ISSN 1978-6743
E-ISSN 2477-3948
Jurnal Ilmiah Kesehatan
(Journal of Health Science)
Fakultas Keperawatan dan Kebidanan | Universitas Nahdlatul Ulama Surabaya

Relationship Between Coffee Consumption Habits and Farmers' Blood Glucose Levels in Jenggawah Village, Jenggawah Subdistrict, Jember Regency

Sugiyanta Sugiyanta[1], Muhammad Isra Rafidin Rayyan[2], Ali Santosa[3]

[1] *Department of Biochemistry, Faculty of Medicine, University of Jember, Jember, Indonesia*
[2] *Faculty of Medicine, University of Jember, Jember, Indonesia*
[3] *Departement of Internal Medicine, dr. Soebandi Regional General Hospital-Faculty of Medicine, University of Jember, Jember, Indonesia*

ARTICLE INFORMATION

Received: June 26, 2023
Revised: August 30, 2023
Available online: November 2023

KEYWORDS

Coffee consumption; Ground coffee; Instant coffee; Blood glucose; Farmers

CORRESPONDENCE

E-mail: sugiyanta97.fk@unej.ac.id

A B S T R A C T

Diabetes mellitus (DM) is a chronic metabolic disorder and a major global problem. Coffee contains several bioactive compounds, such as caffeine, chlorogenic acid, trigonelline, cafestol, and kahweol, associated with a reduced risk of type 2 DM. This study aimed to assess the relationship between coffee consumption habits and blood glucose levels of farmers in Jenggawah Village, Jenggawah Subdistrict, Jember Regency. We used a cross-sectional study design. The sample of this study was 137 farmers who were taken by purposive sampling. Assessment of coffee consumption habits was conducted using a questionnaire. At the same time, data on random blood glucose levels were obtained from medical records of the Bakti Sosial Akbar dan Pengobatan Gratis Agromedis activities in Jenggawah Village in June 2022. Statistical analysis was performed using the Kruskall-Wallis test, and multivariate analysis using linear regression. The results showed that there was no statistically significant difference in random blood glucose levels between groups based on the variable type of coffee consumed (p=0.212), the level of coffee consumption (p=0.211), and the amount of sugar added to the coffee (p=0.086). However, the linear regression test results showed that the amount of added sugar in coffee had the greatest relationship with blood glucose levels compared to other independent variables (p=0.031). In conclusion, there was no relationship between coffee consumption habits and random blood glucose levels of farmers in Jenggawah Village. Further research is needed to confirm these findings.

INTRODUCTION

Diabetes mellitus (DM) is a chronic metabolic disorder that is a global problem with enormous social, health, and economic consequences. It is characterized by persistent hyperglycemia caused by impaired insulin secretion, insulin action, or both (Reed et al., 2021). The number of diabetes patients has been rapidly increasing across the world. The International Diabetes Federation in 2021 reported 537 million people with diabetes, predicted to increase by 783 million in 2045. Indonesia itself ranks fifth in the top 10 countries with the highest number of people with DM, with 19.5 million suffering from this disease (International Diabetes Federation, 2021). Furthermore, according to the data from Riset Kesehatan Dasar (Riskesdas) in 2018, the prevalence of diabetes mellitus based on the type of work as a farmer in Indonesia was 12.6% (Kemenkes RI, 2019).

Dietary intervention has been considered an effective strategy to prevent the occurrence of DM and its complications. Coffee is one of the most popular drinks worldwide, with an estimated consumption of 500 billion cups annually (Forouhi et al., 2018; Ramli et al., 2021). Bioactive compounds in coffee, such as caffeine, chlorogenic acid, trigonelline, cafestol, and kahweol, have received special consideration

https://doi.org/10.33086/jhs.v16.i03.4004

regarding their beneficial effects on various chronic diseases, particularly type 2 DM. Several studies have reported that dose-dependent coffee consumption has been shown to lower the risk of developing type 2 DM (Bae, 2021; Reis et al., 2019). However, many of these studies did not clearly describe the type of coffee they investigated.

