The Effect of an Herbal Supplement Containing Black Tea and Caffeine on Metabolic Parameters in Humans

Andrew T. Roberts, BS; Lilian de Jonge-Levitan, PhD; Catherine C. Parker, BS; Frank L. Greenway, MD

Abstract

OBJECTIVE: The objective of this study was to test an herbal supplement containing black tea (the fully oxidized form of *Camellia sinensis*) and caffeine for stimulation of thermogenesis. METHODS/MATERIALS: A double-blind, placebo-controlled, crossover study was conducted on 16 healthy, weight-stable, non-smoking subjects, ages 21-55 years, with body mass index (BMI) of 20-30 kg/m^2, and on no medications other than oral contraceptives or hormone replacement therapy. Subjects had no caffeine for 48 hours, no exercise for 24 hours, and no food for 12 hours before each visit. Area under the curve (AUC) for resting metabolic rate (RMR), respiratory quotient (RQ), blood pressure, pulse rate, and temperature were measured. At each visit RMR was measured at baseline and at one and two hours following oral administration of a supplement containing principally 600 mg black tea extract (60% polyphenols, 20% caffeine) and 442 mg guarana extract (36% caffeine) or matching placebo. RESULTS: The RMR and systolic blood pressure (SBP) AUCs increased significantly ($p<0.02$ and $p<0.01$, respectively) in the herbal supplement group compared to placebo. The AUC increase in RMR over the two-hour test period was 77.19 kcal/24 hr^2 ± 120.10 kcal/24 hr^2 with an average rise of 52.38 ± 29.52 kcal/24 hrs. The AUC rise in SBP over two hours was 10.3 mm Hg/hr ± 14 mm Hg/hr. The average rise in SBP over two hours was 3.7 mm Hg ± 4.4 mm Hg. DISCUSSION: The herbal supplement increased metabolic rate without changing substrate oxidation. The rise in SBP was consistent with the amount of caffeine the supplement contained. (*Alternative Medicine Review* 2005;10(4):321-325)

Introduction

Tea, a water extract of *Camellia sinensis* L., is a beverage widely consumed around the world. Tea is processed into at least three types: green, oolong, and black. Green tea is the non-oxidized and non-fermented form and contains several polyphenolic components, including epigallocatechin gallate.[1] Dulloo et al found epigallocatechin gallate at a dose of 270 mg/day increased resting metabolic rate when combined with 150 mg/day caffeine, compared to placebo. The same was not true for caffeine 150 mg/day alone.[2] The combination of epigallocatechin gallate and caffeine also synergistically increased the oxygen consumption of brown fat cells *in vitro*.[3]

Although oolong tea decreases weight gain in rodents on a high-fat diet, oxidation of tea has been thought to impair its efficacy in treating obesity.[4] Oolong tea is partially oxidized; oxidation is halted

Andrew T. Roberts, BS – Study coordinator and a master's degree candidate at Louisiana State University, Baton Rouge.

Lilian de Jonge-Levitan, PhD – Supervisor of metabolic carts and metabolic rate trainer at the Pennington Center.

Catherine C. Parker, BS – Medical student, Louisiana State University, Shreveport.

Frank Greenway, MD – Medical Director and Professor at the Pennington Biomedical Research Center; head of clinical trials; consultant to and grant recipient from Numico to study the product.
Correspondence address: Pennington Biomedical Research Center, 6400 Perkins Road, Baton Rouge, LA 70808

by bruising and pan frying the leaves. Black tea, the fully oxidized form of tea, has not been tested for its effect on oxygen consumption, presumably because of the belief that fully oxidized tea would no longer contain the compounds needed to increase metabolic rate. This trial tests the ability of black tea extract in combination with caffeine and other ingredients in the TeaLean® supplement (Numico Research; Boca Raton, Florida) to increase oxygen consumption in humans.

