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Supplementation with Mix of *Garcinia cambogia* Extract, Yerba Mate Extract, and Guarana Extract Lowers Body Fat but has no Effects on High-Density Lipoprotein Cholesterol Level

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ABSTRACT

Background
Obesity and being overweight have become modern health problems due to energy intake being higher than expenditure. The obesity epidemic refers to the worldwide increase in excess weight according to the World Health Organization (WHO).

Objective
In light of the pressing need to check the progression of obesity, this study attempted to determine the effect of an herbal formula tablet, which contains *Garcinia cambogia* extract, yerba mate extract, and guarana extract, on weight control.

Design
We enrolled 30 overweight or obese subjects and randomly assigned them to a control or an intervention group. Subjects were asked to take a placebo or an herbal formula tablet twice a day for 8 weeks. Both groups had five nutrition education courses, and regular anthropometric measurements were taken. At the end of the study, we analyzed blood lipid and glycemic parameters to determine whether the herbal formula tablet had reduced lipid and glucose levels.

Results
Results showed that the waist and hip circumferences, weight, and body fat were significantly reduced in both groups ($p<0.05$); basal metabolic rates were simultaneously maintained, although there were no differences between the two groups. In addition, subjects in the intervention group had greater weight and body fat loss than did those in the control group ($p<0.05$). Blood analytic measurements showed that high-density lipoprotein cholesterol had significantly decreased in the control group ($p<0.05$).

Conclusions
In conclusion, the herbal formula tablet along with nutrition education can be helpful in weight control and maintaining the high-density lipoprotein cholesterol level.

Keywords
Obesity, Yerba mate extract, *Garcinia cambogia* extract, Guarana extract, Weight control.

Abbreviations
BIA: Biochemical impedance analysis; FBG: Fasting blood glucose; HbA1C: Hemoglobin A1C; HDL-C: High-density lipoprotein cholesterol; LDL-C: Low-density lipoproteincholesterol; TC: Total cholesterol; TGs: Triglycerides.

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INTRODUCTION

Obesity is a condition of excessive body fat tissue accumulation. The main cause of obesity is a long-term energy imbalance, which means that caloric intake is greater than consumption. There are three parts of general body energy consumption, including the basal metabolism expenditure, the thermic effect of food, and physical activity. The three kinds of energy consumption account for approximately 60%, 10%, and 30% of total calories consumed. Major factors that affect the body energy balance are dietary intake, the body's metabolic rate, and physical activity. If the ratio of these factors is unbalanced, it is likely to cause obesity. Over the past few decades, research related to causes of obesity has progressed considerably, such as the discovery of an obesity gene, metabolic factors, energy consumption, and utilization. But the prevalence of obesity has not decreased, so we presume that the main reasons causing obesity are environmental factors, which have caused steady increases in obese populations.[1]

As to environmental factors, a correlation of diet and obesity can be found in numerous studies, e.g., excessive dietary fat intake has a direct correlation with the formation of body fat, but still some studies found that even when dietary fat intake is reduced, the incidence of obesity still increases. This shows that obesity is caused by several dietary factors. The major environmental factor that causes an energy imbalance is diet, and numerous factors affect the diet, such as physical and psychological effects, which regulate the appetite of humans. Hunger and satiety are affected by physical factors, sensation, and cognition of the brain, digestion, and absorption. These factors affect regulation of the intake of different foods, and thus cause the energy balance to vary.[2]

Recently, treatment of adult obesity has focused on diet control, exercise guidance, and living habits to amend the basic principles, and finally the use of weight loss drugs has been considered. However, many people directly choose to use drugs for weight loss, which shows the importance of developing weight management formulas.[1,2]

Many weight-loss drugs reduce calorie intake, reduce the appetite, or increase satiety, but are often accompanied by many side effects, such as a dry mouth, constipation, nausea, headaches, and insomnia, and in severe cases may even increase the blood pressure and pulse rate, arrhythmias, and angina, and thus increase the risk of heart disease.[1,2] Although weight-loss drugs contribute to weight control, the side effects are worse than the benefits of weight loss. Therefore, we hope that some weight management formulae can be used as a weight loss aid, to meet the needs of the public.

