TEA: EFFECTS ON CARDIOVASCULAR SYSTEM, BLOOD PRESSURE, EEG AND MANY OTHER SYSTEM OF HUMAN BEING

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ABSTRACT

Catechins belong to the flavan-3-ol class of flavonoids. Green tea catechins are the flavan-3-ols found in green tea leaves (*Camellia sinensis*). The major four catechins in green tea leaves are (-)-epigallocatechin gallate (EGCG), (-)-epicatechin gallate (ECG), (-)-epigallocatechin (EGC) and (-)-epicatechin (EC). They are all polyphenolic substances. Black tea leaves have a much lower content of these catechins. That's because black tea leaves undergo extensive fermentation, during which the majority of the catechins are enzymatically oxidized to the major pigments of black tea leaves, theaflavin and thearubigen.

Keywords: Catechins, theaflavin, thearubigen, *Camellia sinensis*

INTRODUCTION

The green tea catechins make up approximately 30% of the dry weight of green tea leaves. Of the catechins, EGCG is the most abundant one in green tea leaves. Green tea, an aqueous infusion of green tea leaves, has been a popular beverage in China and Japan for centuries. In these countries, it is thought that green tea has a number of health-promoting benefits, and it is used in the management of various disorders. Epidemiological studies suggest that green tea may have cancer chemopreventive, as well as anti-atherogenic, properties.

Mechanism of action

Green tea catechins have been found to have a number of antioxidant activities, including scavenging of such reactive oxygen species as superoxide, hydroxyl and peroxyl radicals, inhibition of lipid peroxidation, inhibition of 2'-deoxyguanosine oxidation in DNA to 8-hydroxy-2' -deoxyguanosine and inhibition of the oxidation of low-density lipoproteins.

The possible anticarcinogenic activity of the green tea catechins may be accounted for by a number of different mechanisms. Much of the research has been done with EGCG, and it appears that, just as EGCG appears to be the most potent antioxidant of the green tea catechins, it also may have the greatest possible anticarcinogenic activity. EGCG has been shown to inhibit angiogenesis. EGCG and ECG have been demonstrated to inhibit tyrosine phosphorylation of the receptor tyrosine kinase PDGF-Rbeta (platelet-derived growth factor receptor-beta) and its downstream signaling pathway and, consequently, to inhibit transformation of human glioblastoma cells. Interestingly, only the green tea catechins possessing the gallate group in their structure had this activity. Green tea catechins have also been found to upregulate the synthesis of some hepatic phase II enzymes that are involved in the detoxication (detoxification) of some xenobiotics, including chemical carcinogens.

In addition to their possible activity in preventing malignant transformation and inhibiting tumor growth, the green tea catechins may have antimetastatic potential. In this regard, EGCG has been found to inhibit the proteolytic enzyme urokinase. Urokinase is an enzyme that cancer cells may use in order to invade normal tissue and form metastases. EGCG and ECG have been demonstrated to inhibit metalloproteinase- -2(MMP-2) (also known as gelatinase A) and metalloproteinase-9(MMP-9) (also known as gelatinase B). These enzymes also appear to play an important role in tumor invasion and metastases. Finally, EGCG has been found to downregulate the expression of the androgen receptor in human prostate cancer cells in culture, consequently inhibiting androgen action. This and its inhibition of 5-alpha reductase may account for EGCG's antiproliferative effect on cultured human prostate cancer cells.

The possible anti-inflammatory activity of the green tea catechins may, in large part, be accounted for by their antioxidant actions. EGCG has been found to inhibit the activity of the transcription factors AP-1 and NF-kappa B, both of which may mediate many inflammatory processes and both of which may be activated by reactive oxygen species. EGCG's antioxidant activity may itself mediate this inhibition.

Again, a few different mechanisms may come into play in the possible anti-atherogenic activity of the green tea catechins. PDGF-R beta, which was discussed above, may also be involved in smooth muscle proliferation. Smooth muscle proliferation is involved in the pathogenic process of atherosclerosis. EGCG and ECG have been shown to inhibit tyrosine phosphorylation of PDGF-Rbeta and its downstream signaling pathway and, consequently, the proliferation of smooth muscle.

The inhibition of the oxidation of low-density lipoproteins is another possible anti-atherogenic mechanism. The green tea catechins may also have antithrombotic activity and may aid in lowering total cholesterol and LDL-cholesterol levels. The antithrombotic effect appears to be at the platelet level. These catechins have been found to inhibit ADP- and collagen-induced platelet aggregation in rats. Coagulation parameters were not affected. The mechanism of the possible cholesterol-lowering effect is unclear. It is thought that the green tea catechins may stimulate the

secretion of bile salts and the fecal excretion of cholesterol.

