

## Review

# Effect of tea in the treatment of obesity

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**Obesity is a growing problem causing significant morbidity and mortality in the world. The efficacy of conventional therapies is limited. Numerous alternative therapies are advocated for weight loss, including dietary modifications, hypnotherapy, and acupuncture. Many herbal medications and dietary supplements have been used. Most have been tested in very limited trials. None have been evaluated to the extent they can be definitively recommended, nor have they been studied to ascertain the extent of potential hazards. Given the scope of the problem, and the potential risk to a vulnerable population, further research was conducted to define the efficacy of these treatments, particularly for the elderly ones.**

**Key words:** Tea, obesity, extract, green tea.

## INTRODUCTION

Obesity is a growing problem, resulting in significant morbidity and mortality from weight-related disease and reduced quality of life (Adam-Perrot et al., 2006). Although obesity does confer the advantage of increased bone mineral density with age, which may result in fewer fractures, obese individuals are more likely to develop arthritis, lung disease, diabetes, metabolic syndrome, hypertension, coronary artery disease, congestive heart failure, urinary incontinence, cataracts, and cancer, and are more likely to suffer an earlier death (Adam-Perrot et al., 2006; Barnes et al., 2004). According to a survey of 184, 450 adults, 46% of women and 33% of men were trying to lose weight (Berube-Parent et al., 2005).

The pathophysiology of obesity over the lifespan is quite complex. Body weight increases until age 65, after which it declines (Barnes et al., 2004), probably due to loss of bone mass, body water, and lean mass with age (Bish et al., 2005). Although total energy intake does not increase with age, total energy expenditure decreases (Adam-Perrot et al., 2006). Resting metabolic rate, fat-free mass, physical activity, and the thermic effect of food are all reduced. Body fat also redistributes in

aging; visceral fat increases, while subcutaneous fat decreases. Changes in hormone and cytokine levels result in increased adipose tissue formation over a lifespan (Diepvens et al., 2005). These include reductions in testosterone and growth hormone levels and decreased responsiveness to leptin and thyroid hormone. Decreased testosterone and growth hormone levels increase fat mass while causing reductions in fat-free mass. There is less oxidative metabolism with fewer surges of thyroid hormone. Loss of response to leptin may create inadequate satiation after feeding (Diepvens et al., 2006). New research has identified that abdominal adiposity, as measured by waist circumference or waist-to-hip ratio, and sarcopenia (loss of muscle mass) are more important correlates of morbidity and mortality than older measures, such as total weight and body mass index (BMI) (Barnes et al., 2004). Despite conventional treatments a significant proportion of the elderly remain obese. Low-calorie diets do induce weight loss - approximately 6 to 10% of body weight after six months. In the Diabetes Prevention Program, older patients utilized a series of lifestyle interventions to lose weight, including diet, exercise, and education. Only 67% achieved their target weights over three years (Boschmann and Thielecke, 2007). Although bariatric surgery can be used safely in appropriately selected individuals (Chantre and Lairon, 2002; Cooper et al.,

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2005), the procedure contributes to higher morbidity and mortality in the elderly, and not all elderly individuals qualify for or desire surgical treatment (Cooper et al., 2005). Many individuals use complementary and alternative medicine (CAM) to aid with weight loss. Herbal supplements and diet-based therapies for weight loss are among the 10 most common CAM modalities (Dansinger et al., 2005). The purpose of this article is to outline from the published medical literature how alternative therapies address obesity in the elderly and identify what therapies might be used in the future.