Garcinia cambogia is a tropical fruit grown in Southeast Asia, southern India, and Africa, and is widely used for cooking because of its sweet and sour taste. It contains (-)-hydroxycitric acid (HCA), which is similar to citric acid, and studies have shown that HCA can be used as a competitive inhibition of ATP-citrate lyase,[3] to reduce the synthesis of fatty acids and cholesterol, and promote glycogen synthesis,[4] thereby reducing the accumulation of body fat. In cases of high dietary intake of excessive glucose, HCA can reduce the role of lipid synthesis, and through its inhibition of glycosylation, it promotes the production of new sugars.[5,6]

Yerba mate tea is a common beverage in South America, and its use quickly extended worldwide. Yerba mate tea is an herbal drink made from *Ilex paraguariensis* St. Hilaire. It contains many different bioactive compounds, such as polyphenols, alkaloids, triterpenoid saponins, and flavonoids. Yerba mate has many important pharmacological properties. Many previous studies indicated that it has an antioxidant effect, anti-inflammatory effect, anti-mutagenic effect, anti-obesity effect, and an effect of lowering blood glucose. In the past, animal and human experiments pointed out that yerba mate regulates blood lipids, but the exact mechanism is still unclear.

Guarana (*Paullinia cupana*) originates in northern Brazil, and is often added to drinks to add flavor.[7,8] In addition, Boozer and other scholars[9] gave subjects an anesthesia mixture of ephedra and guarana, which can effectively reduce body weight and body fat.[10] But its effectiveness is accompanied by side effects, and long-term use still needs to be further evaluated.[9]

L-Carnitine can transport large adipocytes from the mitochondria to the intramedullary membrane of granules and burn fat on the inner membrane of granules.[11] The literature also suggests that carbohydrate-containing compounds can induce high levels of fat in mice.[12]

SUBJECTS AND METHODS

The aim of study was determining the effect of herbal formula tablet, which is containing garcinia cambogia extract, yerba mate extract and guarana extract, on weight control.

Subjects

Thirty subjects were recruited from a neighborhood near Taipei Medical University (Taipei, Taiwan). Inclusion criteria included a BMI of ≥24 kg/m^2, a waist circumference of ≥90 cm in men and ≥80 cm in women, and being aged 20~70 years. Exclusion criteria were hepatic or renal disease, a history of cardiovascular disease or cancer, pregnancy, breast feeding, intending to become pregnant during the study period, thyroid or pituitary disease, gastrointestinal disease, neurological disease, an eating disorder, alcohol consumption, or taking anti-hyperlipidemia medicine. Written informed consents was obtained from all subjects, and consuming of other supplements.

The clinical trial registration No. was TMU-JIRB 201411023.

Supplement Composition

The Burner® Superlative Svelte herbal formula tablet contains yerba mate extract (16%), *Garcinia cambogia* extract (38%), guarana

extract (12%), calcium phosphate dibasic, L-carnitine, and lactate. Each tablet is 414 mg and is to be taken before a meal.

Study Design

There was an 8-week study intervention period (weeks 0 to 8). Subjects were assigned to a control group (placebo) and a supplement group (given an herbal formula tablet 30 min twice a day before a meal). Both groups received nutritional education and dietary counseling every 2-weeks. Every 2-weeks of the intervention period (weeks 0, 2, 4, 6, and 8), anthropometric data and blood pressure were measured. Anthropometric data included the height, weight, body composition, BMI, waist and hip circumferences, and the waist-hip ratio. Body composition was measured by Inbody 3.0 (Biospace, Seoul, Korea) according to the principle of a biochemical impedance analysis (BIA). At weeks 0 and 8, blood samples were collected after a subject had fasted overnight. Subjects were asked to keep a 3-day dietary record (2 weekdays and 1 weekend day) at weeks 0, 2, 4, 6, and 8, and compliance was checked by examining the dietary record. At week 8, subjects were asked to complete a satiety evaluation test. All subjects maintained regular physical activity.

