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Effect of Tea on Balance

**EFFECT OF OOLONG TEA ON BALANCE PERFORMANCE
IN NAÏVE TEA USERS – A PILOT STUDY**

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ABSTRACT

Ben Zhou and Michael Lovegren. Effect of Oolong Tea on Balance Performance in Naive Tea Users – A Pilot Study, **JEPonline** 2007;10(5):43-50. Since the positive results from recent research, herbal tea has been recommended as an alternative for control of blood glucose and prevention of cancers and cardiovascular diseases. However, the effects of herbal tea on balance control, have not been reported. Herbal tea contains components that enhance central nervous system activities, balance may be impacted immediately after using it. The purpose of this pilot study is to determine the effect of hot-water extracted Oolong tea on balance performance. Thirteen healthy college students who were naïve tea users were volunteered to participate in this study. Three balance tests, Sensory Organization (SOT), Adaptation (AT), and Limits of Stability tests (LOS), were conducted on a Neuro-Com Balance System before and after using the tea. The blood glucose and dizziness were evaluated as well by the One Touch system and a questionnaire. The paired t-test was used to compare the difference between the pre- and post-tests in all variables. Oolong tea significantly lowered blood glucose by an average of 11mg % ($p < 0.05$) without change in the dizziness scores ($p > 0.05$). Balance control was improved after treatment. A most significantly improvement was observed in AT ($p < 0.01$). Vestibular ratio, equilibrium and end point excursion scores were enhanced as well ($p < 0.05$). In conclusion, Oolong tea may have a positive impact on balance in our subjects, which might be related to the enhanced central nervous system activity due to caffeine stimulation contained in Oolong tea.

Key Words: Caffeine, Central Nervous System Stimulant, Balance Tests (SOT, AT, and LOS).

INTRODUCTION

The effects of tea on human health have been intensively studied for years. A number of the recent studies indicated that several components in herbal tea, such as caffeine, polyphenoles, flavonoids, catechins, and polysaccharides, have effects on cancer prevention, blood glucose control, and fat utilization (1, 3, 5, & 7). Therefore, herbal tea has been highly recommended as an alternative for control of blood glucose, prevention of cancers and cardiovascular diseases (2, 4, & 6). Since drinking high concentrated tea may induce temporary weakness and dizziness, which might due to hypoglycaemia (8), as a result of using herbal tea, balance performance might be negatively impacted. On the other hand, the caffeine found in tea is classified as a central nervous system stimulant (<http://www.holymtn.com/tea/teacaffeine.htm>) (<http://www.vivarin.com/sitemap.htm>). It might have a positive impact on balance performance since Cole and Eva suggested that caffeine can be used to treat fatigue, drowsiness and improve endurance performance in athletes (9 & 10). The purpose of this pilot study is to investigate whether hot-water extracted Oolong tea has a positive or negative impact on balance performance in college students who are naïve tea users.

METHODS

Subjects

The study was designed as a randomized, double-blind design, however, only thirteen healthy college students who were naïve tea users volunteered to participate in the study. Thus, subjects served as their own controls due to the limited sample size.

Table 1. Characteristics of Subjects (n = 13).

<i>Age</i>	<i>Body Height</i>	<i>Body Weight</i>	<i>Body Composition</i>
<i>(yrs)</i>	<i>(m)</i>	<i>(kg)</i>	<i>(%)</i>
27.3 ±6.8	1.70±0.1	68.5 ±10.7	25.6±9.3

Procedures

The subjects' health and tea using status were determined by the Physical Activity Readiness Questionnaire (PAR-Q), Personal Health History Questionnaire (PHH-Q), and Tea Using Scale (TU-S).