Coffee processed differently can produce different chemical compositions (Shi et al., 2020). In Indonesia, processed coffee widely circulated in the market is usually available in two forms, which are ground coffee and instant coffee. Ground coffee is served by mixing ground coffee beans with boiling water. Meanwhile, most Indonesians consume instant coffee as a mixture of sugar and coffee, including 3-in-1 coffee, a mixture of coffee, sugar, and milk or creamer (Sudiyarto et al., 2012). According to one prospective cohort study conducted on the Korean population, men who consumed 3-in-1 coffee had a lower risk of developing high fasting blood glucose levels than those who did not (Tan et al., 2021). In contrast to these results, a cross-sectional study also conducted in Korea showed that 3-in-1 coffee consumption in DM patients was positively correlated with the increase in fasting blood glucose levels (Yoo & Park, 2022). This suggests that the findings are still inconclusive and further research is needed.

Jenggawah Village is in Jenggawah Subdistrict, Jember Regency. Most of the villagers of Jenggawah work as farmers or farm laborers, as many as 2,519 people, which makes this village one of the Agromedicine-fostered villages (BPS Kabupaten Jember, 2022). Given the high number of Indonesians employed in the agricultural sector, to our knowledge, there are no studies assessing the association between coffee consumption habits in farmer populations. Based on this background, we are interested in conducting further research on the relationship between coffee consumption habits and blood glucose levels among farmers in Jenggawah Village, Jenggawah Subdistrict, Jember Regency.

METHOD

This study used a cross-sectional approach to analyze the relationship between coffee consumption habits and farmers' blood glucose levels. The population of this study is all people who work as farmers and attend the Bakti Sosial Akbar dan Pengobatan Gratis Agromedis activities in June 2022 in Jenggawah Village. The inclusion criteria of this study were Jenggawah villagers who worked as farmers or farm laborers, aged ≥18 years, were willing to participate in this study and had signed the informed consent sheet. While the exclusion criteria were participants who were diagnosed with DM through history taking and blood glucose examination, consumed more than one type of coffee, and had incomplete data. Based on these criteria, 137 samples were obtained using the purposive sampling technique. This study has received ethical approval from the Health Research Ethics Commission of the Faculty of Dentistry, University of Jember, with number 1826/UN25.8/KEPK/DL/2022.

This study used a combination of primary and secondary data. The independent variables studied were coffee consumption habits assessed based on the type of coffee consumed, the level of coffee consumed daily, and the amount of added sugar in coffee obtained from filling out questionnaire sheets through interviews. The research questionnaire has been tested for validity and reliability with a corrected item-total correlation value of more than 0.3 and Cronbach's alpha value of more than 0.7. Meanwhile, the dependent variable was random blood glucose levels obtained from medical record data of the Bakti Sosial Akbar dan Pengobatan Gratis Agromedis activities in Jenggawah Village. For the assessment of coffee consumption habits, participants were asked about the type of coffee consumed, including 1) non-drinkers, 2) mixed instant coffee, and 3) ground coffee; the level of coffee consumption, comprising 1) non-drinkers, 2) <1 cups/day, 3) 1-2 cups/day, and 4) ≥3 cups/day; as well as the amount of added sugar in coffee, that is 1) non-drinkers, 2) mixed instant coffee, 3) <3 teaspoons, and 4) ≥ 3 teaspoons.

Statistical analysis was performed using SPSS version 26 (IBM Corp, Armonk, NY). The univariate analysis used in this study involved analysis of the frequency and percentage of age, gender, and coffee consumption habits. Meanwhile, bivariate analysis was conducted using the Kruskall-Wallis test with an alpha value of 0.05. Then, multivariate analysis was carried out with linear regression tests to see the relationship between several independent variables and the dependent variable, and determine which independent variable had the greatest influence on the dependent variable.

RESULT

Based on Table 1 below, most of the samples were dominated by the age group 45-64 years (63.5%), and according to gender, the proportion of samples that were female (70.1%) was greaterT compared to men (29.9%).