Methods and Materials

Subject Inclusion/Exclusion

Sixteen healthy males and non-pregnant, non-nursing females, ages 21-55 years with a BMI from 20-30 kg/m^2 who ate meals at regular intervals, were included in the study. Good health was assessed by a medical history, physical examination, electrocardiogram, chemistry panel (glucose, creatinine, iron, sodium, potassium, chloride, uric acid, calcium, total protein, phosphorus, albumin, globulin, albumin/globulin ratio, total bilirubin, alkaline phosphatase, gamma-glutamyl transpeptidase, aspartate aminotransferase, alanine aminotransferase, and lactate dehydrogenase), lipid profile (cholesterol, triglycerides, HDL cholesterol, and LDL cholesterol), thyroid stimulating hormone, complete blood count, urinalysis, and a pregnancy test in women with childbearing potential. For study inclusion, lab values, medical history, and physical examination findings were to be within normal limits. The occasional participant with values just outside the normal limits, but not believed to be clinically significant, was allowed to enroll in the study.

Smokers, users of nicotine, subjects taking chronic medications other than oral contraceptives or hormone replacement therapy, subjects who lost or gained more than 4 kg in the preceding three months, and subjects taking ephedra-containing products were specifically excluded from the study. The study was reviewed and approved by a local Institutional Review Board, and those included in the study reviewed and signed a written informed consent form. Characteristics of subjects accepted into the study are shown in Table 1.

Table 1. Characteristics of Subjects

Characteristic	Mean	St. Dev.
Age (years)	27.56	9.59
Weight (kg)	70.26	11.39
BMI (kg/m^2)	25.1	2.65
Male	7	
Female	9	
Caucasian	11	
Non-caucasian	5	

BMI=body mass index

Study Visits

Subjects reported to the Pennington Center on two occasions during the study following the screening process. Before each visit the subjects fasted for 12 hours, refrained from strenuous physical activity for 24 hours, ate a normal diet, and avoided alcohol or caffeine-containing beverages for 48 hours. The study visits were separated by 7 ± 2 days. On each visit, the subject rested for 30 minutes prior to measurement of resting metabolic rate (RMR), respiratory quotient (RQ), systolic blood pressure (SBP), diastolic blood pressure (DBP), pulse, and temperature. Metabolic rate and respiratory quotient were measured for 30 minutes after the resting period by indirect calorimetry using a ventilated hood system (DeltaTrac II metabolic monitor; Datex Inc.; Helsinki, Finland).[5] During this procedure, a transparent ventilated hood is placed over the subject's head and the amount of oxygen consumed and carbon dioxide exhaled is analyzed by the system.

After baseline measurements were taken, subjects were given two capsules to swallow, and the measurements were repeated the last 30 minutes of the hour for two hours. On one visit, the supplement containing black tea extract and caffeine was given,

and on the other visit the subject received identical-appearing placebo capsules. The study was double-blinded and the order in which the supplement and placebo were given was balanced and randomly assigned.