The green tea catechins have been found to promote thermogenesis. The proposed mechanism for this is inhibition of the enzyme catechol-O-methyl-transferase. This enzyme inactivates norepinephrine.

Work Carried out on Tea

Two important studies have been done assessing the thermogenic effect of green tea in humans. The first was a preliminary study that compared the effects of green tea extract (containing 150 mg caffeine and 270 mg EGCG), caffeine (150 mg), and placebo on 24-hour energy expenditure. While caffeine alone increased energy expenditure by about .6% over placebo (which was not statistically significant in this study), the green tea extract increased it by 3.5%. Additionally, while the oxidation of fat contributed to 31.6% of energy expenditure in the placebo group, in contributed 41.5% in the green tea extract group, indicating that the increase in energy expenditure was due to the breakdown of fat, not protein. Measurements of urinary nitrogen excretion, which were significantly different between treatments, further supported this contention. It is also interesting to note that thermogenic response was not correlated with body mass index (BMI), implying that green tea may be equally as effective in relatively lean individuals. Finally, the increased thermogenesis was not accompanied by an increase in heart rate, which makes green tea distinct from other thermogenic d The research, published in a recent issue of the *American Journal of Cardiology*, found that although people who drank green tea everyday were no less likely to have coronary artery disease than people who did not drink tea, they were much less likely to have a heart attack.

"What we found was that myocardial infarction (heart attack) was less prevalent in green tea drinkers, suggesting that regular green tea intake may be playing a protective role against the development of myocardial infarction in Japanese," lead author Dr Yukihiko Momiyama of the National Defense Medical College in Saitama, told NutraIngredients.com.

Significant research suggests that flavonoids, abundant in green tea and also other foods such as wine and chocolate, may protect against atherosclerosis, partly by fighting the effects of damaging free radicals, linked to the onset of heart disease, stroke and several other diseases.

Momiyama's team found that the number of cups of green tea consumed daily did not affect the risk or severity of coronary artery disease. However, people who drank at least one cup of green tea per day were 42 per cent less likely to have a heart attack than people who did not drink green tea.

MATERIALS AND METHODS

Healthy Female (n = 10), 20 years of age were recruited to participate in a 3-wk placebo controlled parallel study. Subjects were recruited from the MCOPS Manipal University of 2008. The selected subject were explained about the procedures and written informed consent (Annexure-1). Exclusion criteria consisted of the following: had not had a cold in the past two years; healthy diet; steroids; chemotherapy or other immune suppressing therapy within the last year; chronic antibiotics or other infectious disease preventative; chronic illness; recent surgery or illness; pregnant and/or lactating females. Also excluded were those who daily consumed: greater than one cup (250mL) of tea; an average of seven or more servings of fruits and vegetables; herbal supplements, vitamins other than a multivitamin or vitamin D. The study was conducted from July through October of 2008.

Separation of tea from its suitable sources

Measurement of effects of tea on Heart Functions like

    1. ECG

    2. Blood Pressure

    3. EEG

RESULTS AND DISCUSSION

Effects of tea on Cardiovascular Functions: In present study Tea found to increase in Aptitude of MAP and Duration of MAP. There were lengthened Left Atrial Effective Refractory Period after one hour of tea consumption. Single cup of tea did not have any effect on QRS interval, QT interval and QTc interval (Table 1).

Table 1: Effect on ECG

Aptitude of MAP	Slightly Increased
Duration of MAP	Slightly Increased
Left Atrial Effective Refractory Period	lengthened
QRS interval	effect
QT interval	No effect
QTc interval	effect
n=10, Interpretation carried out by Physio-pac multichannel data acquisition system	

Effect of Tea on BP

In present work after consumption of Tea, SBP, DBP and HR found to be increased as compared to that were before consumption of Tea.