## TEA IN THE TREATMENT OF OBESITY

A number of studies have used tea to promote thermogenesis to increase energy expenditure in humans and rodents, indirectly implying tea promotes weight loss (Diepvens et al., 2007). While most of the studies have examined green tea, several have used oolong tea and one examined black tea (Diepvens et al., 2005). Green tea is created when tea leaves are processed soon after collection, oolong tea leaves are left to ferment before processing, and black tea leaves are crushed before fermentation (Dulloo et al., 2000). Tea is believed to induce thermogenesis through actions of polyphenol constituents called catechins, which inhibit the breakdown of norepinephrine. This results in a rise in mitochondrial oxidation and lowered coupling with ATP synthesis, producing heat (Dulloo et al., 1999, 2000). Alternatively, catechins may impair angiogenesis and retard the development of adipose tissue (Han et al., 1999). Several studies in rodents and humans suggest green tea augments thermogenesis and energy expenditure (Dulloo et al., 1999, 2000; Han et al., 1999; Hazzan et al., 2006; Jensen and Powers, 2006; Kao et al., 2000; Kovacs et al., 2004; Komatsu et al., 2003; Nagao et al., 2001). The experiments utilized encapsulated green tea extracts rather consumption as a beverage. While some of the increase in energy expenditure is believed to be related to the caffeine content (Dulloo et al., 2000; Jensen and Powers, 2006), substances other than caffeine are thought to be responsible for much of its effect (Dulloo et al., 1999; Kao et al., 2000; Kovacs et al., 2004). A number of investigations have used extracts with different concentrations of green tea, caffeine, and other components, making it difficult to draw conclusions about which components might be responsible for the observed effects, or how much tea is necessary to induce human weight loss. In one study, on three occasions 10 healthy men (average age 25; average BMI=25) were given either a green tea extract containing 90 mg of the green tea catechin epigallocatechin gallate (EGCG) and 50 mg caffeine, a capsule of 50 mg caffeine alone, or a placebo.

Mean daily energy expenditure in the 24 h after consumption was higher (6,754 kJ) in individuals

given the green tea extract than in subjects given either caffeine alone (6,547 kJ) or placebo (6,463 kJ) ( $p < 0.01$ ) (Komatsu et al., 2003). Weight loss induced by green tea extracts has been reported in rats and humans. After seven days of treatment, rats given green tea extract lost 15 to 21% more weight compared to baseline and 30 to 41% more weight than rats given a placebo (Hazzan et al., 2006). A human would have to consume 6-12 cups of tea daily to obtain the equivalent dose the rats received (Kao et al., 2000). In a clinical study, 46 women (ages 19-57; BMI=25-31) were placed on a reduced-calorie diet (60% of expected energy expenditure) and either 1,206.9 mg catechins from green tea or a placebo for 90 days. There were no differences in weight loss, BMI, waist:hip ratio, or fat-free mass between groups (Nagao et al., 2005, 2007). In a controlled trial, 240 Japanese men and women were assigned to consume green tea extract with 583 mg catechins daily (catechin group;  $n=123$ ) or 96 mg catechins daily (control group;  $n=117$ ). Greater decreases in weight, BMI, visceral fat area, and waist and hip circumference, as well as improved signs of cardiovascular health – systolic blood pressure and LDL cholesterol – were observed in the high-catechin group compared to the control group (Rumpler et al., 2001). In an uncontrolled investigation, 70 subjects ages 20-69 (BMI 24-32) consumed two capsules of a green tea extract (270 mg EGCG; 475 mg total catechins) while dieting for three months and lost an average of 4.6% of body weight (Roberts et al., 2005). Green tea extracts have also been used to achieve weight maintenance after loss. In one study, 104 subjects ages 18-60 (BMI 25-35) were given a lowcalorie diet (2.1 mJ daily) for four weeks, then three months of a weight maintenance program in which they received a green tea extract (95.46 mg catechins, 17.25 mg caffeine) or a placebo (Sumiyoshi and Kimura, 2006). Although green tea did not affect weight gain overall, a subset of individuals with lower habitual caffeine intake (mean 149 mg/day versus 511 mg/day) experienced 13% less weight regain with green tea compared to placebo (Sumiyoshi and Kimura, 2006). The low-caffeine group who used green tea also demonstrated greater resting energy expenditure through thermogenesis (Shixian et al., 2006). Several studies have examined oolong tea to induce increased energy expenditure (St-Onge, 2005; Varela et al., 2006), but fat mass and weight loss in humans has only been demonstrated when investigators added green tea extract to oolong tea (Villareal et al., 2005; Wing et al., 2004). In one of these studies, 38 non-obese men ages 27-46 consumed a diet for two weeks containing 90% of their average energy intake. They were then given a drink containing 340 mL oolong tea daily, supplemented with green tea extract containing 209 mg catechins/100 mL for three months. The supplemented tea drinkers lost only 1.1 kg more than those in the control group ( $p < 0.05$ ) (Villareal et al., 2005). In mice, a supplement of oolong tea prevented weight gain in mice fed a high-fat diet

