The Effect of Oolong Tea Consumption on Postprandial Triglyceride Levels: A Randomized, Double-blind, Placebo-controlled Crossover Study

Akkarach Bumrungpert* Rewadee Chongsuwat*

ABSTRACT

Oolong tea is produced by the semi-fermentation of the fresh leaves of *Camellia sinensis*. The major bioactive compound in oolong tea is oolong tea polymerized polyphenol (OTPP). Previous studies found that oolong tea reduces the absorption of fat by inhibiting lipase enzyme resulting in increased fecal lipid excretion. The objective of this study was to examine the effect of oolong tea on blood triglyceride levels after fat intake. Study design was a randomized, double-blind, placebo-controlled crossover study. The subjects were randomly divided into 2 groups; oolong tea group (n = 15) and placebo group (n = 15). The subjects were served 500 mL oolong tea (70 mg OTPP) or placebo to drink and both groups consumed 200 g corn soup (40 g fat). Blood samples were taken before and at the 1st, 2nd, 3rd, 4th, and 5th hours after the consumption of oolong tea and corn soup. The oolong tea significantly decreased changes in the triglyceride level after fat intake. As shown by the incremental blood triglyceride area under the curve (AUC), oolong tea significantly suppressed the postprandial elevation in incremental blood triglyceride AUC compared with placebo. No significant differences in adverse symptoms were observed between groups. Therefore, oolong tea containing 70 mg OTPP can decrease postprandial blood triglyceride after fat intake by blocking fat absorption, suggesting that oolong tea may be a promising anti-obesity agent for weight control. However, we recommend drinking oolong tea without sugar so that it will not increase calorie intake and contributes to a healthy diet, which with regular exercise can contribute to permanent weight control.

Keywords: oolong tea, OTPP, fat absorption, triglyceride

J Public Health 2015; 45(1): 6-17

Correspondence: Akkarach Bumrungpert, Department of Nutrition, Faculty of Public Health, Mahidol University Bangkok 10400, Thailand. E-mail: abnutrition@yahoo.com

* Department of Nutrition, Faculty of Public Health, Mahidol University

Introduction

The prevalence of obesity in the world remains remarkably high. High obesity rates are associated with increased risk of cardiovascular disease and metabolic syndrome factors[1]. A reduction in dietary fat intake by decreasing the absorption of dietary fat has the potential to positively influence body weight by reducing energy intake and blood lipid levels. This, in turn, could lead to a reduction in obesity-related risk factors and disorders. A reduction in dietary fat intake could result in positive health benefits; however, this requires behavioral changes that many individuals find difficult to maintain. Thus, reducing caloric intake from fat by blocking absorption at the gastrointestinal tract represents an interesting alternative. This has led to the search for natural products that can effectively and safely reduce dietary fat absorption. The lipase inhibitor, Orlistat, was the first such medicine, but has fallen out of favor due to its unfavorable side effects[2]. Functional foods are promising alternative medicines that have been used in the reduction of fat absorption; playing a mitigating role in obesity and its complications, and reducing treatment costs.

Several studies have shown that tea, especially oolong tea, has many health benefits. Oolong tea is produced by the semi-fermentation of the fresh leaves of *Camellia sinensis*. During the semi-fermentation process, the constituents of the leaves are enzymatically converted to numerous bioactive compounds, specifically oolong tea polymerized polyphenol (OTPP). The health benefits of oolong tea include anti-oxidant[3], anti-obesity[4-5], and anti-diabetic properties[6], as well as a moderating effect on the risk for cardiovascular disease[7]. Moreover, recent researches have demonstrated that oolong tea consumption increases the metabolic rate, fat oxidation[8], energy expenditure[9], as well as lipid excretion into the feces in subjects fed a high-lipid diet[10]. *In vitro* studies suggest that OTPP could interfere with fat absorption via the inhibition of lipase activity[11]. Also, animal study has shown the suppressive effect of OTPP on postprandial triglyceride after high-fat diet loading in rats and mice[12]. Furthermore, *in vivo* study has shown that OTPP suppressed both lymphatic triglyceride absorption and serum triglyceride elevation with a high lipid diet[13]. Hara Y et al.[14] demonstrated that OTPP suppressed postprandial serum triglyceride and chylomicron levels. Therefore, a drink containing OTPP has the potential to decrease blood triglyceride levels after fat intake. The objective of this study was to examine the effect of oolong tea on blood triglyceride levels after fat intake in Thailand.

