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Research Article
The Potential of Indonesian Honey to Change the Lipid Profiles of Individuals with Central Obesity

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Abstract

Background and Objective: Honey has the ability to improve lipid profiles and influence cholesterol and triglyceride levels in individual with central obesity. Central obesity can be defined as visceral fat accumulation in the upper part of the body. This study was conducted to analyze the effect of the administration of 70 g of honey per day for two months on lipid profiles in patients with central obesity. **Materials and Methods:** This study had a quasi-experimental design, with a non randomized group with pre- and post tests. The sample population consisted of 25 subjects who received the intervention and 25 control subjects. The intervention group was administered honey and provided obesity education. The control group only received obesity education. The 70 g of honey was administered in 250 mL of water each day for 60 days, while obesity education was provided three times within the study period. Total cholesterol, LDL, HDL and triglyceride levels were assessed in both the intervention and control groups as outcomes. The Wilcoxon and Mann-Whitney tests were used to analyze the data. **Results:** There were no significant differences between the intervention group and the control group in terms of age, BMI, waist circumference and lipid profile before the intervention ($p>0.05$). The main effects in the intervention group were reduced levels of total cholesterol (2.25 ± 9.7, $p = 0.33$) and LDL (1.85 ± 13.2, $p = 0.4$). The total amount of honey consumed, which was $\geq$4000 g in the intervention group, showed that total cholesterol ($p = 0.00$), LDL ($p = 0.00$) and HDL ($p = 0.00$) levels differed significantly before and after treatment, with decreases of 6.96 ± 7.26, 8.87 ± 9.79 and 10.9 ± 8.97, respectively. A non-significant difference was found in the triglyceride level of 14.9 ± 27.57 ($p = 0.36$). **Conclusion:** The administration of honey produced in Indonesia significantly reduced the levels of total cholesterol, LDL and HDL in individuals with central obesity; the level of triglyceride was not affected.

Key words: Central obesity, cholesterol, HDL, honey, LDL, lipid profile

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Competing Interest: The authors have declared that no competing interest exists.

Data Availability: All relevant data are within the paper and its supporting information files.

INTRODUCTION

One of the substances that can potentially be used as a natural and inexpensive remedy to improve lipid profiles in the blood is honey[1]. Honey is a food that has been used as a natural medicine in addition to functioning as a sweetener in a normal healthy diet[2,3]. Honey is known to improve lipid profiles and influence cholesterol and triglyceride levels. Therefore, it may help reduce the risk of cardiovascular disease, especially in people with obesity[4-7].

Obesity has become a health and nutrition problem in both developed and developing countries. Compared with individuals with general obesity, those with central obesity have a much higher risk of death related to health issue[8]. Increased accumulation of visceral fat is a risk factor for cardiovascular disease, dyslipidemia, hypertension, stroke and type 2 diabetes[9]. Central obesity causes changes in lipid metabolism, including increased triglyceride levels, decreased HDL-C levels and increased numbers of small and dense LDL particles[1].

The administration of honey to adults resulted in significant improvements in their lipid profiles[10]. The high level of antioxidant activity of honey due to its polyphenol content, especially the high levels of flavonoids, may explain the ability of honey to improve lipid profiles[11,12]. Flavonoids inhibit lipid peroxidation that can alter lipid levels in the body[13,14].

However, the effect of honey depends on the origin of the honey. The quality and composition of honey are influenced by several factors, such as the pollen, season, soil type and weather[15-17]. Prior to the present study, no evidence of the ability of Indonesian honey to decrease blood lipid levels existed. At the same time, the results of antioxidant analyses have shown that Indonesian honey has elevated antioxidant activity[18-20]. The aim of this study was to analyze the effect of the administration of 70 g of honey per day for two months on the lipid profiles of patients with central obesity.

MATERIALS AND METHODS

Research design: This was an experimental study with a quasi-experimental design. The study involved a nonrandomized group with pre- and posttests.