Blood Sample Analysis

Blood samples were analyzed by Taipei Medical University Hospital. Plasma collected by centrifugation at 1500 g for 10 min at 4 °C was stored at -80 °C until further analysis. The lipid profile included total cholesterol (TC), triglycerides (TGs), low-density lipoprotein (LDL) cholesterol (LDL-C), high-density lipoprotein cholesterol (HDL-C), fasting blood glucose (FBG), and hemoglo bin A1c (HbA1c).

Dietary Nutrient intake Analysis

Daily nutrient intake was calculated as the mean daily intake from a 3-day dietary record using the nutrient analytical software (E-kitchen, Taichung, Taiwan). The nutrient assessment included the total caloric intake, dietary macronutrient intake (fat, proteins, and carbohydrates), and dietary fiber.

Statistical Analysis

All data are expressed as the mean ± SD or number (n) and percentages (%). Data were analyzed using Student's T-test and paired T-test. Analyzing data measured by determination of normality. A value of $p<0.05$ was used to indicate statistical significance.

RESULTS

Baseline Characteristics of Subjects

Table 1 presents data on the 15 subjects assigned to the control group (C) and 15 subjects assigned to the supplement group (S) who completed the entire study period. There were no differences in age, height, weight, body fat, BMI, blood pressure, or the waist-hip ratio between the two groups.

Table 1. *Anthropometric Measurements During the Intervention Period*[1,2]

	Control group		Supplement Group		
	0 week	8 week	0 week	8 week	*p* value
n (male)	15 (1)		15 (3)		-
Age (years)	48.2 ± 12.0		51.5 ± 13.2		-
Height (cm)	159.9 ± 7.8		160.3 ± 10.0		-
SBP (mmHg)	127.3 ± 17.1	125.1 ± 21.9	128.7 ± 17.3	123.2 ± 15.6	0.783
DBP (mmHg)	82.1 ± 13.5	79.0 ± 13.4	74.8 ± 13.9	76.8 ± 10.3	0.619
WC (cm)	91.3 ± 7.1	85.1 ± 6.5*	93.8 ± 9.0	87.6 ± 10.2*	0.432
HC (cm)	103.2 ± 6.2	100.6 ± 6.1*	106.5 ± 8.9	102.9 ± 9.3*	0.431
WHR (%)	0.88 ± 0.04	0.85 ± 0.04*	0.88 ± 0.05	0.85 ± 0.06*	0.709
Weight (kg)	71.2 ± 11.5	69.8 ± 11.4*	73.9 ± 14.6	71.0 ± 15.0*	0.809
Muscle mass (kg)	42.5 ± 6.7	42.5 ± 6.8	43.8 ± 10.7	43.2 ± 10.4	0.842
Fat mass (kg)	25.7 ± 6.7	24.3 ± 6.6*	26.9 ± 8.9	24.8 ± 9.2*	0.869
Body fat (%)	35.9 ± 5.0	34.6 ± 5.2*	36.5 ± 8.3	34.7 ± 8.6*	0.970
BMI (kg/m2)	27.7 ± 2.4	27.2 ± 2.5*	28.7 ± 4.8	27.6 ± 5.0*	0.790
BMR (kcal)	1279.2 ± 213.5	1279.5 ± 214.0	1303.4 ± 314.2	1289.8 ± 303.8	0.915

[1]All values are the mean ±SD. BMI, body mass index; WC, waist circumference; HC, hip circumference; WHR, waist-hip ratio; BMR, basal metabolic rate; SBP, systolic blood pressure; DBP, diastolic blood pressure.
[2]Differences between groups were assessed by Student's T-test.
*Differences within groups were assessed by a paired T-test ($p<0.05$ indicates significance).