Table 1. Demographic characteristics of the study participants

Characteristics	Frequency (n)	Percentage (%)
Age (years)		
18-44	23	16.8
45-64	87	63.5
≥65	27	19.7
Gender		
Male	41	29.9
Female	96	70.1
Total	137	100

In addition, Table 2 demonstrates that 56 samples (40.9%) were non-coffee drinkers. By type, ground coffee was the sample's most consumed coffee (41.6%). Furthermore, according to the level of coffee consumption, most of the samples (27.7%) in this study drank 1-2 cups of coffee daily. Moreover, based on the amount of added sugar in coffee, 24 samples (17.5%) were drinkers of mixed instant coffee. In contrast, for those who consumed ground coffee, the majority (23.4%) added ≥3 teaspoons of sugar to their

https://doi.org/10.33086/jhs.v16.i03.4004

coffee. The Kruskall-Wallis test results indicated that there were no significant differences in blood glucose levels according to the type of coffee consumed (p=0.212), the level of coffee consumed daily (p=0.211), and the amount of added sugar in coffee (p=0.086).

Table 2. Kruskall-Wallis test results of the relationship between coffee consumption habits and farmers' blood glucose levels

		N (%)	Median (min-max)	P value
Types of coffee consumed	Non-coffee drinkers	56 (40.9)	116 (68-168)	0.212
	Mixed instant coffee	24 (17.5)	102.5 (77-189)	
	Ground coffee	57 (41.6)	113 (78-184)	
Coffee consumption levels	Non-coffee drinkers	56 (40.9)	116 (68-168)	0.211
	<1 cups/day	31 (22.6)	113 (77-189)	
	1-2 cups/day	38 (27.7)	106 (78-172)	
	≥3 cups/day	12 (8.8)	123 (90-178)	
Amount of added sugar in coffee	Non-coffee drinkers	56 (40.9)	116 (68-168)	0.086
	Mixed instant coffee	24 (17.5)	102.5 (77-189)	
	<3 teaspoons	25 (18.2)	107 (78-172)	
	≥3 teaspoons	32 (23.4)	117.5 (78-184)	
Total		137 (100)		

We further conducted a multivariate analysis using a linear regression test with enter method, as seen in Table 3.

Table 3. Linear regression test results of the relationship between coffee consumption habits and farmers' blood glucose levels

Variables	Standardized beta coefficient	P value
Types of coffee consumed	-0.628	0.089
Coffee consumption levels	-0.024	0.885
Amount of added sugar in coffee	0.684	0.031
F	1.728	0.164
R Square	0.038	

Table 3 indicates that simultaneously there was no significant relationship between the variables of type of coffee consumed, level of coffee consumption, and amount of added sugar in coffee with blood glucose levels (p=0.164). In addition, it is also known that the coefficient of determination or R Square is 0.038 or 3.8%, which means that all the independent variables tested have a very weak relationship with blood glucose levels. However, the analysis obtained that the variable amount of added sugar in coffee has the largest standardized beta coefficient value, which is 0.684, meaning that the more sugar added to coffee, the higher the blood glucose level of the sample (p=0.031).

DISCUSSION

This cross-sectional study investigated the relationship between coffee consumption habits and blood glucose levels in farmers not diagnosed with DM. Over the past few decades, much literature has supported the association between coffee consumption habits and a reduced risk of type 2 DM. Several mechanisms have been proposed to explain the effects of coffee consumption on glucose metabolism. Caffeine may affect blood glucose levels by decreasing appetite and increasing basal metabolic rate or

https://doi.org/10.33086/jhs.v16.i03.4004

thermogenesis by activating the sympathetic nervous system. In addition, caffeine is also known to reduce glucose production in the liver by inhibiting adenosine A2B receptors and stimulating glucose transport through the activation of cyclic adenosine monophosphate (cAMP)-dependent protein kinase α-1. However, there is evidence that acute caffeine consumption may increase postprandial blood glucose levels by transiently impairing insulin sensitivity (Feyisa et al., 2019; Kolb et al., 2021).