Study population: The sample population consisted of all employees of the Ministry of Finance in South Sulawesi Province who met the inclusion criteria. The included participants were 25-60 years old, had abdominal circumferences $\geq$100 cm for men and $\geq$90 cm for women, were willing to consume honey for 60 days, did not receive medical treatments or other alternative therapies and were not allergic to honey. Employees who received medication for heart problems, hypertension, diabetes mellitus and other conditions during the study period, those who were pregnant and those who suffered from degenerative diseases such as coronary heart disease and diabetes mellitus were excluded from the study. The sample population consisted of 50 people divided into the intervention and control groups. Each subject selected as a participant signed an informed consent form after having received a clear explanation of the purpose and design of the study.

Data collection: Waist circumference, weight and blood pressure measurements were performed in accordance with standard procedures[21]. Measurements were taken 3 times before honey was administered, midway through the course of honey administration and after the course was completed. In addition, 24 h dietary recall surveys were administered to measure the quality and quantity of the food consumed by the respondents for 3 days (2 working days and 1 non working day). The lipid profile and blood glucose tests were performed at the Prodia Makassar Laboratory. Subjects were asked to fast for 8-12 h before blood was collected. Blood samples were collected via the extraction of 5 cc of blood from the median cubital vein into a labeled tube. The samples were then sent to the PRODIA laboratory. Blood samples were collected before the subjects consumed honey and on the 61st day after the subjects started the course of honey consumption. Total cholesterol, LDL and HDL levels were assessed via a homogeneous GPO-PAP test intended to determine the levels of triglycerides[22].

The intervention group was administered honey and provided with obesity education, while the control group only received obesity education. Obesity education materials with information about obesity control, the prevention of complications, regular physical activity and nutrition were provided three times during the study period. Educational intervention session lasted at least 15 min and had a maximum of two participants per session. The key recommendations contained in the materials were explained to the subjects. A short message was also sent to each subject every day to remind them of the importance of healthy eating and physical activity.

The honey was from healthy *Apis melifera* in Bima, West Nusa Tenggara and distributed by the health clinic PT Indonesia Sehat Sejahtera. Each day for 60 days, 70 g of honey was consumed in 250 mL of water. Subjects were trained to prepare the honey before they consumed it at home. A short reminder message was sent every day and meetings were conducted every week to monitor the honey intake of the participants. Fourteen subjects succeeded in consuming ≥4000 g of honey during the study period.

Ethical approval number: This study was approved by the ethics committee of Hasanuddin University, Faculty of Medicine with the registration number UH13080316.

Data analysis: The relatively small sample size and nonnormal distribution of the total cholesterol, LDL, HDL and triglyceride data meant that the Wilcoxon and Mann-Whitney tests were used in SPSS, with significance indicated by $p<0.05$.

RESULTS

Subject characteristics: There were 46 individual participants; 23 individuals were in the intervention group and another 23 participants were in the control group. The average age of the subjects in the intervention group was 39.7 years and the average age of the subjects in the control group was 44 years. The total energy intake in the intervention group was greater than 1592 kilocalories and the control group's energy intake was 1481.2 kilocalories. Compared to subjects in the control group, those in the intervention group were more active (363.8 vs. 615.7 MET), heavier (72.3 vs. 75.2 kg), taller (156 vs. 161.6 cm) and had higher triglyceride levels (133.7 vs. 153.6 mg dL^{-1}). The participants in the intervention group had an average waist circumference of 94.4 cm, BMI of 28.9, fasting blood sugar level of 93.4 mg dL^{-1}, LDL level of 141.3 mg dL^{-1} and HDL level of 49.4 mg dL^{-1}. Those in the control group had an average waist circumference of 95 cm, BMI of 29.6, fasting blood sugar level of 97.9 mg dL^{-1}, LDL level of 155.7 mg dL^{-1} and HDL level of 50.4 mg dL^{-1}. With regard to these characteristics, there were no significant differences between the intervention and control groups ($p<0.05$) (Table 1).

Lipid profiles and honey consumption: The levels of total cholesterol ($p = 0.95$), LDL ($p = 0.17$), HDL ($p = 0.72$) and triglycerides ($p = 0.35$) did not differ significantly between the intervention group and the control group after treatment (Table 2).