(Westerterp-Plantenga et al., 2005). Although no published study has found black tea induces weight loss, one study demonstrated increased metabolic rate after consumption of black tea combined with other substances. Sixteen men and women (ages 21-55; BMI 20-30) took an extract consisting of 600 mg black tea (20% caffeine) in addition to guarana (*Paullinia cupana*; a source of caffeine), ginger, dill weed, vitamin C, and rutin (a plant polyphenol) or a placebo (Westerterp-Plantenga et al., 2006). One hour after ingestion, resting metabolic rate increased by 77.19 (kcal/24 h) ( $p < 0.02$ ) in the group receiving the supplement but not in the placebo group.[32]

Recent data from human studies indicate that the consumption of green tea and green tea extracts may help reduce body weight, mainly body fat, by increasing postprandial thermogenesis and fat oxidation. In a randomized, double-blind, placebo-controlled, cross-over pilot study, six overweight men were given 300 mg EGCG per day for two days. Fasting and postprandial changes in energy expenditure and substrate oxidation were assessed. Resting energy expenditure did not differ significantly between EGCG and placebo treatments, although during the first postprandial monitoring phase, respiratory quotient values were significantly lower with EGCG treatment compared to the placebo. These findings suggest that EGCG alone has the potential to increase fat oxidation in men and may thereby contribute to the antiobesity effects of green tea. However, more studies with a greater sample size and a broader range of age and body mass index are needed to define the optimal dose (Zamboni et al., 2005).

## CONCLUSION

Laboratory studies showed the health effects of tea. As the human clinical evidence is still limited, future research needs to define the actual magnitude of health benefits, establishes the safe range of tea consumption associated with these benefits, and elucidates the mechanisms of action. Further research should focus on the pharmacological and clinical effects of green tea and its mechanisms of action.