Table 2: Effect of Tea on SBP, DBP and HR

	SBP	DBP	HR
Before consumption of Tea	127 ± 3.00	81 ± 2.57	75 ± 2.50
After consumption of Tea	230 ± 7.33 [NS]	90 ± 1.90 [NS]	76 ± 1.88 [NS]

Effect of Tea on EEG

Table 3: mental conditions

Mental Condition	Brain wave	Frequency Graph
Sound sleep	Δ	
Light sleep/drowsiness	Θ	
Relax yet alert	A	
Excitable	B	
Cognitive processing	Γ	

DISCUSSIONS

Hypertension

In studies of spontaneously hypertensive rats, L-theanine administration caused a significant reduction in blood pressure. [15, 16] Whether humans will experience similar results has yet to be determined; however, theanine might find a place in antihypertensive treatment regimens.

Caffeine is a well-known stimulant and naturally present in black tea, although black tea is not a high caffeine drink, it seems to provide the beneficial effects of caffeine on mental performance. Indeed, doses of caffeine equivalent or lower than those found in a cup of tea (for example, 35 mg) have been found to have an effect on cognitive performance and have been associated with increases in subjective score for alertness, energy and well being.

L-theanine increases alpha brain wave activity which is associated with a relaxed yet alert mental state during rest. Several studies directly support that in individuals at rest, L- theanine increases alpha brain wave activity.

Emerging research is also suggesting that L-theanine may play a role in attention. Activity in the alpha brain wave has been linked with general attentional processes, and recent research has shown that oscillations in the alpha wave are a key component in selective attention. Selective attention is demonstrated when individuals are able to ignore distractions from, for example, auditory stimuli, and focus on another sensory stimulus such as visual stimuli. It is like being able to ignore people talking while being able to focus on the road during driving. This is known as the "alpha attention effect".

Furthermore, two other randomised, double-blind crossover studies commissioned by the Lipton Institute of Tea have investigated the effects of black tea on focused attention, as assessed by standardized tests on alertness and subjective questionnaires. These studies have shown that consumption of 1 to 2 cups of black tea improves the ability to focus attention and increase alertness. Because L-theanine and caffeine are the two tea components known to influence mental performance, it is thought that their combined natural presence in black tea is responsible for the observed effects.

Mode by which Tea Effect on Mental Performance and Mood

Hydration

Tea, as an ideal fluid choice for hydration, [1] can make a significant contribution to body's hydration status, helping to promote mental performance. Black tea can provide a beneficial effect on mental performance through hydration. Fluid balance is critical for mental performance as dehydration can decrease alertness, concentration, performance and short-term memory in the DRI for water (Dietary Reference Intakes), the Food and Nutrition Board state.

L-Theanine

L-theanine is an amino acid naturally found in tea, but is otherwise rare in nature. L-theanine, through its effect on electrical brain activity, appears to have psychoactive properties. Several studies [2-6] directly support that in individuals at rest, L-theanine increases alpha-brain waves, which are associated with a relaxed but alert mental state. L-theanine may play a role in attention. [2] Activity in the alpha-band has been linked with general attention processes, [6] and that oscillations in the alpha band are a key component in selective attention. For example, there is a very specific pattern of alpha activity when humans focus their attention on information coming from one sensory modality (e.g. auditory) while attempting to exclude or suppress inputs from a distracting sensory modality (e.g. visual).[7,8]

Caffeine

Caffeine is a well-known stimulant and it is widely believed to have an arousing effect on the brain. There is evidence that caffeine has specific effects on cognitive function at low to moderate doses (50 – 300mg). This is most apparent under conditions when circadian alertness is likely to be low10 but it has also been shown when reduced alertness is not involved [11]. Caffeine-induced increases in alertness and vigilance are often evident in faster responses. [12, 13] Caffeine is also known to increase the speed of information processing and response selection [14, 15]. Faster responses have been demonstrated after a single dose of 40mg caffeine, and following a realistic consumption pattern of four doses of 60mg over five hours.[11] The subjective effects of

caffeine include increased feelings of well-being, energy, motivation, self confidence, alertness and concentration.[12]

Although black tea is not a high caffeine drink (around half the caffeine content of coffee – see Table 1), it seems to provide the beneficial effects of caffeine on mental performance. [1,2] Indeed, doses of caffeine equivalent or lower than those found in a cup of tea (e.g. 40 mg) have been found to have an effect on cognitive performance [16] and have been associated with increases in subjective scores for alertness, energy and well being.[2,20]

Although caffeine is undoubtedly responsible for some of the beneficial effects of black tea on mental performance, research suggests that other factors in tea may also play a role: when the level of caffeine in tea is matched to other caffeinated beverages, tea appears to have differential effects on measures of alertness and potentially produces better effects [1, 2, and 3].