Method

Subjects

Thirty men and women between 20 and 60 years old, with a fasting blood triglyceride level between 100-250 mg/dl were enrolled in this study. Exclusion criteria included a smoker, pregnant or lactating women, history of cardiovascular, hepatic, renal or diabetic diseases, cold, chronic diarrhea, constipation, gastrointestinal disorder or digestive disorder, tea allergy, or regular use of a pharmaceutical or food supplement that affects fat metabolism. The study was explained to the subjects and informed consent was obtained from all the participants.

The study was approved by the Ethical Review Committee for Human Research, Faculty of Public Health, Mahidol University (MUPH 2014-144). Furthermore, this study was conducted in accordance with the Declaration of Helsinki on human subjects.

Study design

The study design was a randomized, double-blind, placebo-controlled crossover study. The subjects were randomly divided into two groups (oolong tea group and placebo group). They were followed by a crossover design including 7-day washout periods and 1-day for study day. In addition, the subjects consumed meals prepared by researcher for 3 days before study days. Dietitian set the diet based on energy requirements for each gender. Calorie intakes were 1,600 kcal for females and 2,000 kcal for males. Nutrient distributions were 57% carbohydrate, 13% protein, and 30% fat of total energy. The subjects were not allowed to consume anything other than the food or drink designated by the researcher during this period. On the study day, the subjects who fasted provided blood sample before the fat loading test. Then, the subjects consumed 500 mL oolong tea or placebo and 200 g corn soup containing 40 g of fat, 1.5 g of protein and, 8.5 g of carbohydrate. The subjects rested in the testing room, and blood samples were taken at the 1st, 2nd, 3rd, 4th, and 5th hours after the consumption of corn soup. Fifty mL of water were given between the 1st-5th hours of blood being taken. During the 8-hour period after the test, the subjects were asked to indicate if they experienced symptoms such as nausea, bloating, abdominal discomfort, rectal gas, and obfuscating symptoms.

Beverages

Oolong tea and placebo drink were manufactured by TIPCO F&B Co., Ltd, Thailand. The nutritional and bioactive contents of test drink are shown in Table 1.

Placebo drink was prepared with caramel for coloring. Double-blind crossover design was carried out in this study; none of the participants were able to differentiate between the two beverages in the experiment.

Table 1 Nutritional and Bioactive Content of Test Drinks.

Nutritional and content	Content (per 500 mg)	
	Oolong tea	Placebo
Calories	0 kcal	0 kcal
Protein	N.D.* (< 0.1 g/100 ml)	N.D.* (< 0.1 g/100 ml)
Fat	N.D.* (< 0.1 g/100 ml)	N.D.* (< 0.1 g/100 ml)
Carbohydrate	0 g	0 g
Caffeine	0 mg	0 mg
OTPP	70 mg	0 mg

* N.D. = Not detectable

Analyses of blood sample

The following parameters were measured: serum total cholesterol (TC), low-density lipoprotein cholesterol (LDL-C), high-density lipoprotein cholesterol (HDL-C), Triglyceride (TG), Fasting blood glucose (FBG), HbA1C, Insulin, Hemoglobin (Hb), Hematocrit (Hct), Serum glutamic oxaloacetic transaminase (SGOT), Serum glutamic pyruvic transaminase (SGPT), Alkaline Phosphatase (ALP), gamma-glutamyl transpeptidase (g-GTP), Uric acid, Blood urea nitrogen (BUN), Creatinine, Bilirubin, Lactate dehydrogenase, and Creatine kinase. All biomarkers were measured at N-Health Asia Lab, Thailand, a medical laboratory with ISO15189:2007 certification.

Statistical analysis

All data were represented as mean ± SD. Statistical difference of changes of blood triglyceride and incremental blood triglyceride AUC between the treatment group and placebo group were tested by t-test. Two-way repeated measures analysis of variance (ANOVA) was used to compare the post-prandial blood triglyceride. Pearson Chi-Square was used to compare the adverse effects between groups. The levels of significance were set at $p < 0.05$.

