S2	24,33 b
E3S3	24,50 b
E3S4	25,17 ab

Description: Different letters indicate significant differences

Moisture Content

Moisture content measurement is performed to determine the moisture content of purse liquid sugar from enzyme hydrolysis with the treatment enzyme volume and temperature hydrolysis.The results of measurements of moisture content of purse liquid sugar can be seen in Table 7 and Figure 5.

Table 7.Moisture Content of Purse Liquid Sugar (%)

Treatments	S1	S2	S3	S4	Average
E1	77,47	76,51	73,36	72,05	74,85
E2	76,61	75,72	73,31	73,66	74,83
E3	75,88	74,94	74,30	73,73	74,71
Average	76,65	75,72	73,66	73,15	74,80

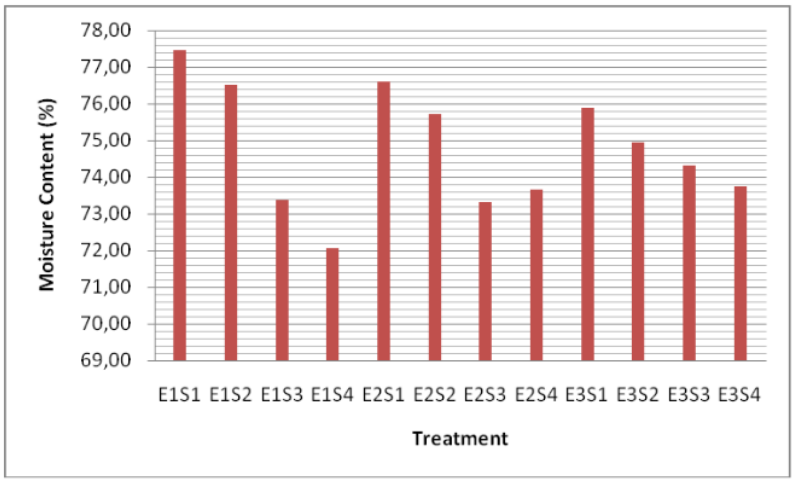

Figure 5. Graph of Purse Liquid Sugar MoistureContent

Results of analysis of variance showed that there were significant differences in the treatments interaction.In Table 8 it appears that at the same concentration, along with increased in hydrolysistemperature, moisture content tends to decrease.This is possibly due to the longer time the hydrolysis will cause more water is evaporated.

Table 8.Notation of Duncan Test for Treatments Interactions

Treatments	Moisture Content (%)
E1S1	77,47 f
E1S2	76,51 ef
E1S3	73,36 ab
E1S4	72,05 a
E2S1	76,61 ef
E2S2	75,72 de
E2S3	73,31 ab
E2S4	73,66 bc
E3S1	75,88 de
E3S2	74,94 cd
E3S3	74,30 bc
E3S4	73,73 bc

Description: Different letters indicate significant differences

Ash Content

Ash content measurement is performed to determine the ash content of purse liquid sugar from enzyme hydrolysis with the treatment enzyme volume and temperature hydrolysis.The results of measurements of ash content of purse liquid sugar can be seen in Table 9 and Figure 6.

Results of analysis of variance showed that there were no significant differences among the treatments.

Reducing Sugar Content

Reducing sugar content measurement is performed to determine the reducing sugar content of purse liquid sugar from enzyme hydrolysis with the treatment enzyme volume and temperature hydrolysis.The results of measurements of reducing sugar content of purse liquid sugar can be seen in Table 10 and Figure 7.

Table 9.Ash Content of Purse Liquid Sugar (%)

Treatments	S1	S2	S3	S4	Average
E1	0,26	0,24	0,23	0,27	0,25
E2	0,29	0,25	0,24	0,24	0,26
E3	0,31	0,26	0,25	0,24	0,27
Average	0,29	0,25	0,24	0,25	0,26