Anthropometric Measures

As shown in Table 2, anthropometric measures included weight, BMI, body fat, fat mass, muscle mass, waist circumference, hip circumference, and the waist-hip ratio. Weight and BMI at week 8 in both groups were significantly lower than at the baseline; at weeks 4 and 8 weight, BMI and body fat percentage changes in the supplement group were significantly lower than those in the control group ($p<0.05$). The body fat percentage, waist circumference, hip circumference, and waist-hip ratio at week 8 in both groups were significantly lower than respective values at the baseline ($p<0.05$). Values of the fat mass at week 8 in both groups were significantly lower than respective values at the baseline ($p<0.05$). There were no differences at the baseline, and weeks 4 and 8 between the two groups. Blood pressure did not differ between the two groups at the baseline, or at weeks 4 and 8.

Table 2. *Anthropometric Measurements Differences before and after the Intervention Period*[1,2]

	0~4 weeks			0~8 weeks		
	Control	Supplement	*p* value*	Control	Supplement	*p* value
SBP (mmHg)	-1.0 ± 14.3	-0.6 ± 14.0	0.939	-2.1 ± 12.1	-5.5 ± 13.5	0.483
DBP (mmHg)	-2.7 ± 8.3	1.7 ± 14.1	0.313	-3.1 ± 11.8	2.0 ± 13.3	0.272
WC (cm)	-3.6 ± 4.3	-6.2 ± 4.1	0.101	-6.2 ± 3.7	-6.2 ± 5.0	1.000
HC (cm)	-1.6 ± 2.2	-3.1 ± 1.2	0.029*	-2.6 ± 1.9	-3.6 ± 1.6	0.132
WHR (%)	-0.02 ± 0.04	-0.03± 0.04	0.375	-0.04 ± 0.04	-0.03 ± 0.04	0.569
Weight (kg)	-0.5 ± 1.1	-1.9 ± 1.2	0.003*	-1.4 ± 1.5	-2.8 ± 1.8	0.023*
Muscle mass (kg)	0.2 ± 0.8	-0.2 ± 1.3	0.271	0.0 ± 0.8	-0.6 ± 1.3	0.115
Fat mass (kg)	-0.8 ± 1.1	-1.6 ± 1.0	0.039*	-1.4 ± 1.1	-2.2 ± 1.2*	0.046*
Body fat (%)	-0.9 ± 1.2	-1.6 ± 1.5	0.169	-1.3 ± 1.2	-1.8 ± 1.4	0.298
BMI (kg/m^2)	-0.2 ± 0.4	-0.7 ± 0.5	0.004*	-0.5 ± 0.6	-1.1 ± 0.7	0.018*
BMR (kcal)	5.8 ± 18.9	-3.7 ± 29.3	0.304	0.3 ± 18.2	-13.7 ± 28.6	0.123

[1]All values are the mean ±SD. BMI, body mass index; WC, waist circumference; HC, hip circumference; WHR, waist-hip ratio; BMR, basal metabolic rate; SBP, systolic blood pressure; DBP, diastolic blood pressure.
*Differences between groups were assessed by Student's T-test ($p<0.05$ indicates significance).
[2]Differences within groups were assessed by a paired T-test.

Blood Lipid Profile and Blood Glucose

As shown in Table 3, baseline TC and LDL-C in both groups were higher than the ideal range (TC<200 mg/dL and LDL-C<130 mg/dL). There were no differences in TC, HDL-C, LDL-C, fasting blood sugar, or hemoglobin A1c between the two groups at the baseline or week 8. After the 8-week intervention, HDL-C in the control group was significantly lower than that at the baseline ($p<0.05$). There were also no differences in TC, LDL-C, TGs, fasting blood sugar, or hemoglobin A1c in the two groups when compared to values at the baseline.

