Preparation of decaffeinated coffee extract: study of the effectiveness of decaffeinated coffee extract toward lowering blood sugar in type 2 diabetes mellitus patients

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ABSTRACT

Introduction: Diabetes mellitus is a disease characterized by an increase in blood sugar levels due to abnormalities in the insulin hormone system. The number of people with this disease is expected to increase every year. Therefore, it is necessary to develop diabetes mellitus drugs that have effective performance in reducing blood glucose level. Coffee contain chlorogenic acid and caffeine. Chlorogenic acid play a role in increasing insulin sensitivity. However, the caffeine causes a decrease in glucose tolerance. The removal of caffeine or the decaffeination process is expected to improve the quality of coffee as an anti-diabetic drug. The aim of this study was to investigate the effectiveness of decaffeinated coffee extract in reducing blood sugar.

Materials and Methods: Green or roasted coffee extract was decaffeinated using activated charcoal. Decaffeinated coffee extract with the lowest caffeine and the highest chlorogenic acid based on HPLC measurement was used for anti-diabetic test. The anti-diabetic test was conducted with 52 DM type 2 patient selected by purposive sample. The test were divided into two groups: intervention (26 respondents) and control group (26 respondents). The data were analysed by Paired and Independent t test.

Results: Decaffeinated green coffee extract is very suitable for use as a drug to lower blood sugar in DM type 2 patients than decaffeinated roasted coffee extract because of higher in chlorogenic acid and lower in caffeine (Figure 2). Treatment by decaffeinated green coffee extract for 3 weeks showed a significant decrease in average fasting blood glucose level from 144.7 g/dl to 92.23 g/dl. All statistical tests showed a p value = 0.001 (below the significant value), this value proves the success of reducing blood glucose by decaffeinated green coffee extract.

Conclusion: The decaffeinated green coffee extract decreases fasting blood sugar significantly.

KEYWORDS:
Green coffee, roasted coffee, chlorogenic acid, blood sugar

INTRODUCTION

Diabetes mellitus (DM) is a metabolic disease caused by insulin resistance and pancreatic B-cell dysfunction. According to WHO, DM affects 463 million patients worldwide[1], a number expected to grow to 592 million by 2035.[2] DM is high risk for stroke, kidney disease, heart and vascular disease, thus seriously affecting the quality of life and even death.[1] However, the cost of treating diabetes is relatively expensive.[3] Therefore, it is necessary to develop inexpensive and effective diabetes drugs to lower blood sugar. Coffee is a commonly consumed beverage around the world; it consists of two main components, caffeine and chlorogenic acid. Raw coffee beans without the roasting process are generally called green coffee. Green coffee contains lower caffeine than roasted coffee.[4] Meanwhile, the content of CA in green coffee is much higher than roasted coffee.[5] Studies related to the effect of caffeine on lowering glucose have been carried out. Caffeine causes a decrease in insulin sensitivity, causing a decrease in glucose tolerance.6 Meanwhile, CA plays a role in preventing insulin resistance so that it triggers a faster decrease in blood sugar.[7,8]

Decaffeination is a caffeine adsorption process so that there is a decrease in caffeine levels in solution. Several studies showed the ability to absorb caffeine using activated carbon.[9–11] The ability to absorb activated carbon is due to the pores spread over the entire surface, large surface area, and the presence of functional groups such as hydrolsil (OH), carboxylate (COOH) and carbonyl (C=O).[11–13]

In this study, the effectiveness of decaffeinated coffee extract was tested in reducing blood sugar of patients with type 2 diabetes mellitus. Treatment was carried out for 3 weeks. Blood sugar measurement using a glucometer before and after treatment with decaffeinated coffee extract.

MATERIALS AND METHODS

Material

This study uses Aceh Gayo green and roasted coffee, activated charcoal and demineralised water.

