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The Impact of Green Tea Consumption and Its Extracts on Fat Reduction and Weight Loss

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Abstract

Introduction: Obesity and overweight are major health problems and challenges in the world today. It is the task of modern pharmacology, medicine and dietetics to search for new therapeutic methods to reduce body weight and body fat. Green tea has been a focus of research on its effects on weight reduction for many years. This article will analyse the available studies on the effectiveness of green tea on body weight and body fat reduction in obese and overweight people.

Aim of the study: The aim of this review is to analyse the available literature in order to answer the question of whether green tea and green tea extracts (GTE) have an effect on weight loss, body fat reduction and associated metabolic processes.
Materials and method: For a comprehensive review on the effects of green tea on weight and body fat reduction, we reviewed studies and literature available in databases such as PubMed and Google Scholar by searching through keywords such as 'green tea', 'obesity', 'fat', 'weight loss', 'matcha'.
Conclusion: green tea and its isolated substances such as epigallocatechin-3-O-gallate (EGCG) appear to have a positive effect on weight and body fat reduction in obese and overweight individuals. It is likely that consumption of green tea extract increases fat oxidation during exercise. In addition, supplementation had a positive effect in a group of diabetics, polycystic ovary syndrome and metabolically stressed patients. The best effects from supplementation were obtained by those who additionally had physical activity. It is suggested that research on green tea, especially on matcha, should continue, as very little reliable research has been produced on this topic

Keywords: green tea, obesity, fat, weight loss, matcha.

Introduction:

Green tea

Green tea is produced from the leaves of the *Camellia sinensis* species and is classified as non-fermented tea. The fermentation process is prevented by thermal methods such as roasting. It contains many bioactive compounds such as polyphenols, including epigallocatechin-3-gallate with antiviral, antibacterial and antifungal properties. Due to the specific nature of its production, it contains the most polyphenols of any type of tea. Other constituents include caffeine, theanine, minerals and many others [1,2,3].

Obesity

Obesity is a chronic disease that manifests itself as an excessive accumulation of body fat. It develops as a result of a long-term positive caloric balance, i.e. as a result of supplying more calories than a person needs for metabolic processes, thermogenesis and physical activity. The most common factors that play a role in the development of obesity are poor eating habits, avoidance of physical activity, eating under the influence of emotions, eating disorders, genetic factors, hormonal disorders, and certain medications (e.g. by increasing appetite). The criterion for the diagnosis of obesity is a body-mass index (BMI) of greater than or equal to 30kg/m^2. There are three degrees of obesity. Between normal weight and obesity, overweight is distinguished with a BMI value between 25.0-29.9 kg/m2 [4, 5].
The World Health Organisation (WHO) predicts that by 2030, the number of people worldwide with obesity will exceed one billion. The WHO also alerts that obesity is no longer a problem only for high-income countries. Obesity has become one of the biggest public health challenges- it is now estimated that the annual cost of obesity is 990 billion USD [6]. According to data published by the Polish National Health Fund (NFZ), in 2019 the percentage of adults with obesity in the Polish population was 19% and is projected to increase further in the following years [7].

Overweight and obesity cause a number of health consequences such as the development of pre-diabetes, type II diabetes, non-alcoholic fatty liver disease (NAFLD), hypertension, kidney failure, endocrine disorders (including fertility disorders), cancerous diseases such as colorectal cancer. The aforementioned diseases and conditions are only part of the complications that put obese patients at risk. It is unethical to stigmatise because of obesity. When working with an obese patient, an appropriate level of empathy and care should be taken to ensure kind communication [4,5].

Methods

This review was based on publications available in PubMed and Google Scholar databases. Materials were searched using key words such as 'green tea', 'matcha', 'weight loss', 'fat', 'obesity'. We focused on studies conducted on large, representative groups and meta-analyses to ensure the high scientific value of the results presented. In addition, we supported ourselves with specialised, valid medical literature in the field of medicine and obesitology based on Evidence Base Medicine (EBM) to improve the content value.