Table 3. *Serum Lipids and Blood Glucose Concentrations During the Intervention Period*[1,2]

	Control		Supplement		
	Week 0	Week 8	Week 0	Week 8	*p* value
TC (mg/dL)	205.7 ± 37.5	197.9 ± 29.3	212.0 ± 33.2	208.2 ± 38.3	0.413
TG (mg/dL)	101.4 ± 47.5	116.7 ± 50.9	123.4 ± 44.9	110.5 ± 47.9	0.737
HDL-C (mg/dL)	55.3 ± 14.9	51.3 ± 13.3*	54.1 ± 11.5	54.8 ± 13.4	0.476
LDL-C (mg/dL)	144.1 ± 35.9	137.7 ± 26.4	146.9 ± 34.0	145.9 ± 38.2	0.503
FBG (mg/dL)	95.4 ± 25.7	94.7 ± 18.3	87.3 ± 6.8	87.5 ± 6.1	0.155
HbA1c (%)	5.71 ± 0.85	5.65 ± 0.66	5.47 ± 0.38	5.53 ± 0.37	0.521

[1]All values are the mean ±SD. TC, total cholesterol; TG, triglyceride; LDL-C, low-density lipoprotein cholesterol; HDL-C, high-density lipoprotein cholesterol; FBG, fasting blood glucose; HbA1c, hemoglobin A1C.
[2]Differences between groups were assessed by Student's T-test.
*Differences within groups were assessed by a paired T-test ($p<0.05$ indicates significance).

DISCUSSION

According to the Ministry of Health and Welfare who announced statistics on the top ten causes of death, the current causes of death due to chronic diseases and malignant tumors (such as colon cancer, breast cancer, and endometrial cancer), heart disease, cerebrovascular disease, diabetes, hypertension, chronic liver disease and cirrhosis, chronic kidney disease are all related to obesity.[13] It can be seen that threats from obesity to health and society are very extensive.

Obesity is the main cause of dyslipidemia. Previous research indicated that peripheral tissues are responsible for insulin resistance caused by obesity, as free fatty acids increase in adipose tissues, and TGs are synthesized in the liver. TGs enter blood vessels by the very-low-density lipoprotein (VLDL) type and react with cholesterol ester protein transport and lipoprotein lipase (LPL) in the blood. This abnormal reaction eventually enhances the concentration of free fatty acids, VLDL and LDL particles in the blood cause the concentration of serum TGs to increase, and the risk of cardiovascular diseases also increases.

In our study, through 8 weeks of five classes of nutrition education courses, we found that nutrition education can reduce the waist and hip circumferences, body weight, and body fat. It also helped maintain the amount of muscle and the basal metabolic rate. The herbal formula tablet can increase weight loss changes, with the main efficacy of the component of the yerba mate tea extract of chlorogenic acid.

Previous studies indicated that a similar daily diet, in which 3 g of yerba mate extract (containing 105 mg of chlorogenic acid) was given daily, significantly decreased the body fat, body fat percentage, and waist-hip ratio compared to a placebo group over 12 weeks, and with no side effects.[14] Other animal experiments found that yerba mate extract can reduce the size of fat cells, inhibit preadipocyte differentiation, and reduce the accumulation of lipids in adipocytes.[12,15] Some studies showed that yerba mate extract can inhibit weight gain and abdominal fat accumulation, while reducing serum cholesterol, TGs, and the LDL-C concentration.[15,16] Many cell and animal studies showed that chlorogenic acid reduces body weight and improves blood lipid and obesity-related hormones, through inhibiting lipid-related genes.[17,18]

Therefore, the components of yerba mate, especially chlorogenic acid, can be useful in weight and body fat control. In our study, we administered about 530 mg of the yerba mate extract (about 14.6~21.9 mg of chlorogenic acid); it was not as much as the amount in other interventions, but could effectively increase weight loss changes. Although our trial did not improve blood lipids, it did not decrease HDL-C compared to the control group. Previous studies found that yerba mate extract can increase the HDL-C concentration.[19] It can be deduced that the herbal formula tablet can avoid a decrease in HDL-C levels during weight loss.