Interaction between caffeine and L-theanine

Emerging science suggests an interaction of L-theanine and caffeine on cognitive performance. [17] Showed that 250mg L-theanine significantly interacted with 150mg caffeine and enhanced the effects of caffeine on a number of cognitive tasks, as well as improved some aspects of mood. [18, 19] also report a synergistic effect of L-theanine (100mg) and caffeine (50mg) on the ability to focus attention. Although the amount of L-theanine and caffeine used in those studies is different from the ratio of L-theanine/caffeine found in black tea, it does suggest that L-theanine and caffeine may interact to improve mental performance [20].

CONCLUSION

Present research on black tea may explain the unique effects felt by tea drinkers that are so different to other hot beverages. 1 to 2 cups of black tea naturally stimulates alpha brain waves, which are associated with a relaxed yet alert state of mind and this effect might be due to L-theanine, a natural component found almost exclusively in tea as mood elevator and alertness.

REFERENCES

1. Creutzfeldt OD, Watanabe S, Lux HD. Relations between EEG phenomena and potentials of single cortical cells. I. Evoked responses after thalamic and epicortical stimulation. *Electroencephalogr Clin Neurophysiol.* 1966; 20: 1-18.

2. Hamalainen M, Hari R, Ilmoniemi RJ, Knuutila J, Lounasmaa OV (1993). "Magnetoencphalography - Theory, instrumentation, and applications to noninvasive studies of the working human brain". *Reviews of Modern Physics* 65: 413-497.

3. Klein, S., & Thorne, B. M. (2007). *Biological psychology*. New York, N.Y.: Worth.

4. Cahn BR, & Polich J. (2006). Meditation states and traits: EEG, ERP, and neuroimaging studies. *Psychological Bulletin*. 132 (2), 180-211.

5. Epstein, Charles M. (1983). *Introduction to EEG and evoked potentials*. J. B. Lippincot Co.. ISBN 0-397-50598-1.

6. Montez T, Poil S-S, Jones BF, Manshanden I, Verbunt JPA, van Dijk BW, Brussaard AB, van Ooyen A, Stam CJ, Scheltens P, Linkenkaer-Hansen K (2009). "Altered temporal correlations in parietal alpha and prefrontal theta oscillations in early-stage Alzheimer disease". *PNAS* 106 (5): 1614-1619. doi: 10.1073/pnas.0811699106. http://www.pnas.org/content/106/5/1614.abstract.

7. Swartz, B.E (1998). "Timeline of the history of EEG and associated fields" (PDF). *Electroencephalography and clinical Neurophysiology* 106: 173–176.

8. Pravdich-Neminsky VV. Ein Versuch der Registrierung der elektrischen Gehirnerscheinungen (In German). Zbl Physiol 27: 951–960, 1913.

9. Katie, Drummond; Noah Schachtman (2009-05-14). "Pentagon Preps Soldier Telepathy Push". *Wired*. http://www.wired.com/dangerroom/2009/05/pentagon-preps-soldier-telepathy-push/. Retrieved 2009-06-14.

10. The clinical value of the ECG in noncardiac conditions." *Chest* 2004; **125(4)**: 1561-76.

11. Waller AD (1887). "A demonstration on man of electromotive changes accompanying the heart's beat". *J Physiol (Lond)* **8**: 229–34.

12. Einthoven's String Galvanometer". Pubmedcentral.nih.gov. 1927-09-29. http://www.pubmedcentral.nih.gov/articlerender.fcgi?artid=2435435. Retrieved 2009-08-15.

13. Cooper J (1986). "Electrocardiography 100 years ago. Origins, pioneers, and contributors". *N Engl J Med* 315 (7): 461–4.

14. Mark, Jonathan B. (1998). *Atlas of cardiovascular monitoring*. New York: Churchill Livingstone. ISBN 0443088918.

15. Mark JB "Atlas of Cardiovascular Monitoring." p. 130. New York: Churchill Livingstone, 1998. .

16. Verrier, Richard L. "Dynamic Tracking of ECG Heterogeneity to Estimate Risk of Life-threatening Arrhythmias." CIMIT Forum. September 25, 2007.

17. Hurst JW. Current Perspective: Naming of the Waves in the ECG, With a Brief Account of Their Genesis. Circulation. 1998;98:1937-1942.

18. http://www.cvphysiology.com/Arrhythmias/A013.htm Retrieved 2009-08-15.

19. Mark JB "Atlas of Cardiovascular Monitoring." p. 130. New York: Churchill Livingstone, 1998.

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