Influence of green tea and green tea extracts (GTE) on weight loss

Over the past few years, a number of studies have been produced on the effectiveness of green tea or its extracts on weight and body fat reduction. A study on a population of overweight or obese women who took green tea extract (GTE) at a high dose of 856.8 mg per day for 12 weeks showed that participants taking GTE, statistically significantly reduced their body weight, which was not observed in the placebo group. In addition, the study group achieved a reduction in waist circumference, a statistically significant decrease in total and LDL cholesterol, and an increase in adiponectin levels with good tolerance of the supplement [8]. An experimental study investigating the effect of a 60-day supplementation with *Camellia sinensis* (green tea) leaf extract on body fat and metabolism in overweight or obese postmenopausal women was conducted. Satisfactory results were obtained, such as a decrease in insulin levels and HOMA index, a decrease in waist circumference by an average of 1.66 cm, a decrease in visceral adipose tissue by an average of 85.25 g, a decrease in fat mass by an average of 1025.64 g, an increase in adiponectin levels, an increase in fat oxidation levels, a decrease in the inflammatory parameter- a decrease in C- Rective Protein. Interestingly, no significant weight reduction was obtained. The results of the study are promising and suggest the sense of conducting further research on GTE supplementation in a group of obese postmenopausal women [9].

Obesity among children is a very serious social problem. Unfortunately, there is very little research on the effects of green tea on body weight in the child and teenage population. A study was conducted to test the effect of a 12-week supplementation with decaffeinated green tea polyphenols on overweight or obese girls aged 6 to 10 years. A statistically significant reduction in body fat, increase in basal metabolic rate (BMR), reduction in uric acid concentration, and reduction in ovarian volume were obtained. The results of the study suggest a positive effect of green tea on a population of obese girls in the absence of adverse events, suggesting the safety of the intervention. These results suggest that further studies on the paediatric population should be conducted [10]. An interesting study was conducted on a population of teenagers to test the effect of coffee and green tea on weight loss and body fat reduction.

For the experiment, three groups were created: a tea consumption group (690 ml of tea containing 252 mg catechins and 96 mg caffeine per day), a coffee consumption group (500 ml of coffee containing 160 mg caffeine per day) and a placebo group. The intervention was implemented for a period of 6 months and after this period it was shown that the coffee-drinking group achieved a significant weight reduction, a mean fat reduction of 7.98% and a decrease in BMI of 9.26% compared to baseline. In the green tea-drinking group, the effects were less spectacular, as after six months, the decrease in mean BMI in this group was only 2.32% compared to baseline, suggesting that coffee may have a more effective effect on weight reduction than green tea, but this requires further research [11].

In a meta-analysis examining the effects of green tea extract (GTE) supplementation on body weight composition, hormones associated with overweight and obesity and oxidative stress, it was found that the use of GTE resulted in a mean weight reduction of -0.64 kg, but the effects are related to the dose used and the duration of supplementation. There was no significant reduction in waist circumference. There was also no effect of GTE on ghrelin and leptin levels, but a significant increase in adiponectin was noted. In addition, a decrease in malondialdehyde and an increase in Total Antioxidant Capacity were noted, suggesting a potential antioxidant effect resulting in a reduction in oxidative stress during GTE intake [12].

A study emerged that wanted to answer the question of whether green tea results in reduced lipid absorption and weight reduction. For this purpose, the study group took GTE for 12 weeks, but no difference was found in lipid absorption and metabolism compared to the placebo group, and there were no statistically significant differences in body weight, body fat levels, waist circumference and hip circumference. In this study, GTE supplementation did not provide a benefit in weight reduction [13]. In a published study conducted on a group of individuals with serum cholesterol levels between 180-220 mg/dL and body fat above 30% of body weight, the use of catechin-enriched green tea at 600 mL per day for a period of 12 weeks was shown to result in a significant reduction in body weight and body fat that was statistically significant [14]. In a study evaluating the effect of a catechin-enriched green tea beverage on weight reduction in obese individuals, a beverage containing 625 mg catechins and 39 mg caffeine was used for a period of 12 weeks. After this period, it was found that the study group experienced a greater weight loss compared to the control group using a beverage with the same amount of caffeine but without green tea catechins (-2.2kg vs. -1.0kg), but these values were close to statistical significance ($p=0.079$); in addition, the study group achieved a 7.7% reduction in abdominal fat and reduced subcutaneous fat by 6.2%, which was statistically significant [15].