However, after analyzing the differences in the variables before and after the consumption of honey in the intervention group, it was found that there were decreases in the levels of total cholesterol (2.25±9.7, $p = 0.33$) and LDL cholesterol (1.85±13.2, $p = 0.4$), although it was not significant. A significant decrease occurred in the level of HDL cholesterol (7.6±9.07, $p = 0.00$), whereas there was a non-significant increase in the level of triglycerides (13.4±31.2; $p = 0.4$). In the

Table 1: Comparison of respondent characteristics between the intervention and control groups

	Intervention group (n=23)		Control group (n=23)		
Variables	Mean	SD	Mean	SD	p-value
Age (year)	39.70	9.24	44.00	9.80	0.08
Energy Intake (kcal)	1592.00	399.90	1481.20	400.70	0.50
Physical activity (MET)	615.70	266.20	568.90	363.80	0.38
Waist circumference (cm)	94.40	7.70	95.00	7.60	0.75
Weight (kg)	75.20	11.28	72.30	11.30	0.29
Height (cm)	161.60	9.97	156.00	8.00	0.08
BMI (kg/m^2)	28.90	3.30	29.57	3.00	0.39
Fasting blood glucose (mg dL^{-1})	93.40	13.70	97.86	16.60	0.31
Total cholesterol	214.90	42.40	234.20	4.,80	0.12
LDL	141.30	34.70	155.70	35.60	0.18
HDL	49.40	11.80	50.43	9.02	0.58
Triglycerides	153.57	74.57	133.70	40.40	0.74

Table 2: Weight, waist circumference, BMI, blood glucose levels and lipid profiles in the intervention group (honey) and control group

	Group Intervention			Group control			p-value
Variables	Pre	Post	p-value	Pre	Post	p-value	(Intervention vs control)
Weight (kg)	75.25±11.3	75.04±11.7	0.38	72.30±11.3	72.00±11.3	0.23	0.87
Waist circumference (cm)	94.40±7.6	92.80±8.85	0.01	95.00±7.6	93.70±7.6	0.28	0.56
BMI (kg/m^2)	28.90±3.3	28.80±3.36	0.14	29.50±3	29.40±3	0.30	0.76
Fasting blood glucose (mg dL^{-1})	93.39±13.7	91.00±13.3	0.23	97.86±16.6	96.13±15.6	0.79	0.58
Total cholesterol	212.60±43.02	207.30±38.2	0.33	234.20±40.8	218.70±35	0.01	0.95
LDL	141.30±34.7	137.40±33.3	0.40	155.70±35.6	145.90±28.7	0.00	0.17
HDL	49.40±11.8	45.60±11.7	0.00	50.43±9.02	46.00±8.5	0.00	0.72
Triglycerides	153.57±74.6	162.40±59.7	0.40	133.70±40.4	155.80±48.6	0.01	0.35

Table 3: Weight, waist circumference, BMI and the levels of blood glucose, total cholesterol, LDL, HDL and triglycerides in the intervention group (Honey ≥4000 g)

	Intervention group (honey) ≥4000 g (n=14)			
Variables	Pre-test	Post-test	Δ	p-value
Weight (kg)	74.65±8.8	74.5±9.03	0.26±1.87	0.53
Waist circumference (cm)	93.90±7.6	92.5±7.9	1.56±3.98	0.16
BMI (kg/m^2)	29.10±3.4	28.9±3.31	0.41±1,81	0.33
Fasting blood glucose (mg dL^{-1})	88.14±10.5	85.6±5.9	2.04±8.41	0.39
Total cholesterol	231.50±45.6	215.3±46.2	6.96±7.26	0.00
LDL	155.40±37.8	141.9±40,3	8.87±9.79	0.00
HDL	52.10±12.7	46.8±13.6	10.90±8.97	0.00
Triglycerides	154.80±84.2	167.9±72.5	14.90±27.57	0.36

control group, the total cholesterol level decreased significantly during the study period (p = 0.01), as did the levels of LDL (p = 0.00) and HDL cholesterol (p = 0.000), whereas the level of triglycerides significantly increased (p = 0.01).