Results

Characteristics of subjects

Thirty healthy volunteers (15 male and 15 female) were recruited for the study. Their mean age was 36.5 years, the average BMI was 25.79 kg/m^2, and mean triglyceride level was 150.93 mg/dL. Other biochemical markers are shown in Table 2.

All the subjects were able to follow the study protocol without difficulty. There were no significant differences in the baseline levels of serum triglyceride from those in the two different sessions.

Table 2 General Characteristic and Blood Chemistry of Subjects.

General Characteristic and Biochemical Parameters	Value
Total Number, Male/Female (n/n)	30 (15/15)
Age (years)	36.50 ± 11.31
BMI (kg/m2)	25.79 ± 4.40
Body fat (%)	28.79 ± 7.33
Waist circumference (cm)	84.62 ± 13.50
Systolic blood pressure (mm Hg)	126.10 ± 12.11
Diastolic blood pressure (mm Hg)	79.77 ± 8.33
Pulse rate (beat/min)	78.07 ± 12.99
Total cholesterol (mg/dL)	218.33 ± 58.96
LDL-C (mg/dL)	151.43 ± 38.95
HDL-C (mg/dL)	56.83 ± 16.29
Triglyceride (mg/dL)	150.93 ± 52.03
FBG (mg/dL)	91.67 ± 24.13
HbA1C (%)	5.52 ± 0.82
Insulin (mIU/mL)	11.89 ± 6.15
Hb (g/dL)	13.89 ± 2.24
Hct (%)	41.66 ± 5.74
SGOT (U/L)	19.00 ± 5.83
SGPT (U/L)	21.20 ± 12.53
ALP (U/L)	60.53 ± 15.97
γ-GTP (U/L)	26.83 ± 13.79
Uric acid (mg/dL)	5.27 ± 1.47
BUN (mg/dL)	11.01 ± 2.02
Creatinine (mg/dL)	0.78 ± 0.16
Bilirubin (mg/dL)	0.43 ± 0.15
Lactate dehydrogenase (U/L)	169.83 ± 32.60
Creatine kinase (U/L)	108.97 ± 42.49

All the data were expressed as means ± standard deviation (SD)

The effect of the oolong tea on blood triglyceride levels after fat intake

The postprandial responses in the serum triglyceride following the ingestion of 40 g fat-diet with or without drink containing OTPP are shown in Table 3-4 and Figure 1-2. The serum triglyceride levels significantly increased over the first 5 hours after the fat-meal. The drink containing OTPP significantly decreased changes of triglyceride levels after the fat-meal intake compared with placebo (Table 3 and Figure 1). As shown by the incremental blood triglyceride area under the curve (AUC), the oolong tea significantly suppressed the postprandial elevation in serum triglyceride (incremental AUC) compared with placebo (Table 4 and Figure 2).

Table 3 Changes of D Triglyceride Levels (mg/dL) after Fat Loading.

Δ TG (hr)	Placebo	Oolong Tea	p*
1	36.33 ± 6.68^{a}	31.00 ± 6.18^{f}	0.002
2	62.30 ± 6.62^{b}	55.63 ± 6.53^{g}	< 0.001
3	76.50 ± 6.78^{c}	60.93 ± 5.64^{h}	< 0.001
4	84.33 ± 9.16^{d}	65.50 ± 6.79^{i}	< 0.001
5	71.13 ± 8.79^{e}	59.03 ± 8.13^{gh}	< 0.001

a- i Values with different superscripts within a column are significantly different from each other ($p < 0.05$) according to two-way repeated measures analysis of variance (ANOVA)

*Statistically significant difference between groups at $p < 0.05$

Table 4 Incremental Blood Triglyceride AUC.

Time (min)	Incremental Triglyceride AUC (mg.min/dL)		p*
	Placebo	Oolong Tea	
0-60	$1,090.00 \pm 200.45^{a}$	923.00 ± 189.19^{f}	0.002
0-120	$4,049.00 \pm 484.86^{b}$	$3,517.00 \pm 449.12^{g}$	< 0.001
0-180	$8,213.00 \pm 777.32^{c}$	$6,992.00 \pm 722.58^{h}$	< 0.001
0-240	$13,038.00 \pm 1,179.22^{d}$	$10,819.00 \pm 1,002.58^{i}$	< 0.001
0-300	$17,702.00 \pm 1,565.60^{e}$	$14,485.00 \pm 1,302.46^{j}$	< 0.001

a- j Values with different superscripts within a column are significantly different from each other ($p < 0.05$) according to two-way repeated measures analysis of variance (ANOVA)