A study to determine the effect of green tea enriched with catechins with a galloyl moiety at different doses for 12 weeks on weight reduction in obese adults showed that both high and low doses resulted in statistically significant reductions in subcutaneous adipose tissue and visceral fat, weight reduction, decrease in BMI, decrease in waist circumference that were statistically significant. In men, the results of the group using higher doses of catechins were slightly better, suggesting that the use of higher doses may be more effective in reducing body fat and body weight [16].

Green tea and physical exercise

A study on a group of overweight young men was published to address the effect of green tea supplementation and interval sprint exercise on body weight and body fat.

The men were divided into four groups and the intervention was applied for 12 weeks (sprint training group, group taking green tea extract (GTE), sprint training group taking GTE and non-exercise group taking placebo). Participants exercising sprinting and exercising sprinting and taking GTE achieved significant reductions in body weight, body fat and abdominal fat, with abdominal fat reduction being higher in those taking GTE (10% vs. 6%). No statistically significant changes were seen in the placebo group and those taking GTE without exercise. Additionally, interval sprint training and GTE increased fat oxidation. The results of this study show that the use of exercise was the most important in achieving weight reduction, while GTE mainly enhanced fat oxidation and the use of supplementation alone has no significant effect on weight reduction [17].

A meta-analysis was published to evaluate the effect of green tea together with the use of exercise on the body composition and body weight of overweight and obese individuals. The results showed that green tea produced a slight improvement in outcomes compared with the use of exercise alone in the context of body weight. Those supplementing with green tea achieved a significantly lower BMI and greater body fat reduction compared to the control group, suggesting a beneficial effect of green tea on body fat reduction when combined with exercise [18]. In a study analysing the effect of decaffeinated green tea extract on overweight individuals who exercised regularly, where three groups were formed (a group taking decaffeinated GTE at a dose of 580 mg with an EGCG content of 400mg, a group taking an additional 50mg of quercetin and 150mg of alpha-lipoic acid, and a placebo group) and the intervention time was 8 weeks. In the group taking decaffeinated GTE without additives, an increase in maximal fat oxidation of 12.7% was achieved, but no decrease in body weight or body fat content. The group taking decaffeinated GTE with quercetin and alpha-lipoic acid achieved the best results with an increase in maximal fat oxidation of 45.4% after an 8-week period compared to baseline and an increase in adiponectin levels, but there were also no significant differences in body weight and body fat levels [19].

A study on decaffeinated GTE and its effect on fat burning during arm exercise has emerged. Participants in the research trial took caffeine-free GTE for a period of four weeks. The study was performed using the crossover method, i.e. the study group four weeks after the end of supplementation became the control and the control group became the study group. In this study, decaffeinated GTE was not shown to increase fat burning and lipolysis [20]. Another study on a population of young men who performed aerobic exercise for a period of 6 weeks investigated what the effect of green tea supplementation would be. There were four groups in the study: a group doing aerobic exercise and supplementing with green tea, a group doing only aerobic exercise, a group consuming only green tea and a control group with no intervention implemented. It turned out that a decrease in BMI and body fat percentage occurred in all groups except the control group, which used neither exercise nor green tea. The group that exercised and supplemented with tea at the same time had the best effect in this respect [21].

Matcha

Matcha is a type of green tea from the species *Camellia sinesnis*, which is sold as a living green powder made from tea leaves. It is distinguished by its high content of plant protein, dietary fibre and unsaturated fatty acids [22].

Matcha is characterised from other types of tea by its high polyphenol content, indicating its valuable health properties, and has a high caffeine content [1, 22].