Chlorogenic acid and trigonelline have similar effects on glucose metabolism, reducing the digestion and absorption of carbohydrates in the gastrointestinal tract by inhibiting the enzymes amylase, α-glucosidase, and sodium-glucose cotransporter (SGLT) channels. In addition, both compounds can also inhibit glucose release in the liver by inhibiting the enzyme glucose-6-phosphatase. It has also been shown that both compounds can improve insulin sensitivity and stimulate glucose transport in skeletal muscle through adenosine monophosphate-activated protein kinase (AMPK) activation. Both caffeine, chlorogenic acid, and trigonelline can also reduce oxidative stress through their antioxidant capabilities (Lu et al., 2020; Sanlier et al., 2019; Zhou et al., 2012). Moreover, the major diterpenes in coffee, cafestol, and kahweol may also increase glucose uptake in muscle via activation of AMPK, which in turn may indirectly stimulate glycolysis via activation of the enzyme phosphofructokinase-2 (Ren et al., 2019).

Our research findings showed no significant relationship between the type of coffee consumed by the sample and blood glucose levels. This result is similar to the study by Cornelis and van Dam (2020), which showed no significant association between coffee consumption and fasting blood glucose levels, regardless of the type of coffee consumed (Cornelis & van Dam, 2020). On the other hand, a systematic review of clinical trials conducted by Reis et al. (2019) reported that short-term consumption of caffeinated coffee or black coffee might lead to an increase in the area under the curve (AUC) of glucose. While in the long term, coffee consumption can improve glucose metabolism by lowering glucose AUC and improving insulin response (Reis et al., 2019).

This study also revealed that there was no significant relationship between the level of coffee consumption and blood glucose levels. This result aligns with a study by Yamashita et al. (2012), who reported no significant correlation between coffee consumption and fasting blood glucose levels (Yamashita et al., 2012). Contrary to these results, several other observational studies have shown that coffee consumption is significantly inversely correlated with fasting blood glucose or blood glucose levels 2 hours after an oral glucose tolerance test (OGTT) (Ghavami et al., 2021; Kabeya et al., 2022; Shin et al., 2019; Takami et al., 2013; Yarmolinsky et al., 2015). In theory, coffee consumption is related to the amount of bioactive content entering the body. To date, there is no specific recommendation for coffee consumption levels to prevent type 2 DM, but a meta-analysis by Ding et al. (2014) mentioned that people who consumed 1-6 cups/day of coffee had a relative risk (RR; 95% CI) of developing diabetes of 0.92 (0.90-0.94), 0.85 (0.82-0.88), 0.79 (0.75-0.83), 0.75 (0.71-0.80), 0.71 (0.65-0.76), and 0.67 (0.61-0.74) compared to those who did

https://doi.org/10.33086/jhs.v16.i03.4004

not or rarely consumed coffee (Ding et al., 2014). However, the United States Food and Drug Administration (US FDA) states that the safe limit for adults to consume coffee is 4-5 cups/day or equivalent to 400 mg of caffeine (US FDA, 2018).

This study also found no significant relationship between the amount of added sugar in coffee and blood glucose levels. However, based on the results of multivariate analysis with linear regression test, the amount of added sugar in coffee had the greatest association with blood glucose levels compared to other independent variables studied. This finding aligns with a cross-sectional study by O'Connor et al. (2018), which showed that sugar added to coffee, tea, and cereal was positively correlated with glycemia and inflammatory markers (O'Connor et al., 2018). In addition, two other cross-sectional studies conducted in Korea showed that consumption of mixed instant coffee containing added sugar and creamer was associated with an increased risk of obesity and abdominal obesity, metabolic syndrome, decreased high-density lipoprotein (HDL) levels, increased fasting blood glucose levels, and hemoglobin A1c (HbA1C). The association observed in the study may be due to excess calorie intake from added sugar and creamer. High sugar intake can lead to an increase in glycemic index and a decrease in HDL levels by disturbing insulin sensitivity. The high saturated fatty acid content of creamer is also associated with reduced anti-inflammatory properties of HDL cholesterol (Kim et al., 2014; Yoo & Park, 2022).

