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Glycemic Index Study of Honey Tonic Herbal from Sweet-Honey West Kalimantan and Bitter-Honey Bangka Belitung

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Abstract

Background: Our research continues two previous studies on the best formulation based on bitter tonic (bajakah, Uncaria lanosa var. glabrata) mixed with sweet honey (West Kalimantan) and *Citrus xamblyarpa*. The other was a bitter tonic (Bangka-Belitung) mixed with *Citrus hystrix*. We didn't know the function of tonics, so we studied to test the tonics for antidiabetics. Most publications on fructose in honey seem to be reducing hyperglycemia. We believed the alkaloids and flavonoids from bajakah, honey, and citrus could lower blood glucose in healthy men. In the future, people could drink tonics without increasing their blood glucose.

Objective: to compare the GI (Glycemic Index) and GL (Glycemic Load) in honey tonic herbal based on sweet honey and honey tonic herbal based on bitter honey.

Methods: Our experimental research used a pretest-posttest design with a control group design. The 12 subjects were younger, healthy men, and the study was conducted in September-November 2023. Two treatments are honey tonic herbal 1 (bajakah extract + sweet honey + limau citrus extract) and honey tonic herbal 2 (bitter honey + kefir citrus extract). The data collected in this study includes proximate, GI, and GL. Data were analyzed in an independent samples t-test using the Mann-Whitney method (alpha 5%).

Results: The two honey tonic herbals were the same, with higher IG and BG. Descriptive honey tonic herbal 2 showed a faster decrease in blood sugar after 30 minutes.

Conclusion: to produce a low GI, the recommended BG consumed by each tonic is 30.97g and 12.7g, respectively.

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INTRODUCTION

One of the sweeteners that is functional for our body is honey. Various honeys in Indonesia, such as sweet honey from Kapuas Hulu District, West Kalimantan Province, and bitter honey pelawan from Bangka Tengah District, Bangka Belitung Province. Two of the honeys are processed for tonic (a substance that can increase the body's defense system)to be honey tonic herbal based on bajakah mixed with sweet honey and citrus flavor[1], and honey tonic herbal based on bitter honey mixed with citrus flavor[2].

Bajakah, honey, and citrus contain alkaloids and flavonoids used for antidiabetics [1,2,3,4,5]. Bajakah is rich in alkaloids, glabratine[6], honey, and citrus, which are rich in flavonoids[7,8,9,10]. Bitter honey is rich in alkaloids[11,12]. Almost all honey consists of fructose, which can decrease blood glucose or hypoglycemia[13,14]. Honey is known as a tonic; it means a compound or mixed compound that could increase the body's immune system, so honey is also called a stimulant. The stimulant could be from alkaloids and flavonoids, too[14,15]. So, we should try to study GI and GL from tonics that consist of fructose, alkaloids, and flavonoids from honey mixed with herbs.

METHODS

Our research is observational, where researchers observe subjects over a specific period using a cross-sectional approach. This research has passed ethical requirements by the Health Research Ethics Committee of the Tanjungpura University, Faculty of Medicine, with No. 1566/UN22.9/PG/2024. The research was conducted in the food chemistry lab at the Faculty of Agriculture, Tanjungpura University, Pontianak. Data was collected in March-August 2024. The volunteers were students from the Food Science and Technology Department, Tanjungpura University, Pontianak.

The volunteers involved met the inclusion and exclusion criteria: healthy adults between 20-35 years, have a normal BMI of 18.5-25 kg/m^2, have a normal blood pressure of 120/80 mmHg, have a fasting blood sugar level of between 70-110mg/dL, do not consume drugs or smoke, and do not suffer from or have a history of DM and dyspepsia. Other requirements are not following a special diet for medical reasons, not having a chronic disease, not being pregnant or breastfeeding, and not having a history of allergies to standard foods and tested foods.

The intervention group was two herbal honey tonics for post-prandial blood glucose in healthy adults. The sample used is based on the best formulation from the research results of Wongso[16] and Koswara[17]. Herbal honey tonic 1 (formulation of the standard: 5ml of Bajakah extract + 3.75ml of sweet honey + 1.25ml of lime citrus extract) and 2). Herbal honey tonic 2 (formulation of standard: 90ml of bitter honey+10ml of kaffir lime extract).