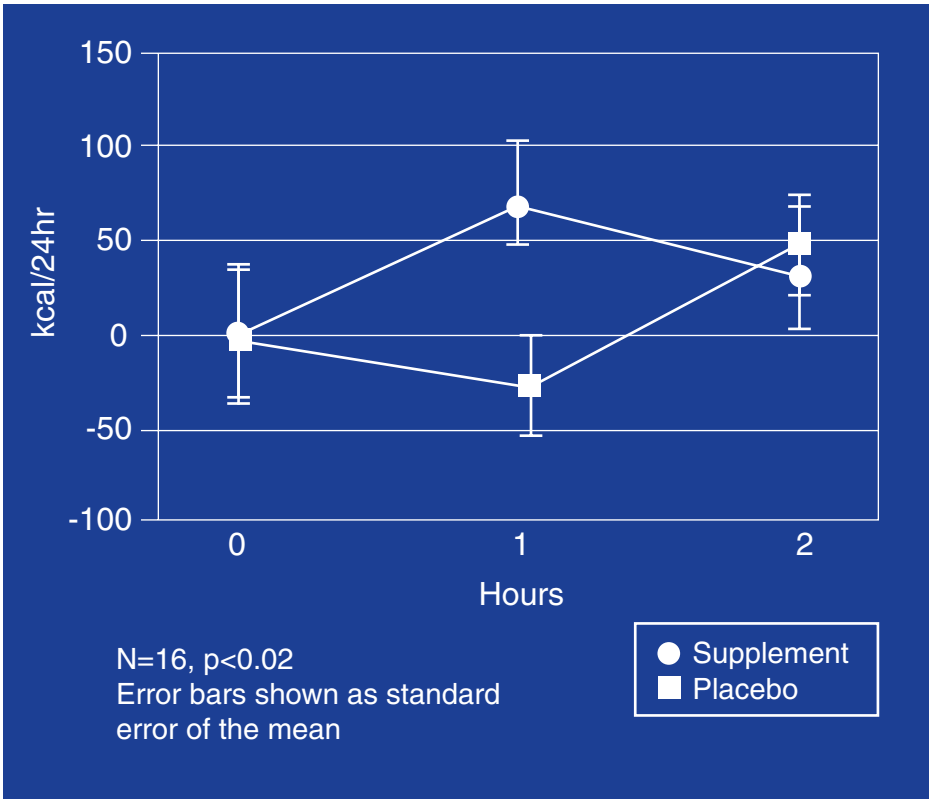
Study Material

The supplement contained water-soluble extracts, including 600 mg black tea extract providing 60-percent polyphenols and 20-percent caffeine, 422 mg guarana extract providing 36-percent caffeine, 100 mg ginger extract providing five-percent gingerols, 5 mg dill weed extract, 150 mg rutin (quercetin-3-O-glucose-rhamnose), and 50 mg vitamin C. Each capsule contained 725 mg for a total of 1,450 mg in two capsules.

Statistical Analysis

The study was analyzed by computing the area under the curve (AUC) for RMR, RQ, pulse, SBP, DBP, pulse rate, and temperature. The two groups were compared by t-test for paired observations.

Figure 1. Differences in Metabolic Rate (Supplement versus Placebo)



Results

The AUC for metabolic rate increased significantly after the herbal supplement by 77.19 ± 120.10 kcal/24 hr^2 ($p<0.02$) compared to placebo (1 kcal is equivalent to 4.184 kJ) (Figure 1). The rise in metabolic rate peaked at one hour, with no statistical significance between active and placebo arms at two hours. The mean rise in metabolic rate was 52.38 ± 29.52 kcal/24 hrs. The AUC for SBP increased 10.3 mm Hg/hr ± 14 mm Hg/hr over two hours in the supplement arm compared to placebo ($p<0.01$). The average increase in systolic blood pressure in the supplement group during the two hours was 3.7 ± 4.4 mm Hg, compared to a decrease of 2.0 ± 8.4 mm Hg in the placebo group (Figure 2). There were no statistically significant differences between the supplement and placebo groups in RQ, DBP, pulse rate, or temperature. (Table 2). Table 3 illustrates baseline values. There were no adverse events, and all patients randomized completed the study.

Discussion

This study confirms that the herbal supplement increased metabolic rate and blood pressure over two hours measured as AUC. The greatest difference between supplement and placebo was seen at one hour, and at the two-hour time point there was no significant difference between the two groups. The supplement also contained ginger extract, dill weed, rutin, and vitamin C. Ginger and dill weed are common dietary herbs. Rutin, a glycoside of quercetin that contains rhamnose and glucose, is a potent antioxidant. The antioxidant vitamin C is present just below the recommended daily allowance in this supplement. The efficacy of the supplement, however, would appear to be due to the black tea extract in combination