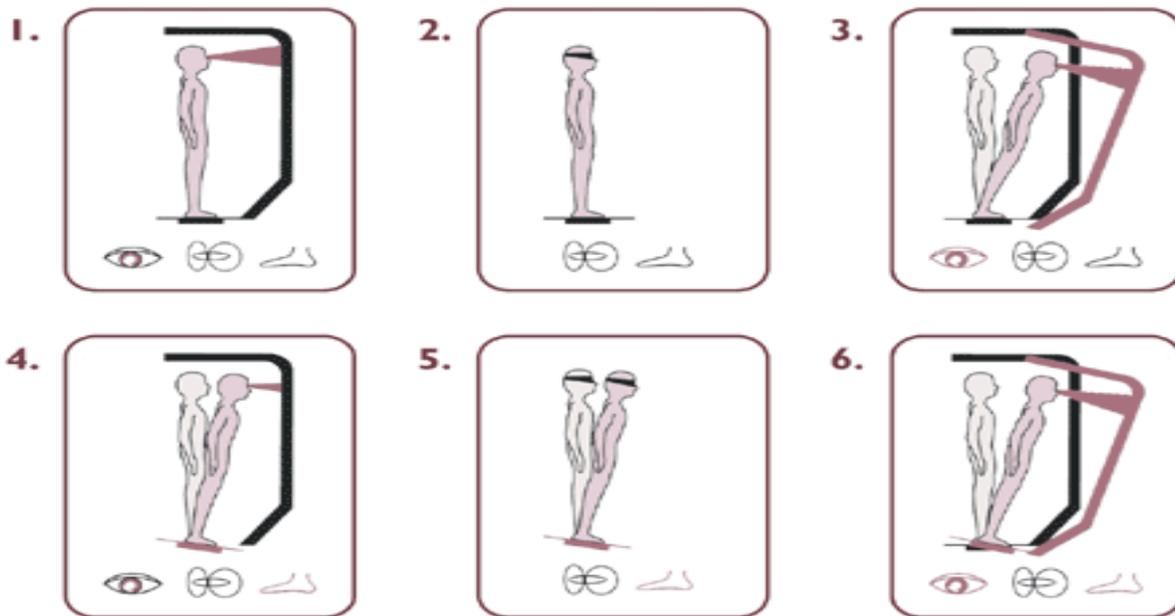
The naïve tea users were defined as less than three cups of iced tea for each week. On the test day, the subjects reported to the Center for Successful Aging at California State University Fullerton (CSUF). After completed the PHH-Q, PAR-Q, TUS, and Test Sheets, the initial measures were conducted to evaluate the baseline of the blood glucose, balance control, weakness, and dizziness status. And then, the subjects were treated by 75ml of Oolong tea. A questionnaire regarding the degree of dizziness and weakness were reevaluated 25 minutes after treatment. The blood glucose and balance control were retested 30 minutes after treatment (3). In concerning the learning effect, each subject was allowed to practice once for each of the following three balance tests before the initial evaluation (20).

Equipment and Balance Control Tests

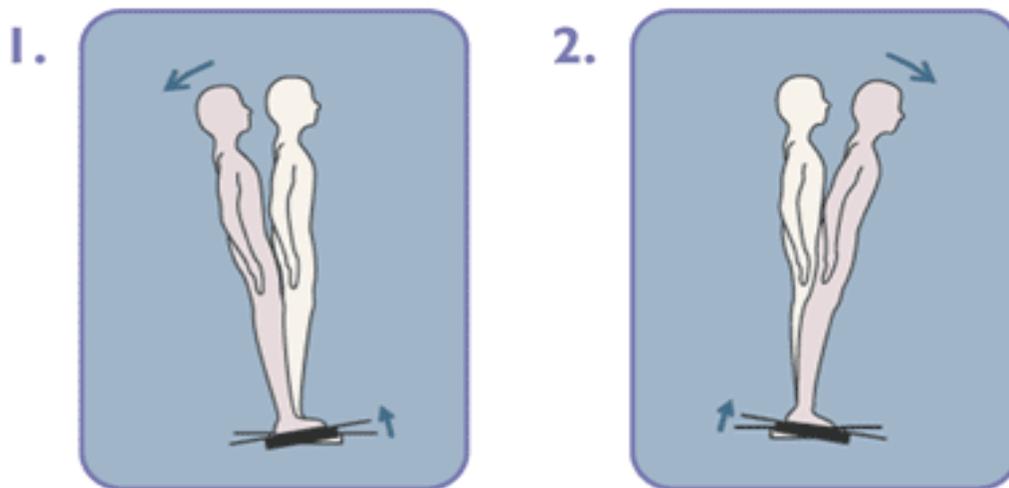
Three balance tests, the Sensory Organization (SOT), Adaptation (AT), and Limits of Stability tests (LOS), were conducted on a NeuronCom Smart Balance System (11, 12)

Sensory Organization Test

The SOT was utilized to measure the subject's ability to use somatosensory, visual, and vestibular information in control of body balance. During the SOT, subjects were asked to stand as little sway as possible for 20 seconds under six conditions (13). Subjects were given three trials for each condition. The somatosensory, visual, and vestibular ratios proposed by Nashner (12) were used to



Sensory Organization Test



Toes Up and Toes Down Rotations

compare balance performance before and after using Oolong tea. A ratio of 100 indicates “no sway” while 0 suggests “loss of balance” (14).

