Mark ET Willems
Institute of Sport
University of Chichester
College Lane
Chichester, PO19 6PE
United Kingdom

Can you enhance exercise-induced fat oxidation with green tea drinking?

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ABSTRACT
Green tea is associated with health benefits. Some studies showed enhanced exercise-induced fat oxidation with intake of capsulated green tea components, primarily with epigallocatechin-3-O-gallate, but that effect was never observed with drinking brewed green tea from unpowdered leaves. In 2013, Hodgson et al. published a review article on green tea intake and exercise-induced fat oxidation. This review will cover some of the green tea studies since 2013 with only one study on the effects of drinking green tea. A study in 2018 showed that drinking a few cups with *normal amounts of* powdered green tea leaves (i.e. Matcha) enhanced fat oxidation during brisk walking in females. Capsulated intake of green tea components but also regular drinking of normal amounts of Matcha have the potential to provide benefits for health and exercise.

SHORT REVIEW

Nutraceuticals are phytochemicals in the diet that provide multiple health benefits but have no or negligible nutritional value. The drinking of brewed green tea provides health benefits due to the water-soluble components from the leaves of the green tea shrub. Green tea leaves have a polyphenol composition, consisting primarily of catechins. More specifically, catechins are flavanols, a subcategory of the polyphenol category flavonoids. Green tea leaves contain catechin gallate, epicatechin gallate, epigallocatechin-3-O-gallate (i.e. EGCG), epicatechin epigallate, gallocatechin and gallocatechin gallate (1). Of these, the catechin EGCG is essential for the antioxidant capacity of brewed green tea and linked with a reduced risk for some chronic diseases such as diabetes (2), for some cancers (3) and cardiovascular and ischemic-related diseases (4). Another important effect of the nutraceuticals in green tea leaves is its link with body-weight management by enhancing energy expenditure and fat oxidation in rest (5). Therefore, green tea possesses potential anti-obesity effects. Fat oxidation also contributes to the energy demands of exercise, particularly for exercise that is not performed with a very high intensity. The health benefits of regular green tea consumption are recognized, but what seems to be less known is that the intake of some of the green tea catechins enhanced exercise-induced fat oxidation. This brief review will present some of the studies that examined the effects of the capsulated intake of green tea components and green tea drinking on exercise-induced fat oxidation.

Studies on the effects of green tea components on exercise-induced fat oxidation used capsulated concentrated intake of those components, probably because an excessive volume of brewed green tea needed to be consumed to obtain sufficient intake of the catechin EGCG. The first observation that green tea components can enhance exercise-induced fat oxidation was less than a decade ago in a study by Venables et al. (6). Twelve healthy males with normal body weight were supplemented with green tea extract capsules the day before (during lunch and dinner) and in the morning, 1 h before a moderate intensity 30 min exercise bout (50% of maximum power output). The capsules contained only 136 mg of EGCG and no caffeine. On the morning of the exercise, the subjects were tested in a fasted state. Fat oxidation rates on average were greater by 17% in the green tea trial compared to placebo. The enhanced fat oxidation during exercise was associated with a trend for higher plasma free fatty acids and higher plasma glycerol, indicating a higher rate in lipolysis, i.e. the breakdown of triglycerides to free fatty acids. Enhanced fat oxidation during exercise by intake of a supplement is considered an important beneficial effect, especially among individual with concerns for body-weight. Since the initial finding by Venables et al (6), more studies have examined the effects of green tea extract on fat oxidation during exercise. These studies were summarized in a review article in 2013 by Hodgson et al. (7). Hodgson et al. (7) reviewed short-term and long-term effects of green tea intake on exercise-induced fat oxidation. No studies on the drinking of green tea were included in the review. At that time, studies on the effects of green tea drinking on exercise-induced fat oxidation were absent. It was concluded that the studies on short-term and long-term intake of green tea components and exercise-induced fat oxidation provided inconclusive results (7).

Since 2013, green tea studies continued to examine effects with capsulated intake of EGCG and provided more observations of no effect on exercise-induced fat oxidation. For example, no effect of intake of green tea extract was observed with moderate intensity exercise in moderately trained males and the extract was provided in a can with slightly flavoured peach and apricot beverage and enriched with 560 mg of catechins of which ~210 mg was EGCG (8). Individuals who are endurance trained have already higher

exercise-induced fat oxidation and it was suggested by Randell et al (8) that it would be more difficult to enhance fat oxidation during exercise when it is already relatively high. Also, Martin et al (9) did not observe an effect of a short-term intake of a decaffeinated green tea extract (3 times/day for 2 days, i.e. 450 mg EGCG/day, with last intake 1 hr before exercise) on fat oxidation during exercise. However, participants in the Martin et al (9) study were provided with a standardized breakfast 90 min before the exercise test, this may have affected the observed substrate oxidation during the exercise. Longer intake of a capsulated decaffeinated green tea extract (i.e. 4 weeks, 400 mg EGCG/day) in healthy males (age: 21 years) provided enhanced fat oxidation by 24.9% during 1 hr of cycling at 50% of maximum oxygen uptake (10). It was of interest as well that the 4 week intake resulted in enhanced endurance performance for a 40-min self-paced cycling trial (10). Studies with capsulated intake of green tea extract seems to provide inconsistent observations regarding fat oxidation during exercise. A few studies have examined post-exercise effects of green tea on fat oxidation, with implications also for individuals aiming to change body composition with exercise that does not rely much on fat as an energy source during the exercise. For example, Gahreman et al (11) examined the effects of a green tea supplement (187.5 polyphenols, 125 mg EGCG and 20 mg caffeine) on fat oxidation during the recovery from sprint interval exercise in untrained and endurance-trained males. Intake were over a period of 24 hours, with three on the day before the exercise and final intake 90 min before the exercise. Fat oxidation was increased in rest by 20% and post-exercise by 15% (11). Capsulated green tea intake is inconclusive for effects on fat oxidation during exercise with emerging evidence for beneficial post-exercise effects. Sprint interval exercise is exercise with high intensity but not necessarily time consuming and with potential for individuals concerned about weight management. In sum, capsulated intake of green tea extracts may enhance exercise-induced or post-exercise fat oxidation.