Methods

Preparation of Decaffeinated Coffee Extract

Green coffee and roasted coffee are ground using a grinder to a size of 20 mesh. Finely ground coffee weighed 200 g. Fine coffee grounds are dissolved in 80°C demineralized water. The stirring process was carried out for 30 minutes. The coffee solution obtained is filtered to separate the insoluble coffee grounds. The filtered coffee solution was added with 200 g of

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Table I: Distribution of respondents based on age (n = 52)

	Intervention group	Control group
Mean	55.1	46.09
Standar Deviasi	13.69	10.62
Min – Max	22 - 87	26 - 65
CI 95 %	49.63 - 60,68	41.79 - 50.37

Table II: Analysis of the effect of decaffeinated coffee extract in the intervention group

Glucose level	Intervention group (g/dL)			Control group (g/dL)	
	Pre-treatment	Post-treatment		First	Post
Mean	144.7	92.23	Mean	151.73	128.35
SD	26.35	16.38	SD	38.30	38.53
Min–Max	112–201	52–132	Min-Max	76–200	61–200
95 % CI	134.09–155.37	92.01–105.85	CI 95 %	135.2–167.20	112.78–143.91

Table III: Analysis of differences in fasting blood glucose level between intervention and control groups

Group	Mean	SD	SE	*p* value	N
Intervention	99.23	16.38	3.21	0.001	26
Control	128.35	38. 53	7.55		26

Table IV: Analysis of differences in fasting blood glucose level between pre and post treatment

Group	Mean	SD	SE	*p* value	N
Pre Treatment	148.23	32.73	4.54	0.001	26
Post treatment	99.23	16.38	3.21		26

activated charcoal. Stirring the mixture of coffee and activated charcoal solution was carried out for 30 minutes at 80°C. After 30 minutes, the decaffeinated coffee solution is refrigerated for 8 hours to maximise caffeine adsorption. After 8 hours of standing, the decaffeinated coffee solution was separated from the undissolved activated charcoal with Buchner filter. Then continued by HPLC testing, which was used to determine the levels of chlorogenic acid and caffeine before and after decaffeination.

Anti-diabetic Test of Decaffeinated Coffee Extract

The Quasy Experiment, pre–post with control group, was conducted among 52 respondents (type 2 DM) that were selected by purposive sampling. Decaffeinated Green coffee was carried out orally on 26 respondents who suffered from type 2 of DM for 3 weeks with a dose of 4 tablespoons every day. Blood sugar was measured with a glucometer before and after treatment (day 21). Paired t test was conducted to determine the effect of giving decaffeinated green coffee extract in the intervention group.

RESULTS

Preparation of Decaffeinated Coffee Extract

Based on Figure 1, the dissolved caffeine in roasted coffee (729.16 ppm) is higher than in green coffee (214.46 ppm). This is because the caffeine content in green coffee beans is lower than roasted coffee beans.[4,14] Caffeine content decreased after decaffeination. Caffeine in roasted coffee extract decreased from 729.16 ppm to 442.54 ppm. Caffeine in green coffee extract decreased from 214.46 ppm to 163.61 ppm. The porous surface and the content of hydroxyl (-OH) and carboxylate (-COOH) functional groups in activated charcoal play a role in the adsorption of caffeine in coffee extract.[15] The possible interaction is hydrogen bonding between the –OH group in activated carbon with the C=O group or the N atom in caffeine.[9]

Green coffee extract showed more chlorogenic acid content than roasted coffee (Figure 2). These results are in accordance with research conducted by previous studies.[5] This is because chlorogenic acid is a phenolic compound that is very sensitive to temperature. Roasting will cause damage to the structure of chlorogenic acid.[7] Figure 2 also shows that caffeine in roasted coffee extract is higher than green coffee extract. However, the content of chlorogenic acid in green coffee extract showed a higher value than roasted coffee. Decaffeinated green coffee extract is very suitable for use as a drug to lower blood sugar in DM patients than decaffeinated roasted coffee extract. Therefore, Antidiabetic testing of type 2 DM patients will only be carried out using decaffeinated green coffee extract.