Adaptation Test The AT was used to test the subject’s ability to minimize sway when the supported surface was suddenly inclined or declined by rotating the platform in toes-up or toes-down to provoke automatic motor responses (11). Each subject was given five trials for toes-up or toes-down. An average score was used to compare balance control before and after tea treatment. A

lower score of the AT represents a better adaptation of sway control in a suddenly changed environment.

Limits of Stability The LOS measured subject's ability to quantify the maximum distance a person can intentionally displace their center of gravity (COG) to eight different directions based on the display of their performance on a computer monitor without losing balance (15). The subject's performance was evaluated by the reaction time (RT), COG movement velocity (MVL), directional control (DCL), end point excursion (EPE), and maximum excursion (MXE) (11, 12, and 18). Subjects have to complete each trial by eight seconds. The RT is measured in seconds from the command to starting movement. The MVL is recorded by an average speed of COG movement in degrees per second. The EPE is the distance of the first movement towards the target, which was expressed as a percentage of the maximum LOS distance. The MXE is the maximum distance achieved during trial, which was expressed in percent. The DCL is a comparison between the amount of movement in the intended direction (toward the target) and the amount of extraneous movement away from the target, which was expressed by percent as well. A score of 100% suggested no off-target movement. A composite score for each category of the LOS was used to determine the effect of Oolong tea on the limits of stability performance (12).

Blood Glucose Test

Blood glucose was measured by the One Touch blood glucose system produced by the LifeScan Inc. The blood samples were collected from the finger tip.

Weakness and Dizziness Scale

Weakness and dizziness were evaluated by a numerical scale of 1 to 10, 1 being no weakness or dizziness felt and 10 being most severe.

Preparation of Tea

Oolong tea were freshly prepared on each occasion by adding 100 ml of boiling distilled water to 25g of dry tea leaves (3). The tea was allowed to infuse for more than 10 minutes and filtered to 75ml of distilled tea drink before it was used by the subjects. As the concentration of herbal tea is much more important than the dose in initiation of an acute effect, the dose of Oolong tea was not justified with subjects' body weight (3). The concentration of tea used in our study was very high.

Statistical Analyses

The paired student t-test was employed to compare the statistical difference of the average scores between pre- and post-tests in all variables. The significant level was set at $p < 0.05$.

Table 2. Comparisons of Physiological Responses

	<i>Blood Glucose</i> (mg %)	<i>Weakness Scale</i> (1 – 10)	<i>Dizziness Scale</i> (1 – 10)
Pre-test	108.5±15.1*	2.00±1.08	1.62±1.33
Post-test	97.8±12.7*	2.46±1.45	1.62± 1.04

* Denotes the significant difference between pre- and post-tests at level of $p < 0.05$

RESULTS

Our results indicated that subject's blood glucose was significantly lowered by an average of 11 mg % ($p < 0.05$) as a result of the treatment of Oolong tea. However the hypoglycemia did not occur in any subject in the present study. According to the results of the weakness and dizziness tests, Oolong tea did not change in subject's weakness and dizziness scores ($p > 0.05$) (Table 2).

Table 3. Comparisons in the Sensory Organization Test

	<i>Equilibrium</i>	<i>Somatosensory Ratio</i>	<i>Visual Ratio</i>	<i>Vestibular Ratio</i>
Pre-test	80.6±5.06*	0.998±0.009	0.904±0.019	0.813±0.054*
Post-test	83.5±4.62*	0.996±0.006	0.911±0.022	0.844±0.040*

* Denotes the significant difference between pre- and post-tests at level of $p < 0.05$.

The most interesting finding of the present study was that compared to the baseline, Oolong tea did improve the subject's performance on balance control in several tests with a most significantly enhancement observed in the adaptation test ($p < 0.01$) (Table 4). In the SOT, the equilibrium scores and vestibular ratio were enhanced ($p < 0.05$), but this positive effect was not seen in the somatosensory and visual ratios ($P > 0.05$) (Table 3). In the LOS, the end point excursion scores was significantly changed ($p < 0.05$), but no changes were seen in other variables ($p > 0.05$) (Table 5).