Therefore, the consumption of ≥4,000 g of honey by the intervention group (Table 3) resulted in significant changes in the levels of total cholesterol (p = 0.00), LDL cholesterol (p = 0.00) and HDL cholesterol (p = 0.00), with decreases of 6.96±7.26, 8.87±9.79 and 10.9±8.97, respectively. Meanwhile, triglyceride levels did not changes over the course of the study (p = 0.36), with an average difference of 14.9±27.57.

DISCUSSION

The results show that the total cholesterol and LDL cholesterol levels decreased both in the intervention and control groups but the decreases were significant only in the control group. Significant decreases were also found in the HDL cholesterol levels in the intervention and control groups, while the triglyceride levels increased in both groups, although the increase was only significant in the control group. Significant decreases in the levels of total and LDL cholesterol were found in the intervention group (consumed ≥4000 g of honey) and the control group. However, in the intervention group, the total cholesterol and LDL cholesterol levels changed over the course of the intervention, with decreases of 6.96±7.26 and 8.87±9.79, which were much decreased than were observed in the control group (6.21±7.13 and 5.14±11.8).

Compared to the control group, which was administered sucrose, the intervention group had a lower level of total cholesterol, although the difference was not significant. The study by Mushtaq *et al.*[10] showed that honey intake significantly reduced the total cholesterol levels in male and female obese subjects in Baloch and Punjabi and in female subjects in Hazara[10]. Nevertheless, in those two previously mentioned studies, the triglycerides in the intervention group decreased significantly while the HDL cholesterol level increased significantly[7].

In this study, the triglyceride levels increased both in the intervention and control groups. The increase was significant only in the control group. The HDL cholesterol levels significantly decreased in both groups. The decrease in the level of HDL cholesterol was larger in the control group than in the intervention group, although the difference was not significant. In this study, the amount of carbohydrates consumed increased significantly in the intervention and control groups. The average carbohydrate intake was higher in the intervention group than that of the control group.

When there is excess food intake, free fatty acids are released from adipose tissue, increasing the production of glucose and triglycerides and the secretion of VLDL in the liver[23-25]. Thus, lipid or lipoprotein abnormalities, including decreased HDL cholesterol and increased LDL cholesterol levels, may be due to the high levels carbohydrate intake in the intervention and control groups.

Carbohydrate intake can also influence antioxidant enzymes. Consumption of carbohydrates decreased the activity of antioxidant enzymes in diabetic rats[26]. The increase in the average carbohydrate intake was significantly greater in the intervention group than in the control group. However, the decreases in the total cholesterol and LDL cholesterol levels were greater in the intervention group that consumed ≥4000 g of honey than that of the control group. This is probably due to the antioxidant role of honey.

Polyphenols are important ingredients in honey and the composition of polyphenols can differ in different types of honey[27,28]. The polyphenols in honey are primarily flavonoids (such as quercetin, luteolin, kaempferol, apigenin, chrysin and galangin), phenolic acids and phenolic acid derivatives, which are antioxidants[29]. There are significant correlations between the antioxidant activity and the polyphenol content in honey and the inhibition of lipoprotein oxidation in vitro in human serum[30]. The honey used in this study was produced in Indonesia by *A. melifera*. The quality of the honey, including the polyphenol content and antioxidant activity, is influenced by the environment in which the bees live, including the climate and species of plants supplying the pollen[16,31]. The percentage free radical capture of the honey used in this study (1000 μg mL^{-1}) is 17.90%, which is 10.16% greater than the free radical captured by honey (7.74%) used in previous studies[32].

However, increasing the concentration of honey does not seem to change the percentage free radical capture, which is 58.1% in the honey used in this study and 61.85% in the honey used in the previous study[33]. This study suggests that Indonesian honey has the potential to improve lipid profiles in patients with central obesity. Therefore, it can be used as an alternative treatment for cardiovascular disease. However, to examine whether the antioxidants in honey influence the body, it is necessary to conduct analyses of MDA malondialdehyde (MDA) in future studies.

CONCLUSION

Consumption of healthy honey produced in Indonesia can significantly reduce the total cholesterol, LDL and HDL levels but not the triglyceride level. The mechanisms underlying these effects should be investigated.