Anti-diabetic Test of Green Coffee Extract

Based on Table I, the average age of the respondents in the intervention group was 55 years with a SD of 13.69 years, the youngest age was 22 years, and the oldest was 87 years. While in the control group, the average age of respondents is 46 years with a SD of 10.62 years, the youngest age is 26 years and the oldest is 65 years.

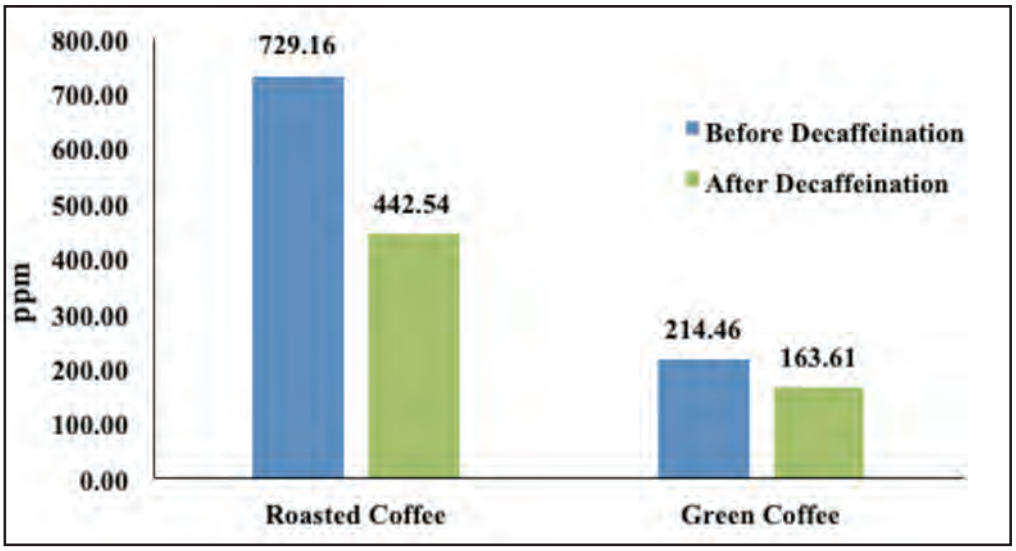

Fig. 1: Comparison of caffeine level before and after decaffeination

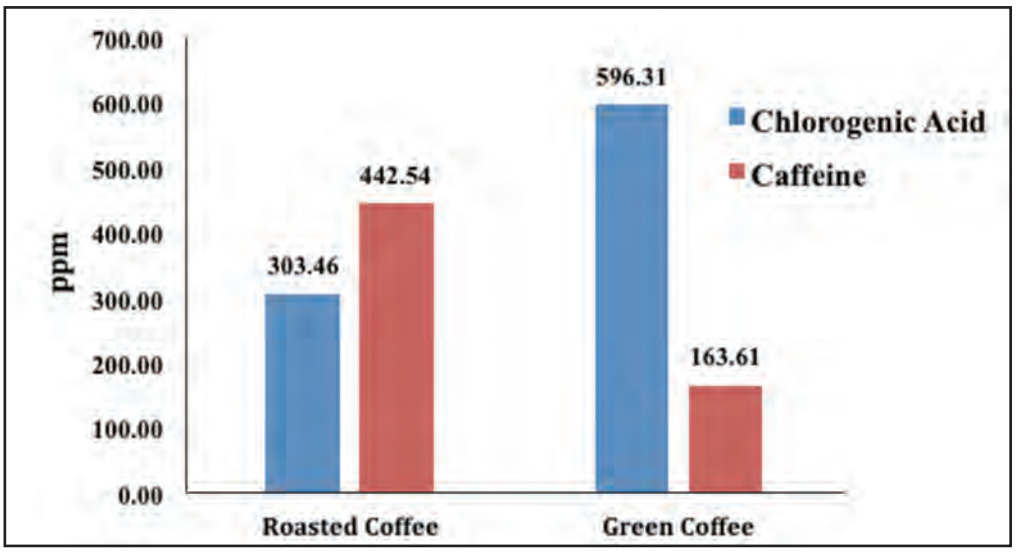

Fig. 2: Comparison of chlorogenic acid and caffeine after decaffeination

Table II showed that the the average of intervention group fasting blood glucose level before treatment was 144.7 g/dl and decreased to 92.23 g/dl. The average of fasting blood glucose level in control group was 151.73 g/dl then in the post decreased to 128.35 g/dl.