*Statistically significant difference between groups at $p < 0.05$

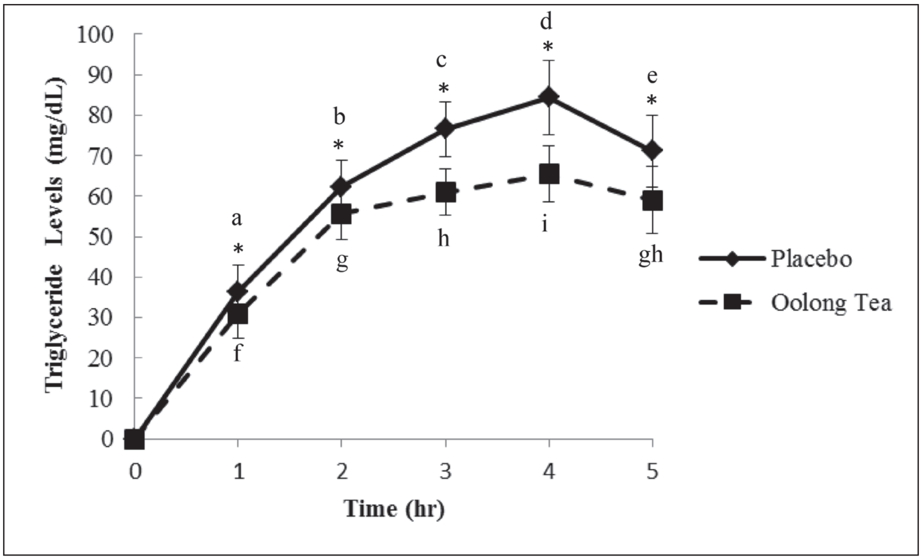

Figure 1 Changes of Triglyceride Levels after Fat Loading.

a- i Values with different superscripts are significantly different from each other ($p < 0.05$) according to two-way repeated measures analysis of variance (ANOVA)

* Statistically significant difference between groups at $p < 0.05$

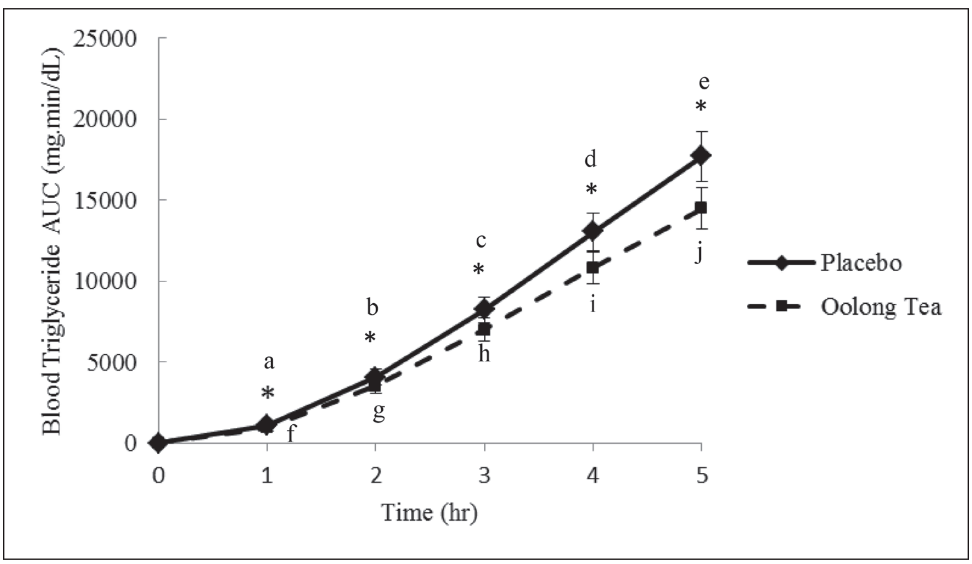

Figure 2 Incremental Blood Triglyceride AUC.

a- j Values with different superscripts are significantly different from each other ($p < 0.05$) according to two-way repeated measures analysis of variance (ANOVA)

* Statistically significant difference between groups at $p < 0.05$

Adverse effect

The severity of symptoms reported by the subjects for the 8 hours of the study is shown in Table 5. No significant differences in symptoms were observed for any symptoms between the 2 drink groups.