The materials are sweet honey (tikung honey is obtained from Putussibau, Kapuas Hulu District, West Kalimantan), while bitter pelawan honey is obtained from Central Bangka, Bangka Belitung. Bajakah (kelait root) was obtained from Mungguk Village, Embaloh Hulu District, Kapuas Hulu District, West Kalimantan, and lime, citrus, and kaffir limes were obtained from the market in

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Pontianak. The parameter measurements are proximate analysis (in three replicates), IG, and BG of herbal honey tonic 1 and herbal honey tonic 2, according to Soviana and Maenasari[18].

Proximate Test

Water, fat, and carbohydrate content were measured according to Sudarmadji S, Haryono B, Suhardi[19]; Ash content was measured according to SNI[20]; protein was measured according to AOAC[21].

Food Conversion Calculation

This research uses a reference food standard, a glucose standard equivalent to 50 g of carbohydrates[22]. This conversion was used to determine the need for bitter Pelawan honey with kaffir lime extract, which is comparable to 50 g of standard glucose given to volunteers as a test food.

IG and GL Test

This test begins with the opponent fasting for 10-12 hours, only allowed to consume water. Before the blood sugar is checked, the blood pressure is checked first using a blood pressure monitor. If blood pressure is normal, blood is taken from volunteers to determine fasting blood sugar, calculated at the 0th minute. The next stage is administering standard glucose dissolved in 200 mL of air consumed in 5 minutes. Blood glucose levels are measured after consuming the glucose standard, which has been carried out at intervals of every 30 minutes for 2 hours, namely at minutes 0, 30, 60, 90, and 120. In the subsequent treatment with predetermined time intervals (4-7 days), reference food or glucose standards are being replaced with food tests for their GI. The glycemic index is the ratio of the area of the test food's glucose response curve to the area of the reference food's glucose response curve, namely standard sugar, multiplied by 100. Glycemic Load calculation is measured by multiplying the GI and carbohydrate levels in the test food, then multiplying by 100[22].

RESULTS

1. Volunteer Profile

Twelve volunteers were used for the IG test. The Body Mass Index (BMI) of volunteers is a requirement, as presented in Table 1. All volunteers are classified as healthy humans according to Indonesia's BMI standard threshold limit.

The IG assessment began with measuring blood sugar levels by comparing the blood sugar levels of volunteers who were given the standard glucose (50g) and herbal honey tonics 1 and 2. Figure 1 showed that volunteers' blood sugar levels given the herbal honey tonic 1 (bajakah extract + sweet honey + limau citrus extract) were lower than standard glucose.

Based on Fig. 2, it has been seen that blood sugar from glucose standard (50g) and herbal honey tonic 2 is almost the same when consumed up to the first 30 minutes. The herbal honey tonic 2 showed an increasingly rapid decrease in blood sugar until 120 minutes.

Figure 3 compares the glycemic index of four interventions: two standard glucose levels of 50g and two tonics.

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Table 1. BMI of Volunteer

Volunteer	Herbal Honey Tonic 1			Notes	Herbal Honey Tonic 2			Notes
	BW (kg)	BH (m)	BMI		BW (kg)	BH (m)	BMI	
1	154	58	24.45	standard	44	148	20	standard
2	155	53	22.58	standard	52	155	21.6	standard
3	154	51	21.5	standard	51	159	20.1	standard
4	145	49	23.31	standard	66	168	23.	standard
5	149	47	21.17	standard	61	165	22.4	standard
6	158	56	22.4	standard	48	158	19.2	standard
7	155	45	18.75	standard	43	152	18.6	standard
8	166	61	22.13	standard	47	158	18.8	standard
9	158	54	21.63	standard	47	158	18.8	standard
10	163	64	24.08	standard	63	167	22.5	standard
11	161	61	23.53	standard	71	178	22.4	standard
12	156	47	19.34	standard	53	151	23.2	standard

2. Proximate of Herbal Honey Tonic

Table 2. Proximate of Herbal Honey Tonic 1 (%)

Repetition	Carbohydrate	Water	Ash	Protein	Fat
1	40.49	57.57	0.46	0.37	1.112
2	47.34	50.67	0.42	0.41	1.158
3	39.80	58.31	0.45	0.37	1.075
average	42.54	55.52	0.44	0.38	1.12