SIGNIFICANCE STATEMENT

This study revealed the possible strong antioxidant effect of Indonesian honey, which may be beneficial for improving lipid profiles in individuals with central obesity. The effect of the honey depends on its origin. This study is the first to indicate that Indonesian honey has the ability to decrease blood lipid levels. This study will help researchers uncover critical mechanisms by which Indonesian honey may improve lipid profiles in people with central obesity, which have not been previously explored. Thus, a new use for Indonesian honey and the possibility of improving lipid profiles in individuals with central obesity have been revealed.

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REFERENCES

1. Adiatmaja, I.B., 2004. Analisis faktor risiko yang berpengaruh terhadap skor kardiovaskular Jakarta dan Skor framingham pada Pekerja PT X-Jakarta. Ph.D. Thesis, Universitas Indonesia, Jakarta.
2. Eteraf-Oskouei, T. and M. Najafi, 2013. Traditional and modern uses of natural honey in human diseases: A review. Iran. J. Basic Med. Sci., 16: 731-742.
3. Requier, F., J.F. Odoux, T. Tamic, N. Moreau, M. Henry, A. Decourtye and V. Bretagnolle, 2015. Honey bee diet in intensive farmland habitats reveals an unexpectedly high flower richness and a major role of weeds. Ecol. Applic., 25: 881-890.
4. Al-Waili, N.S., 2004. Natural honey lowers plasma glucose, C-reactive protein, homocysteine and blood lipids in healthy, diabetic and hyperlipidemic subjects: Comparison with dextrose and sucrose. J. Med. Food, 7: 100-107.
5. Majid, M., M.A. Younis, A.K. Naveed, M.U. Shah, Z. Azeem and S.H. Tirmizi, 2013. Effects of natural honey on blood glucose and lipid profile in young healthy Pakistani males. J. Ayub Med. College Abbottabad, 25: 44-47.
6. Munstedt, K., S. Hoffmann, A. Hauenschild, M. Bulte, R. von Georgi and A. Hackethal, 2009. Effect of honey on serum cholesterol and lipid values. J. Med. Food, 12: 624-628.
7. Yaghoobi, N., N. Al-Waili, M. Ghayour-Mobarhan, S.M.R. Parizadeh and Z. Abasalti *et al*., 2008. Natural honey and cardiovascular risk factors; effects on blood glucose, cholesterol, triacylglycerole, CRP and body weight compared with sucrose. Scient. World J., 8: 463-469.
8. Balkau, B., J.E. Deanfield, J.P. Despres, J.P. Bassand and K.A. Fox *et al*., 2007. International Day for the Evaluation of Abdominal Obesity (IDEA): A study of waist circumference, cardiovascular disease and diabetes mellitus in 168000 primary care patients in 63 countries. Circulation, 116: 1942-1951.
9. Aronne, L.J. and K.R. Segal, 2002. Adiposity and fat distribution outcome measures: Assessment and clinical implications. Obesity Res., 10: 14S-21S.
10. Mushtaq, R., R. Mushtaq and Z.T. Khan, 2011. Effects of natural honey on lipid profile and body weight in normal weight and obese adults: A randomized clinical trial. Pak. J. Zool., 43: 161-169.
11. Ahmed, S., S.A. Sulaiman, A.A. Baig, M. Ibrahim and S. Liaqat *et al*., 2018. Honey as a potential natural antioxidant medicine: An insight into its molecular mechanisms of action. Oxidat. Oxidat. Med. Cell. Longevity, Vol. 2018. 10.1155/2018/8367846
12. Khalil, M.I. and S.A. Sulaiman, 2010. The potential role of honey and its polyphenols in preventing heart diseases: A review. Afr. J. Tradit. Complement Altern. Med., 7: 315-321.