Table 4. Comparisons in the Adaptation Test

	<i>Toes Up</i>	<i>Toes Down</i>
Pre-test	63.2±14.62**	45.8±6.64**
Post-test	53.5 ±8.51**	42.6±6.25**

** Denotes the significant difference between pre- and post-tests at level of $p < 0.01$.

on weakness and dizziness scores ($p > 0.05$) (Table 2).

DISCUSSION

Effect of Oolong Tea on Blood Glucose and Dizziness

Our data agreed with the previous studies (2, 3, 8) that the hot-water extracted Oolong tea significantly reduced the subject's blood glucose to an acceptable value ($108±15.1$ vs. $97.8±12.7$ mg %, $p < 0.05$) by an average of 11 mg %. However, no hypoglycemia was occurred and no negative impact

Effect of Oolong Tea on Balance Performance

The most interesting finding of the present study was that the hot-water extracted oolong tea positively enhanced balance performance in several variables. Our data suggested that after a cup of Oolong tea, subjects achieved less COG sway in equilibrium test and vestibular ratio in which they had rely on the vestibular system during stance with the eyes closed and inaccurate somatosensory input. Particularly, the magnitude of COG sway during recovery period following a support face suddenly rotated by either toes-up or toes-down was significantly decreased in the post-test ($p < 0.01$). To compare with same population, our pre-test scores in the AT are similar with the population average scores, which are 63.2 vs. 64.2 in toes-up and 45.8 vs. 46.8 in toes-down respectively (11). In addition, the subject's performance in voluntary COG shifting with respect to LOS was significantly improved as a result of Oolong tea treatment ($p < 0.05$). The improvement in the above variables

Table 5. Comparisons in the Limits of Stability Tests

	<i>RT</i>	<i>MVL</i>	<i>EPE</i>	<i>MXE</i>	<i>DCL</i>
Pre-test	0.77±0.13	5.63±1.61	83.0±11.31*	98.2±5.88	77.2±7.00
Post-test	0.72±0.17	5.81±1.52	88.2±9.24*	98.0±6.51	75.9±7.41

* Denotes the significant difference between pre- and post-tests at level of $p < 0.05$.

was probably due to caffeine stimulation of the central nervous system (10), which was also founded in Oolong tea leaves:

- (<http://www.ibiblio.org/herbmed/fags/medi-2-14-green-tea.html>)
- http://www.vivarin.com/infocenter/caffeine_background.pdf)

Cole and his colleagues suggested that caffeinated drinks and caffeine ingestion reduced the rate of perceived exertion and elevated the central nervous system activity, which, in turn, increased recruitment of motor units, and resulted in improvement in endurance performance (9). Eva Kovacs et al. proved that performance of 1 hour time trial cycling was improved after using the low (150 mg / L) and medium (225 mg / L) dosage of caffeine (10). Since no differences in FFA utilization were observed when caffeine was added in the study, they postulated that the ergogenic effect of caffeine was more likely due to the central stimulation.

Oolong tea contains about 2 to 3 percent of caffeine (<http://www.holymtn.com/tea/teacaffeine.htm>). What we used was 25 grams of tea leaves per 100 ml of water for each tea drink. The caffeine content of our Oolong tea was greater than that in the aforementioned research.

Since no differences were found in the somatosensory and visual ratios, it might be probably explained by that in normal condition, people rely on the above two sensory systems in responsible for balance control more than the vestibular system (13), therefore, the vestibular system might have more room to be improved.

CONCLUSIONS

Compared to the baseline, Oolong tea significantly reduced blood glucose. Subject's performance on balance control was improved as the results of tea treatment. In conclusion, it was the first time to reveal that Oolong tea positively affected the balance performance in young college naïve tea users, which might be related to the enhanced central nervous system activity due to stimulation of caffeine contained in Oolong tea. Whether the same results can be found in different population, such as diabetes (19), needs further investigation.

