Biota
Biologi dan Pendidikan Biologi
http://biota.ac.id/index.php/jb
DOI: http://dx.doi.org/10.20414/jb.v12i1.148

Research Article

Making Liquid Sugar Preparations from Lombok-Traditional Sugarcane Juice and Its Potential as Anti-Diabetic Sugar

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Abstract

The prevalence of Patients with Diabetes Mellitus remains on the rise worldwide. Diabetes is a multifactorial disorder that emboils genetic and environmental factors such as an unhealthy diet by consuming white sugar crystals. White crystal sugar consists of less chromium content that induces glucose in the blood to the cells, which can trigger hyperglycemia or high blood sugar levels. Chromium works by increasing the activity of insulin receptors to enhance glucose translocation to the cell. Previous studies showed sugarcane Nira had a high level of chromium compared with those processed into white crystalline sugar. However, it could not be used as a sweetener substitute since its storage age was only 2 to 3 days. This study identified that the treatment process of Lombok's Nira sugarcane into local liquefied sugar should be addressed to maintain chromium levels compared to the processing of Nira into the white crystalline sugar requiring optimum sucrose and omitting several minerals. Hence, sugarcane Nira as a refined sugar product can substitute for white sugar consumption in diabetes patients.

Keywords: *Local Liquid Sugar, Sugarcane Nira, Anti-Diabetes Sugar, Chromium Content (III)*

1. Introduction

According to the International Diabetes Federation (IDF) in 2018, Diabetes Mellitus (DM) is a global problem with a prevalence of 425 million people worldwide, which tend to continue to increase in both type 1 and type 2. If this is not addressed quickly and responsively, by 2045 prevalence of sufferers will be 625 million (IDF). Whereas in Indonesia, the DM prevalence of 10.3 million will experience an increase by 2030 to 21.3 million (Indrahadi et al., 2021).

Diabetes is caused by hyperglycemia, a condition where high sugar levels are in the blood. Glucose metabolism can occur when glucose in the blood can enter cells, preceded by binding insulin to its receptors (chromodulin protein) on the cell surface. Insulin receptors are only active if they have bound to chromium (III), so chromium is an essential component of the Glucose Tolerance Factor (GTF) (Zheng et al., 2018).

Diabetes is divided into two types; where type 1 diabetes is caused by the inability of the pancreas to produce adequate amounts of insulin and usually occurs due to hereditary factors, while type 2 diabetes is caused by abnormalities of insulin receptors on the surface of cells that are not sensitive or resistant to insulin (Picke et al, 2019). In addition, generally, type 2 diabetes occurs due to low intake of organic chromium (III) from food in the body, namely in the form of chromium picolinate, which is bound as a complex with vitamin B3 (niacin) (Hussain and Chowdhury, 2019). Whereas the need for organic chromium in people with diabetes, especially those with type 2 diabetes, is between 200

to 1000 micrograms per day, whose value is much higher than the need for organic chromium in healthy people, which is about 50 to 200 micrograms per day (Eckstein et al., 2019).

One of the diets that cause poor organic chromium intake is the consumption of white crystalline sugar made from sugarcane as a sweetener. In contrast, the process in which the white crystalline sugar is produced is a refining process of sucrose, where the levels of sucrose are optimized while the levels of other substances, including the minerals chromium in the sugarcane juice, are eliminated (Rmarathinam et al., 2021). As for brown sugar, organic chromium still exists since the production is simple. While people today generally drink more sugar than white crystals in sweeteners, rarely using brown sugar and hardly ever using sugarcane juice. Thus, there is an increase in the prevalence of type 2 diabetes in society as a result of this pattern of sugar consumption (Surayya et al., 2020).

To overcome organic chromium deficiency in DM patients, chromium picolinate supplements have been used, which are more easily absorbed by the body than inorganic types. This chromium supplement has been shown to improve the symptoms of diabetes, but the supplement's price is still relatively high and must be imported (Hua et al., 2017). On the other hand, such supplements cannot replace sugar as a sweetener. Using various types of natural local liquid sugar preparations whose chromium content is still very likely to be relatively high, these expensive supplements can be replaced by their function (Khodavirdipour et al., 2020).

The candidate for liquid sugar preparations as an anti-diabetic is sugarcane juice. Unprocessed sugarcane juice contains a higher level of chromium (III) which is 0.475 ppm, than white crystal sugar of 0.013 ppm, so it has the potential to become an anti-diabetic sugar preparation. However, the main disadvantage of sugarcane juice preparations is their low shelf life and their easily oxidized, so they need to be modified into other products with a higher shelf life (Wijayanti et al., 2019). Therefore, it is necessary to process the Processing of Lombok's Typical Sugarcane Juice into Liquid Sugar to Provide Anti-Diabetes Sugar with high chromium levels.