Table 2. Herbal Supplement AUC versus Placebo AUC over Two Hours

	Mean difference Supplement/ Placebo	St.Dev.	P value
RMR (kcal/24hrs)	77.19	120.10	0.02
RQ	0.0091	0.0593	N/S
SBP (mm Hg)	10.313	13.923	0.01
DBP (mm Hg)	-1.922	6.629	N/S
Pulse (bpm)	-3.094	8.932	N/S
Temperature (˚F)	0.634	8.022	N/S

RMR=resting metabolic rate
RQ=respiratory quotient
SBP (mm Hg)=systolic blood pressure
DBP (mm Hg)=diastolic blood pressure

Table 3. Baseline Values

	Mean	St.Dev.
RMR (kcal/24hrs)	1604.38	327.29
RQ	0.85	0.04
SBP (mm Hg)	111.50	10.52
DBP (mm Hg)	75.63	8.55
Pulse (bpm)	65.63	7.09
Temperature (˚F)	97.94	0.64

RMR=resting metabolic rate
RQ=respiratory quotient
SBP (mm Hg)=systolic blood pressure
DBP (mm Hg)=diastolic blood pressure

with caffeine, since none of the other constituents have any known effect on metabolic rate.

The rise in metabolic rate was two percent from baseline and compares to an eight-percent rise in metabolic rate from baseline with 70 mg caffeine and 24 mg ephedra.[6] Weight loss with caffeine and ephedra plateaus at six months and yields a seven- to eight-percent loss of body weight. Since there is a one-percent loss of body weight for every one-percent rise in oxygen consumption from baseline with caffeine and ephedra, one could predict the black tea supplement that yielded a two-percent increase in metabolic rate might be expected to result in a two-percent loss of body weight at the six-month weight loss plateau.

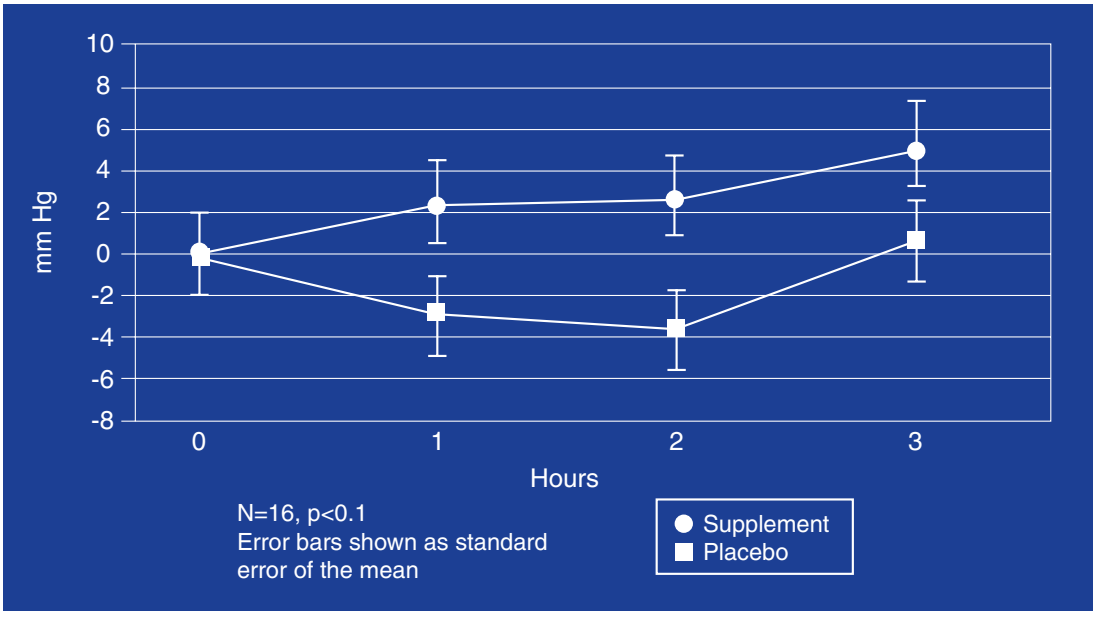
Although there was a one-percent decrease in body weight for every one-percent increase in RMR with caffeine and ephedra, the rise in metabolic rate is only responsible for 25 percent of the weight loss.[7] In addition to causing an increase in metabolic rate, caffeine and ephedra consumption decreases food intake, accounting for the other 75 percent of the weight loss seen in the caffeine and ephedra study. Since both the caffeine with ephedra supplement and the black tea supplement appear to work via the adrenergic nervous system, the presumption could be made that the proportion of weight loss due to increase in thermogenesis and decrements in food intake would be similar in the two studies.