The lack of a significant relationship between coffee consumption habits and blood glucose levels in this study could be due to several factors. The different species, processing methods, and brewing techniques of coffee participants consume are known to affect the quality and composition of coffee. The roasting process can reduce most of the polyphenol content in coffee while causing no significant change in caffeine content (Hu et al., 2019; Shi et al., 2020). In addition, there may be participants who forgot to recall their coffee consumption habits, so recall bias cannot be excluded from this study. The predominance of the female gender may also affect the results of this study. In women, estrogen is known to protect against insulin resistance by activating estrogen receptor α (ERα). Estrogen also has antioxidant properties that protect pancreatic β-cells from apoptosis and prevent insulin deficiency (Lionardi et al., 2020; Tramunt et al., 2020). The impact of habitual coffee consumption may also not be observed in apparently healthy samples with normal glucose metabolism (Yamashita et al., 2012). This is supported by the fact that, in general, agricultural populations have higher levels of occupational and physical activity, and healthier traditional diets than other occupation groups, which in turn have a lower risk of developing DM (Davis-Lameloise et al., 2013).

This study has several limitations; the use of a cross-sectional study design cannot determine the direction of causality because exposure and outcomes are assessed simultaneously. Also, participants were not asked to provide information on caffeine's presence, coffee consumption duration, and total daily energy intake. Other than that, we only focused on coffee consumption habits as a determinant of farmers' random blood

glucose levels, whereas there are several other important factors, such as physical activity level, smoking and alcohol consumption history, comorbidities, and certain restrictions that may alter the diet. Nevertheless, observational studies conducted directly in humans can also provide credible information because they are assessed based on clinical conditions in the community.

CONCLUSION

In conclusion, there was no significant relationship between coffee consumption habits and blood glucose levels assessed by the type of coffee consumed, the level of coffee consumption in a day, and the amount of added sugar in coffee. However, the results of multivariate analysis showed that the amount of added sugar in coffee had the highest relationship with blood glucose levels than other independent variables. Further observational studies or clinical trials with a randomized controlled trial (RCT) design and a larger sample considering other factors not examined in this study are needed to determine a more precise relationship.

REFERENCES

Bae, J.-M. (2021). Coffee consumption and risk of type 2 diabetes mellitus in Asians: A meta-epidemiological study of population-based cohort studies. *World Journal of Diabetes*, *12*(6), 908–915. https://doi.org/10.4239/wjd.v12.i6.908

BPS Kabupaten Jember. (2022). *KECAMATAN JENGGAWAH DALAM ANGKA*.

Cornelis, M. C., & van Dam, R. M. (2020). Habitual Coffee and Tea Consumption and Cardiometabolic Biomarkers in the UK Biobank: The Role of Beverage Types and Genetic Variation. *The Journal of Nutrition*, *150*(10), 2772–2788. https://doi.org/10.1093/jn/nxaa212

Davis-Lameloise, N., Philpot, B., Janus, E. D., Versace, V. L., Laatikainen, T., Vartiainen, E. A., & Dunbar, J. A. (2013). Occupational differences, cardiovascular risk factors and lifestyle habits in South Eastern rural Australia. *BMC Public Health*, *13*, 1090. https://doi.org/10.1186/1471-2458-13-1090

Ding, M., Bhupathiraju, S. N., Chen, M., van Dam, R. M., & Hu, F. B. (2014). Caffeinated and decaffeinated coffee consumption and risk of type 2 diabetes: a systematic review and a dose-response meta-analysis. *Diabetes Care*, *37*(2), 569–586. https://doi.org/10.2337/dc13-1203

Feyisa, T. O., Melka, D. S., Menon, M., Labisso, W. L., & Habte, M. L. (2019). Investigation of the effect of coffee on body weight, serum glucose, uric acid and lipid profile levels in male albino Wistar rats feeding on high-fructose diet. *Laboratory Animal Research*, *35*(1), 29. https://doi.org/10.1186/s42826-019-0024-y

Forouhi, N. G., Misra, A., Mohan, V., Taylor, R., & Yancy, W. (2018). Dietary and nutritional approaches for prevention and management of type 2 diabetes. *BMJ (Clinical Research Ed.)*, *361*, k2234. https://doi.org/10.1136/bmj.k2234

Ghavami, H. S., Khoshtinat, M., Sadeghi-Farah, S., Kalimani, A. B., Ferrie, S., & Faraji, H. (2021). The relationship of coffee consumption and CVD risk factors in elderly patients with T2DM. *BMC Cardiovascular Disorders*, *21*(1), 241. https://doi.org/10.1186/s12872-021-02058-7