Table 5 Adverse Effect During the 8-Hour Period After the Test.

Symptom	Placebo	Oolong Tea	p
Headache			
- None	27 (90.0 %)	28 (93.3 %)	0.601
- Mild	2 (6.7 %)	2 (6.7 %)	
- Moderate	1 (3.3 %)	0 (0.0 %)	
Fullness			
- None	27 (90.0 %)	26 (86.7 %)	0.688
- Mild	3 (10.0 %)	4 (13.3 %)	
- Moderate	0 (0.0 %)	0 (0.0 %)	
Itching			
- None	29 (96.7 %)	30 (100.0 %)	0.313
- Mild	1 (3.3 %)	0 (0.0 %)	
- Moderate	0 (0.0 %)	0 (0.0 %)	
Incomplete evacuation			
- None	29 (96.7 %)	28 (93.3 %)	0.601
- Mild	1 (3.3 %)	1 (3.3 %)	
- Moderate	0 (0.0 %)	1 (3.3 %)	
Nausea			
- None	29 (96.7 %)	29 (96.7 %)	1.000
- Mild	1 (3.3 %)	1 (3.3 %)	
- Moderate	0 (0.0 %)	0 (0.0 %)	
Excessive rectal gas			
- None	27 (90.0 %)	26 (86.7 %)	0.688
- Mild	3 (10.0 %)	4 (13.3 %)	
- Moderate	0 (0.0 %)	0 (0.0 %)	
Fatigue			
- None	26 (86.7 %)	28 (93.3 %)	0.389
- Mild	4 (13.3 %)	2 (6.7 %)	
- Moderate	0 (0.0 %)	0 (0.0 %)	
Bloating			
- None	28 (93.3 %)	28 (93.3 %)	0.513
- Mild	1 (3.3 %)	2 (6.7 %)	
- Moderate	1 (3.3 %)	0 (0.0 %)	
Abdominal pain			
- None	28 (93.3 %)	29 (96.7 %)	0.554
- Mild	2 (6.7 %)	1 (3.3 %)	
- Moderate	0 (0.0 %)	0 (0.0 %)	

No statistically significant difference between groups (Pearson Chi-Square)

Discussion

In this study, we determined the extent to which OTPP decreased the postprandial elevation in serum triglyceride after fat intake by blocking fat absorption. We demonstrated that oolong tea reduced the incremental blood triglyceride at 1-5 h after fat-meal consumption.

Results are consistent with previous findings, Toyoda-Ono et al.[12] found suppressive effect of OTPP on postprandial triglyceride after high-fat diet loading in rats and mice. Moreover, Nakai et al.[13] showed that OTPP suppressed both lymphatic triglyceride absorption and serum triglyceride elevation under a high fat diet condition. Further, Hara et al.[14] found that OTPP plays a key role in the suppression by oolong tea of postprandial blood triglyceride, in a randomized double-blind placebo-control cross-over study using OTPP-enriched oolong tea beverage. The study was conducted on 22 subjects with mild hyperlipidemia. The AUC of serum triglyceride significantly decreased.

Possible mechanism of action by which OTPP suppresses elevation of postprandial triglyceride after fat meal is by blocking fat absorption. Nakai et al.[11] found that OTPP could interfere with fat absorption via the inhibition of lipase activity *in vitro*. Also, Han et al.[4] reported that oolong tea prevented obesity induced by feeding a high-fat diet by inhibiting pancreatic lipase activity. In a clinical study, Hsu et al.[10] determined that polyphenol-enriched oolong tea increased lipid excretion into the feces when subjects took a high fat diet. These findings indicated that oolong tea inhibited dietary fat absorption in intestinal by inhibiting pancreatic lipase activity.

Based on our result and previously published data, we propose the following scenario by which OTPP decreases postprandial triglyceride after dietary fat intake. The drinks containing OTPP could inhibit lipase activity resulting in block fat absorption causing increased fecal lipid excretion and decreased postprandial triglyceride.