Table 3. Proximate of Herbal Honey Tonic 2 (%)

Repetition	Carbohydrate	Water	Ash	Protein	Fat
1	64.61	33.75	0.07	0.42	1.15
2	66.58	31.50	0.08	0.43	1.41
3	65.61	32.50	0.09	0.39	1.41
average	65.60	32.58	0.08	0.41	1.32

3. Glycemic Index and Glycemic Load

3.1. Herbal Honey Tonic 1

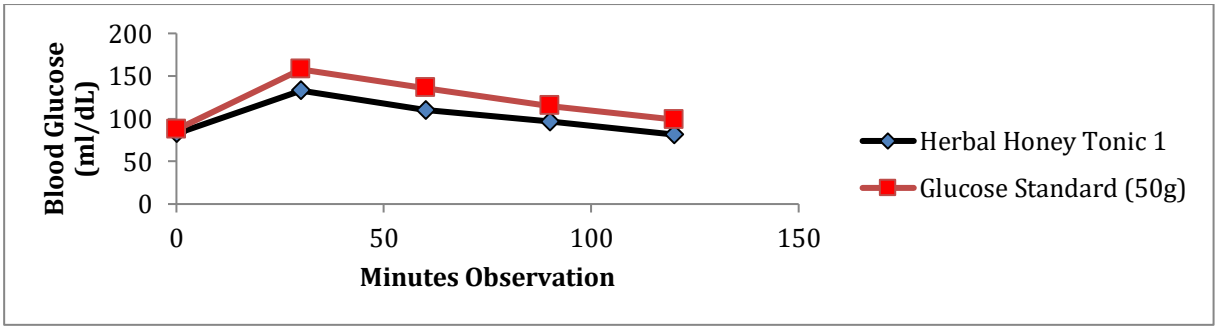

Figure 1. Comparison between the GI of Volunteers who consumed a glucose standard (50g) and the Herbal Honey Tonic 1

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3.2. Herbal Honey Tonic 2

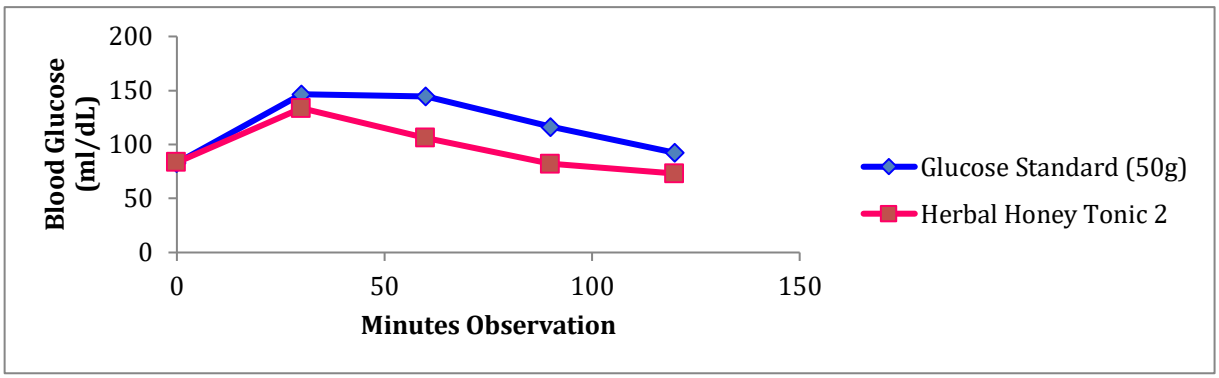

Figure 2. Comparison between the GI of Volunteers who consumed the standard of glucose (50g) and the Herbal Honey Tonic 2