Hu, G. L., Wang, X., Zhang, L., & Qiu, M. H. (2019). The sources and mechanisms of bioactive ingredients in coffee. *Food Funct.*, *10*(6), 3113–3126. https://doi.org/10.1039/C9FO00288J

International Diabetes Federation. (2021). *IDF Diabetes Atlas* (10th ed.). International Diabetes Federation. www.diabetesatlas.org

Kabeya, Y., Goto, A., Kato, M., Takahashi, Y., Isogawa, A., Matsushita, Y., Mizoue, T., Inoue, M., Sawada, N., Kadowaki, T., Tsugane, S., & Noda, M. (2022). Cross-sectional associations between the types/amounts of beverages consumed and the glycemia status: The Japan Public Health Center-based Prospective Diabetes study. *Metabolism Open*, *14*, 100185. https://doi.org/10.1016/j.metop.2022.100185

Kemenkes RI. (2019). *Laporan Nasional Riskesdas 2018*. Lembaga Penerbit Badan Penelitian dan Pengembangan Kesehatan.

Kim, H.-J., Cho, S., Jacobs, D. R. J., & Park, K. (2014). Instant coffee consumption may be associated with higher risk of metabolic syndrome in Korean adults. *Diabetes Research and Clinical Practice*, *106*(1), 145–153. https://doi.org/10.1016/j.diabres.2014.07.007

Kolb, H., Martin, S., & Kempf, K. (2021). Coffee and Lower Risk of Type 2 Diabetes: Arguments for a Causal Relationship. *Nutrients*, *13*(4). https://doi.org/10.3390/nu13041144

Lionardi, D., Ginting, C. N., & Chiuman, L. (2020). Correlation Between Blood Glucose and Estradiol Levels in Women in Reproductive Age. *Bandung Medical Journal*, *52*(3), 139–143. https://doi.org/https://doi.org/10.15395/mkb.v52n3.2079

Lu, H., Tian, Z., Cui, Y., Liu, Z., & Ma, X. (2020). Chlorogenic acid: A comprehensive review of the dietary sources, processing effects, bioavailability, beneficial properties, mechanisms of action, and future directions. *Comprehensive Reviews in Food Science and Food Safety*, *19*(6), 3130–3158. https://doi.org/10.1111/1541-4337.12620

O'Connor, L., Imamura, F., Brage, S., Griffin, S. J., Wareham, N. J., & Forouhi, N. G. (2018). Intakes and sources of dietary sugars and their association with metabolic and inflammatory markers. *Clinical Nutrition (Edinburgh, Scotland)*, *37*(4), 1313–1322. https://doi.org/10.1016/j.clnu.2017.05.030

Ramli, N. N. S., Alkhaldy, A. A., & Mhd Jalil, A. M. (2021). Effects of Caffeinated and Decaffeinated Coffee Consumption on Metabolic Syndrome Parameters: A Systematic Review and Meta-Analysis of Data from Randomised Controlled Trials. *Medicina (Kaunas, Lithuania)*, *57*(9). https://doi.org/10.3390/medicina57090957

Reed, J., Bain, S., & Kanamarlapudi, V. (2021). A Review of Current Trends with Type 2 Diabetes Epidemiology, Aetiology, Pathogenesis, Treatments and Future Perspectives. *Diabetes, Metabolic Syndrome and Obesity : Targets and Therapy*, *14*, 3567–3602. https://doi.org/10.2147/DMSO.S319895

Reis, C. E. G., Dórea, J. G., & da Costa, T. H. M. (2019). Effects of coffee consumption on glucose metabolism: A systematic review of clinical trials. *Journal of Traditional and Complementary Medicine*, *9*(3), 184–191. https://doi.org/10.1016/j.jtcme.2018.01.001

Ren, Y., Wang, C., Xu, J., & Wang, S. (2019). Cafestol and Kahweol: A Review on Their Bioactivities and Pharmacological Properties. *International Journal of Molecular Sciences*, *20*(17). https://doi.org/10.3390/ijms20174238