Our findings suggest that ingestion of oolong tea with food is beneficial in preventing obesity and for weight management. However, we recommend drinking oolong tea without sugar so that it will not increase calorie intake and contributes to a healthy diet[15], which with regular exercise can contribute to permanent weight control.

Conclusion

The oolong tea containing major bioactive compound, OTPP can decrease postprandial blood triglyceride after fat intake by blocking fat absorption, suggesting that oolong tea may be a promising anti-obesity agent for weight control.

Acknowledgements

We thank the subjects for their participation, Dr. Sirintip Jira-adisai, Anti-Aging and Regenerative Medicine Program, Dhurakijpundit University, and Dr. Nuttiyakorn Kitsamhanmit, School of Anti-Aging and Regenerative Medicine, Mae Fah Luang University for assistance as the study physicians. The financial support was provided by the Suntory Beverage & Food Limited Co., Ltd.

References

1. Tilg H, Moschen AR. Adipocytokines: mediators linking adipose tissue, inflammation and immunity. Nat Rev Immunol 2006; 6(10): 772-83.
2. Garcia Diaz E, Martin Folgueras T. Systematic review of the clinical efficacy of sibutramine and orlistat in weigth loss, quality of life and its adverse effects in obese adolescents. Nutr Hosp 2011; 26(3): 451-7.
3. Kurihara H, Fukami H, Toyada Y, Kageyama N, Tsuruoka N, Shibata H et al. Inhibitory effect of oolong tea on the oxidative state of low density lipoprotein (LDL). Biol Pharm Bull 2003; 26(5): 739-42.
4. Han LK, Takaku T, Li J, Kimura Y, Okuda H. Anti-obesity action of oolong tea. Int J Obes Relat Metab Disord. 1999; 23(1): 98-105.
5. Rong-rong H, Ling C, Bing-hui L, Yokichi M, Xin-sheng Y, Hiroshi K. Beneficial effects of oolong tea consumption on diet-induced overweight and obese subjects. Chin J Integr Med 2009; 15(1): 34-41.
6. Hosoda K, Wang MF, Liao ML, Chuang CK, Iha M, Clevidence B, et al. Antihyperglycemic effect of oolong tea in type 2 diabetes. Diabetes Care. 2003; 26(6): 1714-8.
7. Shimada K , Kawarabayashi T, Tanaka A, Fukuda D, Nakamura Y, Yoshiyama M, et al. Oolong tea increases plasma adiponectin levels and low-density lipoprotein particle size in patients with coronary artery disease. Diabetes Res Clin Pract. 2004; 65(3): 227-34.
8. Rumpler W, Seale J, Clevidence B, Judd J, Wiley E, Yamamoto S, et al. Oolong tea increases metabolic rate and fat oxidation in men. J Nutr 2001; 131: 2848-52.
9. Komatsu T, Nakamori M, Komatsu K, Hosoda K, Okamura M, Toyama K, et al. Oolong tea increases energy metabolism in Japanese females. J Med Invest 2003; 50(3-4): 170-5.
10. Hsu TF, Kusumoto A, Abe K, Hosoda K, Kiso Y, Wang MF, et al. polyphenol-enriched oolong tea increases fecal lipid excretion. Eur J Clin Nutr 2006; 60: 1330-6.

11. Nakai M, Fukui Y, Asami S, Toyoda-Ono Y, Iwashita T, Shibata H et al. Inhibitory effects of oolong tea polyphenols on pancreatic lipase *in vitro*. J Agric Food Chem 2005; 53: 4593-8.
12. Toyoda-Ono Y, Yoshimura M, Nakai M, Fukui Y, Asami S, Shibata H, et al. Suppression of postprandial hypertriglyceridemia in rats and mice by oolong tea polymerized polyphenols. Biosci Biotechnol Biochem 2007; 71(4): 971-6.
13. Nakai M, Fukui Y, Asami S, Toyoda-Ono Y. Effect of oolong tea polymerized polyphenols on mechanism of serum triglyceride elevetion suppressive. JJpn Soc Study Obes 2005; 11: 88-90.
14. Hara Y, Moriguchi S, Kusumoto A, Nakai M, Ono Y, Abe K et al. Suppressive effect of oolong tea polymerized polyphenols enriched oolong tea on postprandial serum triglyceride elevation. Jpn Pharmacol Ther 2004: 32: 335-42.
15. Bumrungpert A. Weight-loss diets. Journal of Public Health 2010; 40(2): 226-36.