A study was conducted on the effects of matcha on weight reduction, in which the study group consumed 2 grams of matcha daily for 12 weeks in addition to a low-calorie diet. It turned out that matcha supplementation had no effect on weight reduction compared to the control group, which only followed the diet. In addition, among other things, there was a small increase in HDL-C, a decrease in fasting glucose values with an unexpected slight increase in HbA1c and an increase in IL-10, which may suggest a potential anti-inflammatory effect of matcha [23]. A study on women doing moderate exercise and supplementing with matcha over a three-week period showed that there were metabolic changes-an increase in fat oxidation and a decrease in carbohydrate oxidation-compared to the placebo group. However, there was no difference in terms of weight reduction and body composition change between the groups [24]. Similar results were obtained in a 2018 study, where matcha supplementation before brisk walking training resulted in decreased carbohydrate oxidation and increased fat oxidation [25]. The beneficial effects of matcha on fat metabolism during exercise are likely to have a supporting effect on weight loss, but this requires further research [24,25].

Epigallocatechin-3-O-gallate (EGCG)

EGCG is a compound belonging to the polyphenols, which are antioxidants and also have antimicrobial effects, among other things. EGCG is the main polyphenol of green tea [1,2]. Due to its very high content in green tea, studies evaluating the effect of EGCG alone on body weight have been produced. In a study comparing the effects of green tea and guarana extracts with a fixed dose of caffeine (200 mg) and variable EGCG content (90 mg to 400 mg) on 24-hour energy expenditure and fat oxidation, it was shown that the use of EGCG with caffeine and guarana increased 24-hour energy expenditure by approximately 8% compared to the placebo group and was not dose-dependent, suggesting that higher doses of EGCG do not carry additional benefits. This study also showed no significant effect on fat oxidation [26]. A study on the efficacy of combining ECEG with α-glucosyl hesperidin, which is a citrus polyphenol on weight reduction, was published in 2021. Supplementation with 178 mg α-glucosyl hesperidin and 146 mg EGCG per day for 12 weeks was used, while the control group took a placebo. After this period, it was found that the supplementation group had less weight gain than the placebo group, with no effect on body fat. Participants under 50 years of age benefited the most from the supplementation, as they scored statistically significant reductions in body weight, body fat and abdominal fat, indicating that ECEG with α-glucosyl hesperidin helped to maintain body weight and its effect was dependent on the participant's age. The placebo group scored a statistically significant increase in body weight and abdominal fat [27].

Impact of green tea on ghrelin and leptin levels

The proper functioning of the human endocrine system is essential for the body's homeostasis. To summarise the most important information, ghrelin is a peptide hormone produced by the cells of the fundus of the stomach and duodenum, which reaches its highest concentration in the period before meal intake (i.e. during the period of hunger) and decreases after meal intake.

Ghrelin mainly acts on receptors in the hypothalamus and additionally causes an increase in appetite, reduces insulin secretion, stimulates glucose production and has a prokinetic effect on the gastrointestinal tract. Leptin is an adipokine produced by fat cells, in direct proportion to their number. Its levels are highest in people with large amounts of adipose tissue (especially subcutaneous fat). By acting on hypothalamic receptors, leptin inhibits appetite, additionally inhibits lipogenesis and stimulates lipolysis . In addition, its normal levels are essential for a normal menstrual cycle [28].

In a meta-analysis evaluating the effects of green tea and its extract on ghrelin and leptin levels, it was shown that green tea can increase leptin secretion, but only after prolonged use as has been shown for interventions over 12 weeks. Taking green tea for a shorter period of time seems to have no effect on leptin secretion. An increase in ghrelin secretion under the influence of green tea supplementation has only been shown for countries outside Asia [29]. In a study conducted in Taiwan, women received high doses of GTE at 856.8 mg per day. One of the parameters assessed was the effect on hormone levels. It was found that ghrelin levels were statistically significantly lower in the GTE-supplemented group, with no recorded effect on leptin levels [8]. In a meta-analysis examining the effect of GTE supplementation on body weight, no effect of GTE supplementation on ghrelin or leptin levels was shown [12].