2. Materials and Methods

2.1 Materials

Falcon tubes of 15, 25, and 50 mL, Microtubes of 1.5 and 2 mL, Sterile Glass Bottles, Stoves, Stirrers, Sterile Containers, and Inductively Coupled Plasma (ICP). Green sugarcane juice typical of Lombok, HNO3, H2SO4, White Crystal Sugar, Alcohol, and Aquades.

2.2 Methods

2.2.1 The Making of Liquified Sugar From Sugarcane Juice

A ten-gallon (10 L) litre of sugarcane juice is cooked using a container and stove, heated for 2 hours until the water shrinks, a honey-like caramel texture is formed, the

heat is reduced, and the resulting liquid sugar is stirred, and then the fire is turned off. The results are placed in sterile glass vials for further testing.

2.2.2 Determination of Chromium Content

The chromium levels are analysed using Inductively Coupled Plasma (ICP) devices that measure metals up to the ppm (part per million) level. The method to destroy H2SO4 1:1 was as much as 5 mL, then diluted and filtered. And then attacked with HNO3 and measured chromium with Inductively Coupled Plasma (ICP) devices.

3. Results and Discussion

3.1 Results

Table 1. Results of Analysis of Chromium (III) Levels in Sugarcane Juice, Liquid Sugar Preparations, and White Crystal Sugar

No	Types of Preparations	Level of Chromium (III) (ppm)
1	Sugarcane Nira	0,357
2	Liquid Sugar	0,495
3	White Crystal Sugar	0,016

Table 2. Comparison of The Amount of Sugarcane Juice, Liquid Sugar Preparations, and White Crystal Sugar to supply the Daily Needs of Chromium

No	Types of Preparations	Levels of Chromium (III) (ppm)	Minimum amount that must be consumed per day (gram)
1	Sugarcane Nira	0,357	140,06
2	Liquid Sugar	0,495	101,01
3	White Crystal Sugar	0,016	3.125

(a) **(b)**

Figure 1. (a) sugarcane juice before being processed into liquid sugar preparations; (b) liquid sugar preparations from sugarcane juice look like honey

3.2 Discussion

As for some of the chemical composition and nutritional value of sugarcane juice can be seen in the table below (Williams et al., 2018)

Table 3. Chemical Composition and Nutrition Value of Sugarcane Juice

No	Chemical composition and nutritional value	Value
1	Protein	0.16 ± 0.03 g
2	Carbohydrate	13.11 ± 0.93 g
3	Energy	242 ± 18 KJ
4	Chromium	0.33 ±0. 2 3 mg
5	Total Carotenoids	41.23 ± 4.16 µg
6	Amino Acid	1.89-5.22 g
7	Biotin (B7)	0.59 ± 0.06 µg
8	Total Folates (B9)	44.53 ± 4.14 µg
9	Total Ascorbic Acid	6.73 ± 1.56 mg

Analysis of chromium (III) of pure sugarcane juice, the preparations of liquid sugar, and white crystals sugar is indicated in Table 1 above. According to the Table, liquid sugar obtained that higher levels of chromium (III) are less advanced than pure green cane juice, but when compared with white crystals sugar, there is a higher concentration of chromium. This is because of the ability of phytoextraction from the cane plant. Fitoextraction is the plant's nature to attract the contaminant/ mineral from media, so it accumulates around the plant's roots and is subsequently transplanted into plant organs (Rebecca et al., 2018).

A person's daily need for chromium (= 11 years) is a minimum of 50 µg per day and a maximum of 200 µg per day. When the need for chromium is filled only with sugarcane juice's consumption, liquid sugar, or white crystal sugar, then the third proportion should be consumed to supply the minimum daily need for chromium (50 µg) as good as Table 2. It would be suggested that a daily requirement for chromium could be satisfied with a mere consumption of about 105 grams of sugarcane juice and 101 grams of liquid sugar. However, consuming white crystal sugar requires as much as 3,125 kgs of sugar a day. This is undoubtedly influential on the increased potential of a person affected by Diabetes Mellitus (DM) when consuming white crystal sugar (Lai et al., 2018).

Besides being able to overcome Diabetes Mellitus (DM), it turns out that the results of previous studies also prove that chromium intake can increase good cholesterol (HDL) and reduce bad cholesterol (LDL) levels in the blood. Therefore, replacing white sugarcane juice is predicted to benefit health. In the body, chromium (III) acts as a Glucose Tolerance Factor (GTF), a component on the cell's surface that, together with insulin, facilitates the entry of glucose into cells, with a mechanism as shown in Picture 1 (Idoko, 2019).