## REFERENCES

- Adam-Perrot A, Clifton P, Brouns F (2006). Lowcarbohydrate diets: nutritional and physiological aspects. *Obes Rev.*, 7: 49-58.
- Barnes PM, Powell-Griner E, McFann K, Nahin RL (2004). Complementary and alternative medicine use among adults: United States, 2002. *Adv. Data*, 343: 1-19.
- Berube-Parent S, Pelletier C, Dore J, Tremblay A (2005). Effects of encapsulated green tea and Guarana extracts containing a mixture of epigallocatechin-3-gallate and caffeine on 24 h energy expenditure and fat oxidation in men. *Br J. Nutr.*, 94: 432-436.
- Bish CL, Blanck HM, Serdula MK, Marcus M, Kohl HW 3rd, Khan LK (2005). Diet and physical activity behaviors among Americans trying to lose weight: 2000 Behavioral Risk Factor Surveillance System. *Obes. Res.*, 13: 596-607.
- Boschmann M, Thielecke F (2007). The effects of epigallocatechin-3-gallate on thermogenesis and fat oxidation in obese men: a pilot study. *J. Am. Coll. Nutr.*, 26(4): 389S-395S.
- Chantre P, Lairon D (2002). Recent findings of green tea extract AR25 (Exolise) and its activity for the treatment of obesity. *Phytomedicine*, 9: 3-8.
- Cooper R, Morre DJ, Morre DM (2005). Medicinal benefits of green tea: Part I. Review of noncancer health benefits. *J Altern. Complement Med.*, 11: 521-528.
- Dansinger ML, Gleason JA, Griffith JL (2005). Comparison of the Atkins, Ornish, Weight Watchers, and Zone diets for weight loss and heart disease risk reduction: a randomized trial. *JAMA*, 293: 43-49.
- Diepvens K, Kovacs EM, Vogels N (2006). Metabolic effects of green tea and of phases of weight loss. *Physiol Behav.*, 87: 185-191.
- Diepvens K, Klaas RW, Westerterp-Plantenga MS (2007). Obesity and thermogenesis related to the consumption of caffeine, ephedrine, capsaicin and green tea. *Am. J. Physiol. Regul. Integr. Comp. Physiol.*, 292: R77-R85.
- Diepvens K, Kovacs EM, Nijs IMT, Vogels N, Westerterp-Plantenga MS (2005). Effect of green tea on resting energy expenditure and substrate oxidation during weight loss in overweight females. *Br. J. Nutr.*, 94: 1026-1034.
- Dulloo AG, Seydoux J, Girardier L (2000). Green tea and thermogenesis: interactions between catechinpolyphenols, caffeine and sympathetic activity. *Int. J. Obes. Relat. Metab. Disord.*, 24: 252-258.
- Dulloo AG, Duret C, Rohrer D (1999). 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.*, 70: 1040-1045.
- Han LK, Takaku T, Li J (1999). Anti-obesity action of oolong tea. *Int. J. Obes. Relat. Metab. Disord.*, 23: 98-105.
- Hazzan D, Chin EH, Steinhagen E (2006). Laparoscopic bariatric surgery can be safe for treatment of morbid obesity in patients older than 60 years. *Surg. Obes. Relat. Dis.*, 2: 613-616.
- Jensen GL, Powers JS (2006). Malnutrition. In: Pompei P, ed. *Geriatrics Review Syllabus*. 6th ed. New York, NY: Am. Geriatrics Soc., pp. 174-180.
- Kao YH, Hiiipakka RA, Liao S (2000). Modulation of endocrine systems and food intake by green tea epigallocatechin gallate. *Endocrinology*, 141: 980-987.
- Kovacs EM, Lejeune MP, Nijs I, Westerterp-Plantenga MS (2004). Effects of green tea on weight maintenance after body-weight loss. *Br. J. Nutr.*, 91: 431-437.
- Komatsu T, Nakamori M, Komatsu K (2003). Oolong tea increases energy metabolism in Japanese females. *J. Med. Invest.*, 50: 170-175.
- Nagao T, Hase T, Tokimitsu I (2007). A green tea extract high in catechins reduces body fat and cardiovascular risks in humans. *Obes. (Silver Spring)*, 15: 1473-1483.
- Nagao T, Komine Y, Soga S (2005). Ingestion of a tea rich in catechins leads to a reduction in body fat and malondialdehyde-modified LDL in men. *Am. J. Clin. Nutr.*, 81: 122-129.
- Nagao T, Meguro S, Soga S (2001). Tea catechins suppress accumulation of body fat in humans. *J. Oleo. Sci.*, 50:717-728.
- Rumpler W, Seale J, Clevidence B (2001). Oolong tea increases metabolic rate and fat oxidation in men. *J. Nutr.* 131: 2848-2852.
- Roberts AT, de Jonge-Levitan L, Parker CC, Greenway F (2005). The effect of an herbal supplement containing black tea and caffeine on metabolic parameters in humans. *Altern. Med. Rev.*, 10:321-325.
- Sumiyoshi M, Kimura Y (2006). Low molecular weight chitosan inhibits obesity induced by feeding a high-fat diet long-term in mice. *J. Pharm. Pharmacol.*, 58: 201-207.
- Shixian Q, VanCrey B, Shi J (2006). Green tea extract thermogenesis-induced weight loss by epigallocatechin gallate inhibition of catechol O-methyltransferase. *J. Med. Food*, 9: 451-458.
- St-Onge MP (2005). Dietary fats, teas, dairy, and nuts: potential functional foods for weight control? *Am. J. Clin. Nutr.*, 81: 7-15.
- Varela JE, Wilson SE, Nguyen NT (2006). Outcomes of bariatric surgery in the elderly. *Am. Surg.*, 72: 865-869.
- Villareal DT, Apovian CM, Kushner RF (2005). Obesity in older

- adults: technical review and position statement of the American Society for Nutrition and NAASO, *Obes. Soc. Obes. Res.*, 13: 1849-1863.
- Wing RR, Hamman RF, Bray GA (2004). Achieving weight and activity goals among diabetes prevention program lifestyle participants. *Obes. Res.*, 12: 1426-1434.
- Westerterp-Plantenga MS, Lejeune MP, Kovacs EM (2005). Body weight loss and weight maintenance in relation to habitual caffeine intake and green tea supplementation. *Obes. Res.*, 13: 1195-1204.
- Westerterp-Plantenga M, Diepvens K, Joosen AM (2006). Metabolic effects of spices, teas, and caffeine. *Physiol. Behav.*, 89: 85-91.
- Zamboni M, Mazzali G, Zoico E (2005). Health consequences of obesity in the elderly: a review of four unresolved questions. *Int. J. Obes. (Lond)*, 29: 1011-1029.