Sanlier, N., Atik, A., & Atik, I. (2019). Consumption of green coffee and the risk of chronic diseases. *Critical Reviews in Food Science and Nutrition*, *59*(16), 2573–2585. https://doi.org/10.1080/10408398.2018.1461061

Shi, L., Brunius, C., Johansson, I., Bergdahl, I. A., Rolandsson, O., van Guelpen, B., Winkvist, A., Hanhineva, K., & Landberg, R. (2020). Plasma metabolite biomarkers of boiled and filtered coffee intake and their association with type 2 diabetes risk. *Journal of Internal Medicine*, *287*(4), 405–421. https://doi.org/https://doi.org/10.1111/joim.13009

Shin, S., Lim, J., Lee, H.-W., Kim, C. E., Kim, S.-A., Lee, J.-K., & Kang, D. (2019). Association between the prevalence of metabolic syndrome and coffee consumption among Korean adults: results from the Health Examinees study. *Applied Physiology, Nutrition, and Metabolism = Physiologie Appliquee, Nutrition et Metabolisme*, *44*(12), 1371–1378. https://doi.org/10.1139/apnm-2018-0880

Sudiyarto, S., Widayanti, S., & Kresna, D. M. (2012). Perilaku Konsumen Penikmat Kopi Tubruk dan Kopi Instan. *Jurnal Sosial Ekonomi Pertanian (JSEP)*, *6*(3).

Takami, H., Nakamoto, M., Uemura, H., Katsuura, S., Yamaguchi, M., Hiyoshi, M., Sawachika, F., Juta, T., & Arisawa, K. (2013). Inverse correlation between coffee consumption and prevalence of metabolic syndrome: baseline survey of the Japan Multi-Institutional Collaborative Cohort (J-MICC) Study in Tokushima, Japan. *Journal of Epidemiology*, *23*(1), 12–20. https://doi.org/10.2188/jea.je20120053

Tan, L.-J., Jeon, H. J., Park, S., Kim, S.-A., Lim, K., Chung, S., Chang, P.-S., Lee, J.-K., Kang, D., & Shin, S. (2021). Association of Coffee Consumption and Its Types According to Addition of Sugar and Creamer with Metabolic Syndrome Incidence in a Korean Population from the Health Examinees (HEXA) Study. *Nutrients*, *13*(3). https://doi.org/10.3390/nu13030920

Tramunt, B., Smati, S., Grandgeorge, N., Lenfant, F., Arnal, J.-F., Montagner, A., & Gourdy, P. (2020). Sex differences in metabolic regulation and diabetes susceptibility. *Diabetologia*, *63*(3), 453–461. https://doi.org/10.1007/s00125-019-05040-3

US FDA. (2018). *Spilling the Beans: How Much Caffeine is Too Much?* Food & Beverages. https://www.fda.gov/consumers/consumer-updates/spilling-beans-how-much-caffeine-too-much

Yamashita, K., Yatsuya, H., Muramatsu, T., Toyoshima, H., Murohara, T., & Tamakoshi, K. (2012). Association of coffee consumption with serum adiponectin, leptin, inflammation and metabolic markers in Japanese workers: a cross-sectional study. *Nutrition & Diabetes*, *2*(4), e33. https://doi.org/10.1038/nutd.2012.6

Yarmolinsky, J., Mueller, N. T., Duncan, B. B., Bisi Molina, M. D. C., Goulart, A. C., & Schmidt, M. I. (2015). Coffee Consumption, Newly Diagnosed Diabetes, and Other Alterations in Glucose Homeostasis: A Cross-Sectional Analysis of the Longitudinal Study of Adult Health (ELSA-Brasil). *PloS One*, *10*(5), e0126469. https://doi.org/10.1371/journal.pone.0126469

Yoo, H., & Park, K. (2022). Sugar-Sweetened Coffee Intake and Blood Glucose Management in Korean Patients with Diabetes Mellitus. *Metabolites*, *12*(12). https://doi.org/10.3390/metabo12121177

Zhou, J., Chan, L., & Zhou, S. (2012). Trigonelline: a plant alkaloid with therapeutic potential for diabetes and central nervous system disease. *Current Medicinal Chemistry*, *19*(21), 3523–3531. https://doi.org/10.2174/092986712801323171