Popular strategies on weight loss often fail to address many key factors such as fat mass, muscle density, bone density, water mass, their inter-relationships and impact on energy production, body composition, and overall health and well-being. (-)-Hydroxycitric acid (HCA), a natural plant extract from the dried fruit rind of *Garcinia cambogia*, has been reported to promote body fat loss in humans without stimulating the central nervous system.[20-22]

The strengths of this study are that this is the novel supplements for weight loss. On the other hand, there are limitations in this study. The study has small sample size, and since the lifestyle of the participants is similar, which could limit the outcome of the trial. Therefore, bigger sample size form different countries are required to investigate this phenomenon. There are many active components in diets, such as lycopene, vitamin C, vitamin E and γ-aminobutyric acid (GABA). However, the influences effect of other active components is not investigated in this study. Therefore, the role of other active components in this effect should be distinguished in the future.

CONCLUSION

In conclusion, the herbal formula tablet helped reduce the waist and hip circumferences, body weight, and body fat percentage, and with a balanced diet can increase the weight loss efficiency. After 8 weeks, the average weight reduction was about 2.2 kg, the average body fat percentage was reduced by about 2%, and a decrease in the HDL-C concentration was avoided during the weight-loss period. We suggest this formula can prevent the accumulation of adipose tissue by improving fatty acid oxidation enzyme activity and through inhibiting lipid-related genes.

DECLARATIONS

The authors have no conflicts of interest to declare.

ETHICS APPROVAL AND CONSENT TO PARTICIPATE

Written informed consent was obtained from all subjects, and the study was approved by the Joint Institutional Review Board of Taipei Medical University.

CONSENT FOR PUBLICATION

All the authors consent to publish.

AVAILABILITY OF DATA AND MATERIAL

N/A.

AUTHORS' CONTRIBUTIONS

C-Y L. conducted experimental work and data analyses. C-T S, C-C L, and Y-W C. supervised the techniques and critically reviewed the manuscript. Y-W C conceptualized and designed the study, drafted the initial manuscript, and approved the final manuscript.

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REFERENCES

1. Coulter DM. The New Zealand intensive medicines monitoring programme in proactive safety surveillance. *Pharmacoepidemiol Drug Saf*. 2000; 9: 273-280. doi: 10.1002/1099-1557(200007/08)9:4<273::AID-PDS512>3.0.CO;2-T

2. Harrison-Woolrych M, Clark DW, Hill GR, Rees MI, Skinner JR. QT interval prolongation associated with sibutramine treatment. *Br J Clin Pharmacol.* 2006; 61: 464-469. doi: 10.1111/j.1365-2125.2006.02574.x

3. Sullivan A, Singh M, Srere PA, Glusker JP. Reactivity and inhibitor potential of hydroxycitrate isomers with citrate synthase, citrate lyase, and ATP citrate lyase. *J Biol Chem.* 1977; 252: 7583-7590.

4. Jena B, Jayaprakasha G, Singh R, Sakariah K. Chemistry and biochemistry of (−)-hydroxycitric acid from Garcinia. *J Agric Food Chem.* 2002; 50: 10-22.

5. Hellerstein MK, Xie Y. The indirect pathway of hepatic glycogen synthesis and reduction of food intake by metabolic inhibitors. *Life Sci.* 1993; 53: 1833-1845.

6. McCarty MF. Promotion of hepatic lipid oxidation and gluconeogenesis as a strategy for appetite control. *Med Hypotheses.* 1994; 42: 215-225.

7. Campos A, Barros A, Santos F, Rao V. Guarana (*Paullinia cupana* Mart.) offers protection against gastric lesions induced by ethanol and indomethacin in rats. *Phytother Res.* 2003; 17: 1199-1202.

8. Mattei R, Dias R, Espınola E, Carlini E, Barros S. Guarana (*Paullinia cupana*): Toxic behavioral effects in laboratory animals and antioxidant activity in vitro. *J Ethnopharmacol.* 1998; 60: 111-116.