4. Comparison Between GI of Two Tonics

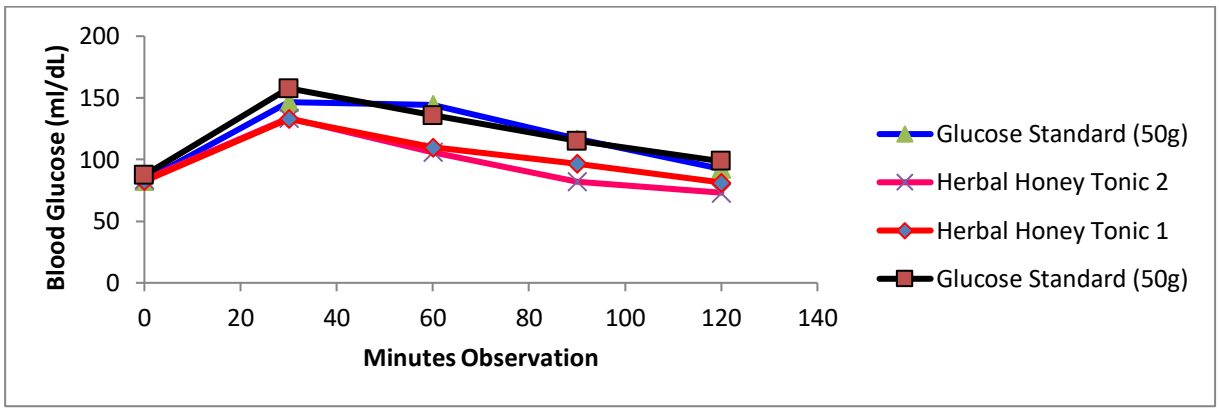

Figure 3. Comparison between the GI of Volunteer in Herbal Honey Tonic 1 and Herbal Honey Tonic 2

DISCUSSION

1. GI of Herbal Honey Tonic 1 (Sweet Honey)

To give the samples to volunteers, the proximate must first be calculated from the herbal honey tonics (Tables 2 and 3). Only carbohydrate values can be used, while water, ash, protein, and fat contents are tested to obtain carbohydrate levels by difference. The carbohydrate test on herbal tonic 1 showed that the formulation contained 65.60% (60.60 g/100 ml). Because the sample tested on volunteers is equivalent to 50g, the carbohydrate of the sample must be measured first. The equalization result is 100: (60.60/50)= 76.22 ml. Thus, each volunteer was given a test sample of 1 herbal tonic of 76.66ml. The results of the carbohydrate test on herbal tonic 2 showed that the formulation contained 42.54% (42.54 g/100 ml). So, in tonic 2, the sample tested on volunteers is equivalent to 50g, and the carbohydrate content of the sample is 100: (42.54/50)= 117.54 ml. Thus, each volunteer is given a test sample of herbal tonic 1 of 117.54ml.

After calculating the AUC of standard glucose 15051 and the AUC of herbal honey tonic 1,

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which is 12649.95, the GI of herbal honey tonic 1 is 84.05. The GI group produced from the herbal honey tonic 1 is high. The GI value is high because herbal honey tonic 1 is consumed 123.89g with a carbohydrate content of 40.43%. The herbal honey tonic 1 must be consumed to reduce blood sugar based on the GL (Glycemic Load) value. When the IG value is 84.05, tonic has GL 33.98 (high). Because the low BG value is <10, the herbal honey tonic 1 must be reduced to 1/4 to 30.97g. Thus, the GL produced to decrease in blood sugar is 8.49 (low GL). This GL value comes from the GI value x (1/4 x carbohydrate content/portion) /100. So, the herbal honey tonic 1 is consumed at 123.89g/4=30.97g for low blood sugar.

2. GI of Herbal Honey Tonic 2 (Bitter Honey)

After calculating the AUC of standard glucose (4954.55) and the AUC of herbal honey tonic 2 (12207), the GI of herbal honey tonic 2 is 81.63 (high group). The GI value is high because the amount of herbal honey tonic 2 consumed was 76.22g with a carbohydrate content of 50%. To decrease blood sugar, the amount of the herbal honey tonic 2 can be consumed based on the BG (Glycemic Load). With the IG value of 81.63, the GL is 53.56 (very high). For the BG to have a low value of <10, the herbal honey tonic 2 must be reduced to 1/6 (12.7g). Thus, the BG produced to lower blood sugar is 8.9 (low BG). This BG value comes from the IG value x (1/6 x carbohydrate content/portion)/100. The portion of herbal honey tonic 2 to give a low blood sugar is 76.2 g/6 = 12.7 g.