Potential Limitation

As aforementioned above, the current study did not receive any grant. Further, some costs such as herbal tea, transportation, and parking fee were even from our own pocket. In addition, the data collection was limited by four weeks. Therefore, the major concern of this pilot study was the experimental design such as a small and non-random sample, no control group, no control on subjects' diet. A further study with regarding the limitations of the study is warranted until the funding is available.

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REFERENCES

1. Benzie IFF, Szeto YT, Strain JJ and Tomlinson B. Consumption of Green Tea Causes Rapid Increase in Plasma Antioxidant Power in Humans. *Nutrition and Cancer* 1999;34:83.
2. Gomes A, Vedasiromoni JR, Das M, Sharma RM, Ganguly DK. Anti-hyperglycemic effect of black tea in rats. *J Ethnopharmacol* 1995;45:223-6.
3. Hosoda K, Wang MF, Liao ML, Chuang CK, Iha M, Clevidence B, Yamamoto S. Antihyperglycemic Effect of Oolong Tea in Type 2 Diabetes. *Diabetes Care* 2003;26: 1714-1718.
4. Katiyar Santosh K: Skin Photoprotection by Green Tea: Antioxidant and Immunomodulatory Effects, University of Alabama at Birmingham; *Immune, Endocrine & Metabolic Disorders* 2003;3:234-242.
5. Kurihara H, Fukami H, Koda h, Tsuruoka N, Sugiura N, and Shibata H, Tanaka T.: Effects of oolong tea on metabolism of plasma fat in mice under restraint stress. *Biosci Biotechnol Biochem* 2002;66:1955-1958.
6. Rumpler W, Seale J, Clevidence B, Judd J. Oolong Tea Increase Metabolic Rate and Fat Oxidation in Men. *The Journal of Nutrition* 2001;131:2848-2852.
7. Zhu Qy, Hackman RM, Ensunsa JL, Holt RR, Keen CL: Antioxidative activities of Oolong tea. *Agric Food Chem* 2002;50:6929-34.
8. Shenoy C. Hypoglycemic activity of bio-tea in mice. *Indian J Exp Biol* 2000;38:278-279.
9. Cole KJ, Costill DL, Starling RD, Goodpaster BH, Trappe SW, and Fink WJ. Effect of caffeine ingestion on perception of effort and subsequent work production. *Int. J. Sport Nutr* 1996;6:14-23.
10. Kovacs EMR, Stegen JHCH, and Brouns F. Effect of caffeinated drinks on substrate metabolism, caffeine excretion, and performance. *J Appl Physiol* 1998; 85: 709-715.
11. Jacobson GP, Newman CW, and Kartush JM. **Handbook of Balance Function Testing**. St. Louis: Mosby Year Book, 1993.
12. Nashner L. M. **Computerized Dynamic Posturagraphy: Clinical Application**. In: **Handbook of Balance Function and testing**. St. Louis: Mosby Year Book, 1993.
13. Tsang WW and Hui-Chan CH. Effect of 4- and 8-wk intensive Tai Chi training on balance control in the elderly. *Med Sci Sports Exerc* 2004;36: 648-657.
14. Tsang WW and Hui-Chan CH. Effects of exercise on joint sense and balance in elderly men: Tai Chi versus golf. *Med Sci Sports Exerc* 2004;36:658-667.
15. Tsang WW, N, Wong VSW, Fu SN, and Hui-Chan CH. Tai Chi improves standing balance control under reduced or conflicting sensory conditions. *Arch Phys Med Rehabil* 2004; 85:129-37.
16. Di Nardo, et al. The use of dynamic posturography to detect neurosensorial disorder in IDDM without clinical neuropathy. *Journal of Diabetes and Its Complications* 1999;13: 79-85.
17. Rohrbaugh JW, Anokhin AP, Sirevaag EJ, Goebel JA. Effects of lifetime ethanol consumption on postural control: A computerized dynamic posturography study, *J Vest Research* 2002;12: 53-64.

18. Rose, et al. Can the control of bodily orientation be significantly improved in a group of older adults with a history of falls? **JAGS** 2000;48: 275-282.
19. Simmons, et al. Postural stability of diabetic patients with and without cutaneous sensory deficit in the foot. **Elsevier, Diabetes Research and Clinical Practice** 1997;36: 153-160.
20. Hu MH, Hung YC, Huang YL et al. Validity of force platform measures for stance stability under varying sensory conditions. **Proc Natl Sci Counc Repub China B** 1996; 20:78-86.

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