13. Ghaffari, M.A. and M. Shanaki, 2010. Evalution of *in vitro* effect of flavonoids on human low-density lipoprotein carbamylation. Iran. J. Pharm. Res., 9: 67-74.
14. Viuda-Martos, M., Y. Ruiz-Navajas, J. Fernandez-Lopez and J.A. Perez-Alvarez, 2008. Functional properties of honey, propolis and royal jelly. J. Food Sci., 73: R117-R124.
15. Adgaba, N., A. Al-Ghamdi, Y. Tadesse, A. Getachew and A.M. Awad *et al*., 2017. Nectar secretion dynamics and honey production potentials of some major honey plants in Saudi Arabia. Saudi J. Biol. Sci., 24: 180-191.
16. El Sohaimy, S.A., S.H.D. Masry and M.G. Shehata, 2015. Physicochemical characteristics of honey from different origins. Ann. Agric. Sci., 60: 279-287.
17. Soares, S., D. Pinto, F. Rodrigues, R.C. Alves and M.B.P.P. Oliveira, 2017. Portuguese honeys from different geographical and botanical origins: A 4-year stability study regarding quality parameters and antioxidant activity. Molecules, Vol. 22. 10.3390/molecules22081338
18. Chayati, I. and I. Miladiyah, 2014. Study of phenolic compounts, total phenolic and antioxidant activities of monofloral honeys from some areas in Java and Sumatera. MGMI., 6: 11-24.
19. Marianti, A., N.R. Utami and W. Christijanti, 2013. Aktivitas antioksidan madu floral terhadap profil lipid darah tikus putih hiperlipidemik. Sainteknol, 11: 1-8.
20. Sumarlin, L.O., A. Muawanah, P. Wardhani and Masitoh, 2014. Anticancer and antioxidant activity of honey in the market local Indonesia. J. Ilmu Pertan Indones, 9: 136-144.
21. KRI. and RKDT., 2013. Badan penelitian dan pengembangan Kesehatan. Departemen Kesehatan, Kemenkes RI and Riset Kesehatah Dasar Tahun, Republik of Indonesia.
22. Nauck, M., G.R. Warnick and N. Rifai, 2002. Methods for measurement of LDL-cholesterol: A critical assessment of direct measurement by homogeneous assays versus calculation. Clin. Chem., 48: 236-254.
23. Boden, G., 2008. Obesity and free fatty acids. Endocrinol. Metab. Clin. North Am., 37: 635-646.
24. Saponaro, C., M. Gaggini, F. Carli and A. Gastaldelli, 2015. The subtle balance between lipolysis and lipogenesis: A critical point in metabolic homeostasis. Nutrients, 7: 9453-9474.
25. Sondermeijer, B.M., S. Battjes, T.H. van Dijk, M.T. Ackermans and M.J. Serlie *et al*., 2013. Lactate increases hepatic secretion of VLDL-triglycerides in humans. Atherosclerosis, 228: 443-450.
26. McDermott, B.M., J.J. Strain and P.R. Flatt, 1995. Effects of dietary carbohydrate intake on antioxidant enzyme activity and copper status in the copper-deficient streptozotocin (STZ) diabetic rat. J. Nutr. Biochem., 6: 638-643.
27. Hossen, M.S., M.Y. Ali, M.H.A. Jahurul, M.M. Abdel-Daim, S.H. Gan and M.I. Khalil, 2017. Beneficial roles of honey polyphenols against some human degenerative diseases: A review. Pharmacol. Rep., 69: 1194-1205.
28. Istasse, T., N. Jacquet, T. Berchem, E. Haubruge, B.K. Nguyen and A. Richel, 2016. Extraction of honey polyphenols: Method development and evidence of Cis isomerization. Anal. Chem. Insights, 11: 49-57.
29. Gheldof, N., X.H. Wang and N.J. Engeseth, 2002. Identification and quantification of antioxidant components of honeys from various floral sources. J. Agric. Food Chem., 50: 5870-5877.
30. Gheldof, N. and N.J. Engeseth, 2002. Antioxidant capacity of honeys from various floral sources based on the determination of oxygen radical absorbance capacity and inhibition of in vitro lipoprotein oxidation in human serum samples. J. Agric. Food Chem., 50: 3050-3055.
31. Gul, A. and T. Pehlivan, 2018. Antioxidant activities of some monofloral honey types produced across Turkey. Saudi J. Biol. Sci., 25: 1056-1065.
32. Marianti, 2014. Analisis antioksidan madu. Hasanuddin University, Indonesia.
33. Jayadi, Y. and R. Noviasty, 2014. Analisis antioksidan madu sehat. Hasanuddin University, Indonesia.