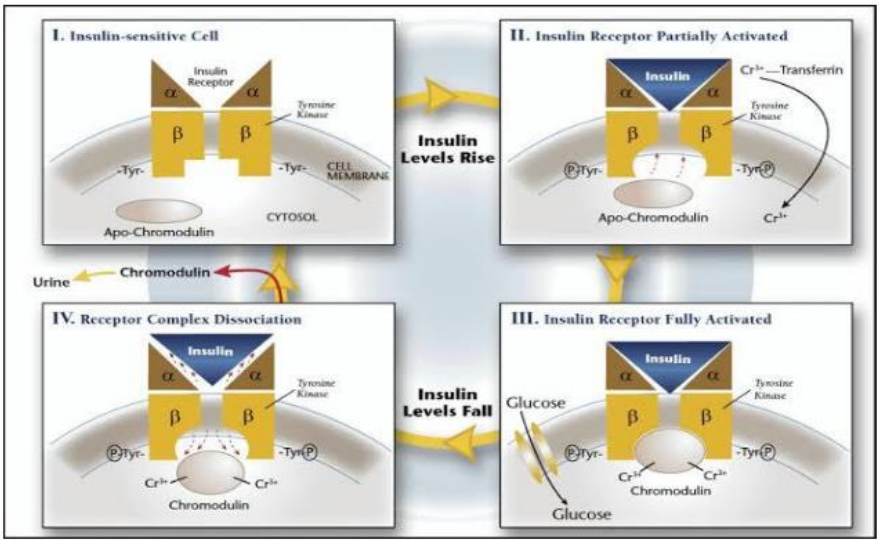

Figure 2. The Mechanism of Chromium Adsorbsion in the body and its activities in increasing Insulin Receptor (IR) sensitivities.

Once absorbed into the body, chromium ions will be bound to *apochromodulin* to create an active *chromodulin*. Furthermore, chromodulins then bind to insulin receptors and increase the activity of these receptors, which in turn increases insulin action in facilitating the entry of glucose into the cells. Experimental data in muscle cells indicate a stimulant effect of chromium (III) is highly positive as an insulin cofactor for glucose absorption into the cells; This action of chromium is also supported by data on the increased sensitivity of cells to insulin after cells receive a supply of chromium (III). As it is known, the more accessible glucose gets into the cells, the glucose level in the blood will drop, reducing the risk of developing Diabetes mellitus (Khodavirpour et al., 2020).

The results of previous studies where unprocessed Sugarcane juice contained 0.475 ppm of chromium (III) content (Wijayanti *et al*., 2019) are not much different from the results in this research where unprocessed Sugarcane juice contained 0.357 ppm of chromium (III) levels, but because this Sugarcane juice has a low shelf life, it cannot be consumed if it is oxidized and even stale. Other studies have shown that this liquid sugar preparation from Sugarcane juice has a high shelf life of about two months at room temperature and has a taste, aroma, and organoleptic shape similar to honey, so it is not easily oxidized or stale (Furqan and Maharani, 2022). So it can be said that liquid sugar preparations made from pure Sugarcane juice can reduce the potential for diabetes mellitus, or it can be claimed that this liquid sugar preparation has an anti-diabetic function.

In a comprehensive study, an investigation was carried out to discover whether the glycemic indices of sugarcane juice can be recommended as an alternative sweetener for sucrose. They suggested that the glycemic index for sugarcane was practically hypoglycemic. Thus, sugarcane can be indicated as an elective sugar for sucrose (Uma et al., 2017). The present study shows that sugarcane has the lowest glycemic index starting at 83.3 at 0 min, then honey at 84.5, and jaggery at 87.4. And after 30 minutes, sugarcane

offers the lowest mean value, 102 among all other products, i.e., 115.5, 129.6, and 102.1, respectively. After 60 minutes, sugarcane was at the peak point of the mean value of 96.1 among all other products, i.e., 106.1, 103.1, and 107.4, respectively. After 90 minutes, sugarcane was at the bottom, with the lowest glycemic index at 74.6. Thus, recommended that sugarcane juice can be used by healthy individuals (Iqbal et al., 2020).

Ingestion of sugarcane juice showed a significant increase ($P<0.05$) in blood glucose levels during and after exercise compared to SpD and PW. However, no significant difference was found between PW, SpD, and ScJ for total exercise time, heart rate, blood lactate, and plasma volume. ScJ may be equally effective as SpD and PW during exercise in a comfortable environment (<30°C) and a more effective rehydration drink than SpD and PW in post-exercise as it enhances muscle glycogen resynthesis (Kommi et al., 2018)

4. Conclusions

Liquid sugar preparations from Sugarcane juice have a chromium (III) content of 0.495 ppm, and this value is higher than pure green sugar cane at 0.357 ppm and white crystal sugar at 0.016 ppm. Based on this, the daily need for chromium can be met only by consuming about 105 grams of sugar cane juice dan 101 grams of liquid sugar. However, if you consume white crystals sugar, you need 3,125 kg of sugar per day. So it can be said that liquid sugar preparations made from pure Cane juice can reduce the potential for diabetes mellitus, or it can be claimed that this liquid sugar preparation has an anti-diabetic function.

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