In contrast to a trial with green tea, the respiratory quotient was not decreased in this study.[2] This suggests the black tea extract and caffeine in the supplement increased fat oxidation in proportion to the oxidation of other substrates. The rise in temperature, although not statistically significant, is consistent with an increase in metabolic rate.

The supplement appeared to be well tolerated. The only potential safety concern raised by this study was the increase in systolic blood pressure, an average of 3-4 mm Hg. In a clinical trial of caffeine with ephedrine, blood pressure reached placebo levels by the eighth week of treatment, possibly due to down-regulation of the adrenergic receptors.[8] It is possible a similar situation would prevail with black tea extract and caffeine. Furthermore, increases in SBP after an acute dose of caffeine have been well documented. Acute administration of 100-360 mg of caffeine to normotensive subjects is

reported to result in SBP increases ranging from 2-14 mm Hg.[9] The increase in SBP seen in the present study is in keeping with the published literature.

Figure 2. Differences in Systolic Blood Pressure (Supplement versus Placebo)



Conclusion

This preliminary study confirms the rise in metabolic rate after one hour, and over two hours as measured by AUC with an herbal supplement containing black tea and caffeine. It suggests potential for the supplement to cause weight loss with longer-term treatment. The modest significant rise in systolic blood pressure can be attributed to the known pressor effect of caffeine. Although it is likely there would be a lessening of this effect on blood pressure with chronic treatment, confirmation of this presumption and that of weight loss await a longer-term clinical trial.

Acknowledgements

The authors would like to acknowledge Numico Research who awarded the grant that funded this study.

References

1. Chantre P, Lairon D. Recent findings of green tea extract AR25 (Exolise) and its activity for the treatment of obesity. *Phytomedicine* 2002;9:3-8.
2. Dulloo AG, Duret C, Rohrer D, et al. Efficacy of a green tea extract rich in catechin polyphenols and caffeine in increasing 24-h energy expenditure and fat oxidation in humans. *Am J Clin Nutr* 1999;70:1040-1045.
3. Dulloo AG, Seydoux J, Girardier L, et al. Green tea and thermogenesis: interactions between catechin-polyphenols, caffeine and sympathetic activity. *Int J Obes Relat Metab Disord* 2000;24:252-258.
4. Han LK, Takaku T, Li J, et al. Anti-obesity action of ooling tea. *Int J Obes Relat Metab Disord* 1999;23:98-105.
5. De Jonge L, Agoues I, Garrel DR. Decreased thermogenic response to food with intragastric vs oral feeding. *Am J Physiol* 1991;260: E238-E242.
6. Greenway FL, De Jonge L, Blanchard D, et al. Effect of a dietary herbal supplement containing caffeine and ephedra on weight, metabolic rate, and body composition. *Obes Res* 2004;12:1152-1157.
7. Astrup A, Toubro S, Christensen NJ, Quaade F. Pharmacology of thermogenic drugs. *Am J Clin Nutr* 1992;55:246S-248S.
8. Astrup A, Breum L, Toubro S, et al. The effect and safety of an ephedrine/caffeine compound compared to ephedrine, caffeine and placebo in obese subjects on an energy restricted diet. A double blind trial. *Int J Obes Relat Metab Disord* 1992;16:269-277.
9. Nurminen ML, Niittynen L, Korpela R, Vapaatalo H. Coffee, caffeine and blood pressure: a critical review. *Eur J Clin Nutr* 1999;53:831-839.