3. Comparison Between GI of Herbal Honey Tonic

After combining the blood sugar of two groups of individuals between herbal honey tonics 1 and 2 (Figure 11), both herbal honey tonics showed a lower blood sugar than the blood sugar of volunteers who were given 50g of standard glucose. Herbal honey tonics 1 and 2 are equivalent to a carbohydrate content of 50g. However, after 30 minutes, there was a decrease in blood sugar from the herbal honey tonic 2. The increase in blood sugar from the control (standard glucose 50g) was between 140 and 180 mg/dL, while the blood sugar produced from the two herbal honey tonics showed <140 mg/dL. It showed that the herbal honey tonic is still relatively high because it will reach 140 mg/dL. Based on Soelistijo et al.[23], blood laboratory test levels for diagnosing pre-diabetics: plasma blood glucose 2 hours after OGTT (mg/dL) is 140-199 mg/dL, while for a normal human, OGTT <140mg/dL.

The increase in blood sugar for all interventions until 30 minutes is thought to be due to monosaccharide sugar levels (glucose and fructose) in all honey tonics because the types of honey are different: sweet honey and bitter honey. The presence of glucose will accelerate the rise in blood sugar, while high fructose can reduce blood sugar. Based on Riswahyuli et al.[24], honey from Kapuas Hulu and Pelawan from Central Bangka have different sugar and phenolic content. Pelawan honey is very low in sucrose compared to KH honey, while the glucose and fructose content is also lower than KH, which contains 2-3x the sucrose of Pelawan honey. The total sugars of glucose, fructose, and sucrose in KH honey are almost

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90%, while Central Bangka honey is only <70%. Herbal honey tonic 1 with high fructose content slows blood sugar rise. The conclusions have been explained by Erejuwa et al.[4], Bobiş et al.[13], Amalia[25] that fructose will stimulate the glucokinase enzyme in hepatocytes, which regulates the uptake and storage of glucose as glycogen in the liver. Glucose increases fructose absorption and promotes liver function by increasing glucose delivery.

We believed that other compounds were suspected to be non-sugar (such as phenolics and alkaloids) in each honey, especially in herbal honey tonic 2, which contains many chemical compounds that can lower blood sugar. These non-sugar chemical compounds can lower blood sugar after 30 minutes. Reported by Riswahyuli et al.[26] also described phenolic acid and polyphenolic content in KH and Central Bangka honey. Pelawan honey was rich in phenolic compounds (254.92 mg GAE/kg + 1.09 mg QER/100g compared to KH honey (188.03 mg GAE/kg + 0.81 mg QER/100g. According to Bobiş et al.[13] the role of fructose is hypoglycemic due to interactions with mineral ions (selenium, zinc, copper, and vanadium) and phenolic compounds. These phenolic compounds are known to lower blood sugar by inhibiting the enzyme amylase, glucosidase[27,28,29,30]. Another compound that plays a role in reducing blood sugar in the herbal honey tonic 2 is alkaloids. Besides flavonoids (polyphenolic), the compound that contributes to the bitter taste is alkaloids, too.

The role of alkaloids has been widely proven to be able to lower blood sugar and have an anti-diabetic effect[31,32,33,34]. According to Behl et al.[31] and Adhikari[34] explained that the role of alkaloids in DM management is by inhibiting enzymes (α-amylase, α-glucosidase, aldose reductase, dipeptidyl peptidase-IV, protein tyrosine phosphatase-1B); inhibiting end product glycation development; increaseing insulin secretion and sensitivity; increasing glucose uptake, including its ability as an antioxidant[32], also explained that alkaloids induce proteins in AMP-activated protein kinase, glucose transporters, glycogen synthase kinase-3, sterol regulatory element-binding proteins 1, glucokinase, glucose-6-phosphatase, acetyl-CoA carboxylase in glucose metabolism.

The results of the data analysis used the Mann-Whitney test because the data do not have a normal distribution, so nonparametric statistics were used. The Mann-Whitney test results showed a significant value between the two herbal honey tonics of 0.347 (alpha 5% significantly). It can be concluded that herbal honey tonic 1 and honey tonic 2 have the same GI.

CONCLUSION

Herbal honey tonic based on sweet honey from West Kalimantan and bitter honey from Bangka Belitung have the same Glycemic Index (high groups). The lower Glycemic Load value for each tonic consumed was 30.97g and 12.7g in healthy men.

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