Table III showed the average fasting blood glucose level of the intervention group was 99.23 gr/dl with a standard deviation of 16.38 gr/dl, while in the control group the average fasting blood glucose level was 128.35 gr/dl with a standard deviation of 38.53 gr/dl. The results of the statistical test obtained a p value of 0.001. It can be concluded that there is a significant difference in the fasting blood glucose level of intervention group and the control group. So it can be concluded that the treatment of decaffeinated green coffee extract has an effect on decreasing fasting blood glucose level.

Table IV showed the average fasting blood glucose level in the pre-intervention measurement was 148.23 gr/dl with a standard deviation of 32.73 gr/dl, while in the post-intervention measurement the average fasting blood glucose level was 99.23 gr/dl with a standard deviation of 16.38 gr/dl. The results of the statistical test obtained a p value of 0.001 so it could be concluded that the treatment of decaffeinated green coffee extract had an effect on decreasing fasting blood sugar.

DISCUSSION

There was a decrease in blood sugar after giving decaffeinated green coffee extract in the treatment group. Decaffeinated green coffee extract contains chlorogenic acid with low caffeine. Chlorogenic acid inhibits the activation of the glucosidase enzyme so that there is a decrease in the breakdown of carbohydrates into glucose.[16–18] Caffeine has a negative effect in the form of decreasing insulin sensitivity

which interferes with glucose tolerance and increases blood glucose.[6,16] Therefore, the low caffeine in green coffee extract increases its activity in lowering blood sugar.[7] Chlorogenic acid prevents insulin resistance so that it triggers a faster decrease in blood sugar.[7,8] Chlorogenic acid also repairs the pancreas damaged by diabetes.[19] This compound is useful to prevent insulin resistance so that it triggers a faster decrease in blood sugar levels.[20] Chlorogenic acid reduces blood glucose adsorption by interfering with the active transport of glucose and increasing insulin secretion by pancreas. However, Chlorogenic acid has low stability and bioaccessibility, resulting in slower metabolism.[21]

This study is in line with research conducted by Zuñiga et al. (2018), Chlorogenic Acid also played a role in reducing fasting blood sugar that occurred in 15 patients with diabetes melitus type 2 who had been treated 3 times a day for 12 weeks in a randomized, double-blind, placebo-controlled clinical trial. In another clinical trial conducted by Roshan et al. (2018), chlorogenic acid also played a role in reducing fasting blood sugar in 21 patients with diabetes melitus type 2 with treatment 2 times a day for 8 weeks.

If a comparison is made to some of the literature, this study is superior based on the time of decreasing fasting blood sugar. Some literature shows that decreasing fasting blood sugar with chlorogenic acid treatment takes more than 1 month. Meanwhile, in this study it only took 3 weeks. This proves that the process of removing caffeine (decaffeination) is very influential on the speed of decreasing fasting blood sugar. However, this study was limited to type 2 diabetes mellitus patients. Treatment of patients with type 1 diabetes mellitus needs further research. Type 1 diabetes mellitus shows more severe pancreatic damage so that insulin production cannot be done at all.

CONCLUSION

Decaffeinated roasted coffee extract contains lower CA than green coffee extract. Decaffeinated green coffee extract showed a significant decrease in fasting blood sugar level on the Paired t test. There is a difference in blood sugar reduction between respondents in the intervention group and the control group based on the Independent t test.

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