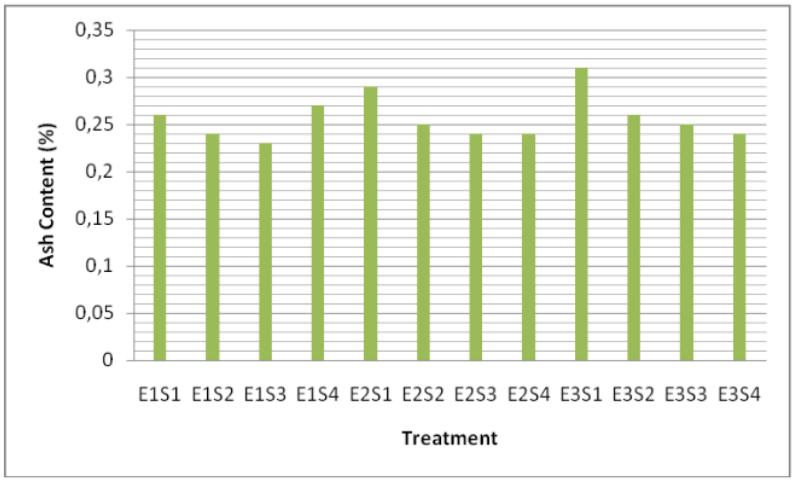

Figure 6. Graph of Purse Liquid Sugar Ash Content

Table 10.Reducing Sugar Content of Purse Liquid Sugar (%)

Treatments	S1	S2	S3	S4	Average
E1	14,88	16,97	14,42	23,63	17,48
E2	18,73	17,04	18,69	21,08	18,89
E3	14,05	18,19	19,92	23,43	18,90
Average	15,89	17,40	17,68	22,71	18,42

Results of analysis of variance showed that there were significant differences in the treatments interaction.In Table 11 it appears that the same enzyme concentration, the higher the hydrolysis temperature showed that reducung sugar content tends to increase.This is in accordance with the opinion of Suhartono (1989) that the α-amylase enzyme works in the temperature range 90-100^{o}C, thereby reducing sugar content produced are also getting bigger.

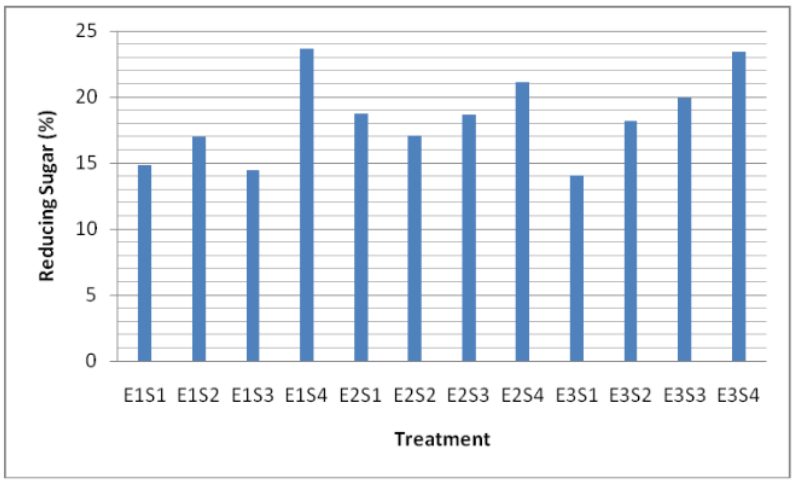

Figure 7. Graph of Purse Liquid Sugar Reducing Sugar Content

Table11.Notation of Duncan Test for Treatments Interactions

Treatments	Reducing Sugar Content (%)
E1S1	14,88 f
E1S2	16,97e
E1S3	14,42f
E1S4	23,63a
E2S1	18,73cd
E2S2	17,04e
E2S3	18,69cd
E2S4	21,08b
E3S1	14,05f
E3S2	18,19de
E3S3	19,92bc
E3S4	23,43a

Description: Different letters indicate significant differences

Alternative Selection

Alternative selection is done with the aim of selecting the best treatment of some existing treatments.Decision-making is a process of systematically selecting the best treatment.Determining the weight of the interests of each parameter is done by using Analytical Hierarchi Process. As for determining the selection of the best treatment based Expected Value Method.

Based on the expected value method, the best process is hydrolysis process by adding 3 ml enzyme and hydrolysis temperature of 100^0C (E3S4) with expected value of 8.58.

Calories Value and Glycemic Index

Calories value of purse liquid sugar from enzymatic hydrolysis process chosen is 106 calories with IG value of 80.63.

Conclusion

Treatment difference of enzyme volume and the heating temperature on the enzyme hydrolysis causes no significant difference in the parameters of taste, aroma and color of the purse liquid sugar product. While, treatment interaction between enzyme volume and heating temperature on the enzyme hydrolysis causes a significant differences in parameters of ^{o}Brix, water content, and reducing sugar, but did not cause significant differences in the parameter of the ash content. Based on the expected value method, the best process is hydrolysis process by adding 3 ml enzyme and hydrolysis temperature of 100^{0}C (E3S4), which produces liquid sugar of purse with 73.73% water content, 0.24% ash content, 25.17 ^{o}Brix, 23.43 % reducing sugar, 106 calories and value IG is 80.63.

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