ผลของการบริโภคชาอู่หลงต่อระดับไตรกลีเซอร์ไรด์ในเลือดหลังอาหาร: การศึกษาวิจัยแบบสุ่มชนิดปกปิดสองด้านมีกลุ่มควบคุมและสลับกลุ่ม

เอกราช บำรุงพืชน์ เรวดี จงสุวัฒน์**

บทคัดย่อ

ชาอู่หลง คือ ชาที่ผ่านกระบวนการบ่มแบบกึ่งหมักจากใบชาสด ซึ่งมีสารออกฤทธิ์ทางชีวภาพหลัก ได้แก่ อู่หลงที โพลีเมอไรซ์ โพลีฟีนอล หรือ โอทีพีพี การศึกษาวิจัยก่อนหน้านี้พบว่า ชาอู่หลงสามารถลดการดูดซึมไขมันได้โดยยับยั้งเอนไซม์ไลเปส ทำให้เพิ่มการขับไขมันออกทางอุจจาระ การศึกษาวิจัยครั้งนี้จึงมีวัตถุประสงค์ เพื่อศึกษาผลของการดื่มชาอู่หลงต่อระดับไตรกลีเซอไรด์ในเลือดหลังอาหาร โดยมีรูปแบบการศึกษาเป็นแบบสุ่มชนิดปกปิดสองด้านมีกลุ่มควบคุมและสลับกลุ่ม (randomized, double-blind, placebo-controlled crossover study) ผู้เข้าร่วมวิจัยถูกแบ่งออกเป็น 2 กลุ่ม คือ กลุ่มชาอู่หลง จำนวน 15 คน และกลุ่มชาหลอก จำนวน 15 คน โดยผู้เข้าร่วมวิจัยดื่มชาอู่หลง (มีโอทีพีพี 70 มก.) หรือ ชาหลอก (มีโอทีพีพี 0 มก.) ปริมาณ 500 มล. และซุปข้าวโพด (มีปริมาณไขมัน 40 กรัม) ผู้เข้าร่วมวิจัยถูกเก็บตัวอย่างเลือดก่อน-หลังดื่มชาอู่หลงหรือชาหลอก และซุปข้าวโพด ที่เวลา 1, 2, 3, 4, 5 ชม. ผลการศึกษาพบว่า ชาอู่หลงสามารถลดระดับไตรกลีเซอไรด์ในเลือดหลังการบริโภคซุปข้าวโพดที่มีไขมันสูงได้อย่างมีนัยสำคัญทางสถิติ นอกจากนี้ยังพบว่า พื้นที่ใต้กราฟของระดับไตรกลีเซอไรด์ในกลุ่มที่ดื่มชาอู่หลงลดลงอย่างมีนัยสำคัญทางสถิติ เมื่อเปรียบเทียบกับชาหลอก และไม่พบความแตกต่างของอาการหรือผลข้างเคียงระหว่างกลุ่มที่ดื่มชาอู่หลงและชาหลอก จากการศึกษาครั้งนี้จึงสรุปได้ว่า การดื่มชาอู่หลงที่มีสารโอทีพีพี 70 มก. สามารถยับยั้งการดูดซึมไขมัน ทำให้ระดับไตรกลีเซอไรด์ในเลือดหลังบริโภคอาหารที่มีไขมันสูงลดลงได้ ดังนั้นการดื่มชาอู่หลงจึงอาจเป็นทางเลือกหนึ่งที่ใช้สำหรับป้องกันโรคอ้วน หรือช่วยควบคุมน้ำหนักตัวได้ อย่างไรก็ตาม เราควรเลือกดื่มชาอู่หลงที่ปราศจากน้ำตาลร่วมกันกับการควบคุมอาหารและออกกำลังกายเป็นประจำ เพื่อการควบคุมน้ำหนักตัวได้อย่างถาวร

คำสำคัญ: ชาอู่หลง, โอทีพีพี, การดูดซึมไขมัน, ไตรกลีเซอร์ไรด์

วารสารสาธารณสุขศาสตร์ 2558; 45(1): 6-17

* ภาควิชาโภชนวิทยา คณะสาธารณสุขศาสตร์ มหาวิทยาลัยมหิดล