No studies have examined the effect of *traditional* brewed green tea drinks that is consumed with the water-soluble components from the unpowdered leaves on fat oxidation during exercise. Matcha is made from powdered green tea leaves and contains both catechins and caffeine. High quality Matcha originates from Japan, has a fine particle size and has a vibrant green colour due to shaded growing of the leaves in the weeks before harvesting (12). When Matcha is consumed as a drink, all the green tea leaf components are consumed. The intake of green tea components by Matcha green tea drinking may be higher than brewed green tea without the leaf consumption and guarantees intake of water-soluble and water-insoluble parts (13). Recently, Willems et al (14) examined the effects of drinking Matcha on exercise-induced fat oxidation in healthy females. The exercise modality was walking. The exercise intensity was individualised and the females walked with moderate intensity and therefore within recommended guidelines for exercise intensity that would provide health benefits. The females (age: 27±8 years) in the study were tested during the follicular phase, although there is inconsistent evidence on the hormonal effects on fat oxidation in females during exercise. Of the thirteen females taking part in the study, ten females (i.e. 78%) responded with enhanced exercise-induced fat oxidation. Matcha green tea drinking, just 4 cups in 24 hours enhanced fat oxidation by 18% during brisk walking in healthy females (Figure 1).

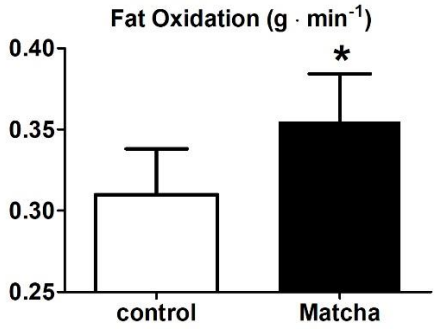

Figure 1. Fat oxidation during brisk walking in healthy females in control and after 4 cups of green tea made with 1 gram of Matcha, consumed in the 24 hours before the exercise.

As far as we know, this is the first study on exercise-induced fat oxidation by drinking normal amounts of green tea, in this case, drinking Matcha. Each cup of Matcha was made with 1 gram of powder of green tea leaves containing 143 mg total catechins and 30 mg caffeine. Our study was applied in focus so we can only speculate what elements of the composition of Matcha were required to provide the observed effect. However, it is also possible that the synergistic effects of the catechins and caffeine in Matcha was required. In summary, it seems that the composition of Matcha green tea leaves is sufficient for habitual Matcha drinking to provide beneficial metabolic responses during brisk walking. However, more studies are required to examine the effects of drinking Matcha for weeks on the metabolic responses during exercise. In addition, combinations of regular exercise and Matcha intake may even provide complementary effects. Research on effects of Matcha with application in sport and exercise is emerging, and Matcha seems to have the potential as a nutritional ergogenic aid with benefits for competitive athletes. Time will tell.

REFERENCES

1. Xu J.Z., Yeung S.Y., et al., Br J Nutr, **91(6)**, 873-881 (2004).
2. Suzuki Y., Miyoshi N., et al., Proc Jpn Acad Ser B Phys Biol Sci, **88(3)**, 88-101 (2012).
3. Guo, Y., Zhi, F., et al., Medicine (Baltimore), **96(13)**, e6426 (2017).
4. Pang J., Zhang Z., et al., Int J Cardiol, **202**, 967-974 (2016).
5. Janssens P.L., Hursel R., et al., Physiol Behav, **162**, 83-87 (2016).
6. Venables M.C., Hulston C.J., et al., Am J Clin Nutr, **87(3)**, 778-784 (2008).
7. Hodgson A.B., Randell R.K., et al., Adv Nutr, **4(2)**, 129-140 (2013).
8. Randell R.K., Hodgson A.B., et al., Med Sci Sports Exerc, **45(5)**, 883-891 (2013).
9. Martin, B.J., Tan, R.B., et al., Int J Sport Nutr Exerc Metab, **24(6)**, 656-664 (2014).
10. Roberts J.D., Roberts M.G., et al., J Int Soc Sports Nutr, **12(1)**, 1 (2015).
11. Gahreman D.E., Boutcher Y. N., et al. J Exerc Nutrition Biochem, **20(1)**, 1-8 (2016).
12. Fujioka K., Iwamoto, T., et al., Molecules, **21(4)**, 474 (2016).
13. Xu P., Ying L., et al., Food Funct. **7(1)**, 294-300 (2016).
14. Willems M.E.T., Şahin M.A., et al., Int J Sport Nutr Exerc Metab. (in press).

Willems et al (2018) examined effects of Matcha premium grade (OMGTea Ltd, United Kingdom)**.**