9. Boozer C, Nasser J, Heymsfield S, et al. An herbal supplement containing Ma Huang-Guarana for weight loss: A randomized, double-blind trial. *Int J Obes Relat Metab Disord.* 2001; 25: 316-324.

10. Salvadori MC, Rieser EM, Neto LMR, Nascimento ES. Determination of xanthines by high-performance liquid chromatography and thin-layer chromatography in horse urine after ingestion of guarana powder. *Analyst.* 1994; 119: 2701-2703.

11. Marcovina SM, Sirtori C, Peracino A, et al. Translating the basic knowledge of mitochondrial functions to metabolic therapy: Role of L-carnitine. *Translational Research.* 2013; 161: 73-84. doi: 10.1016/j.trsl.2012.10.006

12. Kang YR, Lee HY, Kim JH, et al. Anti-obesity and anti-diabetic effects of Yerba Mate (*Ilex paraguariensis*) in C57BL/6J mice fed a high-fat diet. *Lab Anim Res.* 2012; 28: 23-29. doi: 10.5625/lar.2012.28.1.23

13. World Health Organization (WHO). Obesity and Overweight. Fact sheet No 311. Ref Type: Online Source 2015.

14. Kim S-Y, Oh M-R, Kim M-G, Chae H-J, Chae S-W. Anti-obesity effects of Yerba Mate (*Ilex paraguariensis*): A randomized, double-blind, placebo-controlled clinical trial. *BMC Complement Altern Med.* 2015; 15: 338. doi: 10.1186/s12906-015-0859-1

15. Gosmann G, Barlette AG, Dhamer T, et al. Phenolic compounds from mate (*Ilex paraguariensis*) inhibit adipogenesis in 3T3-L1 preadipocytes. *Plant Foods Hum Nutr.* 2012; 67: 156-161. doi: 10.1007/s11130-012-0289-x

16. Mosimann ALP, Wilhelm-Filho D, Da Silva EL. Aqueous extract of *Ilex paraguariensis* attenuates the progression of atherosclerosis in cholesterol-fed rabbits. *Biofactors* 2006; 26: 59-70.

17. Arcari DP, Santos JC, Gambero A, Ribeiro M. The in vitro and in vivo effects of yerba mate (*Ilex paraguariensis*) extract on adipogenesis. *Food Chem.* 2013; 141: 809-815. doi: 10.1016/j.foodchem.2013.04.062

18. Cho A-S, Jeon S-M, Kim M-J, et al. Chlorogenic acid exhibits anti-obesity property and improves lipid metabolism in high-fat diet-induced-obese mice. *Food Chem Toxicol.* 2010; 48: 937-943. doi: 10.1016/j.fct.2010.01.003

19. De Morais EC, Stefanuto A, Klein GA, et al. Consumption of yerba mate (*Ilex paraguariensis*) improves serum lipid parameters in healthy dyslipidemic subjects and provides an additional LDL-cholesterol reduction in individuals on statin therapy. *J Agric Food Chem.* 2009; 57: 8316-8324. doi: 10.1021/jf901660g

20. Roongpisuthipong C, Kantawan R, Roongpisuthipong W. Reduction of adipose tissue and body weight: effect of water soluble calcium hydroxycitrate in *Garcinia atroviridis* on the short term treatment of obese women in Thailand. *Asia Pac J Clin Nutr.* 2007; 16: 25-29.

21. Asghar M, Monjok E, Kouamou G, et al. Super CitriMax (HCA-SX) attenuates increases in oxidative stress, inflammation, insulin resistance, and body weight in developing obese Zucker rats. *Mol Cell Biochem.* 2007; 304: 93-99. doi: 10.1007/s11010-007-9489-3

22. Roy S, Shah H, Rink C, et al. Transcriptome of primary adipocytes from obese women in response to a novel hydroxycitric acid-based dietary supplement. *DNA Cell Biol.* 2007; 26: 627-639. doi: 10.1089/dna.2007.0617