Polycystic Ovarian Syndrome and obesity

Polycystic ovarian syndrome (PCOS) is a disorder affecting women of reproductive age. Clinically, it is manifested by symptoms of hyperandrogenism (e.g. hirsutism), ovulatory disorders (oligoovulation or anovulation) and the image of polycystic ovaries on imaging tests. Insulin resistance is one of the main endocrine disorders in the course of PCOS. It is estimated that up to more than half of patients are obese or overweight. Hyperinsulinaemia stimulates ovarian androgen production and further inhibits the production of sex hormone binding globulin, provoking symptoms of hyperandrogenisation in women with the syndrome. Consequently, the treatment of obesity and metabolic abnormalities is one of the main therapeutic targets for the treatment of PCOS [30].

A meta-analysis was established to evaluate the effectiveness of green tea supplementation in women struggling with Polycystic Ovarian Syndrome (PCOS). Women who supplemented with green tea achieved a statistically significant reduction in body weight (mainly Caucasian), a reduction in waist to hips ratio (WHR) mainly among Asian women, a reduction in fasting glucose and insulin levels. Green tea supplementation was not associated with adverse effects and had good tolerability [31]. In a Chinese study investigating the effect of green tea supplementation in women with PCOS, 540 mg EGCG per day was used. It was shown that there was no reduction in body weight or body fat in the study group after 3 months, but the placebo group had a statistically significant increase in body weight and body fat, suggesting that green tea may help to maintain body weight [32]. In a meta-analysis evaluating the effect of green tea in women with PCOS, there was a statistically significant reduction in body weight in women supplementing with green tea compared to the placebo group. The mean weight difference was -2.80 kg to baseline. The results of this meta-analysis are promising, but further research, especially on large groups of women, is required to conclusively demonstrate the effect of green tea on weight reduction in women with PCOS [33].

Type II diabetes and metabolic syndrome

Type II diabetes is a chronic metabolic disease in the developing of which factors such as obesity and insulin resistance are crucial. One of the main goals of diabetes treatment is to reduce body weight and, in particular, visceral fat [34].

In a meta-analysis of the effects of green tea or GTE in people with diabetes, it was shown to improve fasting insulin levels and there was a reduction in abdominal circumference after prolonged supplementation. No statistically significant metabolic changes such as effects on insulin resistance or lipidogram were shown. Due to the waist circumference reduction effect demonstrated in the study, green tea may carry benefits among patients with abdominal obesity and accompanied diabetes [35].

A study analysis was conducted on people with metabolic syndrome and pre-metabolic conditions who took a green tea beverage with low or high amounts of catechins for 12 weeks. Consumption of green tea with a high amount of catechins resulted in a decrease in body weight and BMI, a decrease in waist circumference, and a reduction in visceral and subcutaneous adipose tissue. Additionally, participants experienced a number of metabolic benefits. The results suggest a positive effect of taking high doses of green tea catechins on people with metabolic syndrome or pre-metabolic conditions [36]. A meta-analysis examining the effects of tea extracts on obesity and metabolic syndrome was published in 2019. GTE supplementation promoted lower BMI, weight loss, reduced waist and hip circumference, lower fasting glucose levels and positive effects on lipidogram. GTE supplementation was also well tolerated among participants, suggesting the appropriateness of its supplementation in this group [37].

Conclusion

The global obesity pandemic is a huge health problem in the modern world. Epidemiological studies mercilessly show a galloping increase in the number of people suffering from obesity and facing excess weight. As a result, many scientific studies have focused on the search for substances that can reduce body weight. Green tea, green tea extracts (GTE) and the compounds it contains have been a focus of interest for researchers for many years. Large clinical studies and meta-analyses have been produced to draw some conclusions.

Based on the data from clinical trials and statistical analyses, it can be concluded that green tea and the GTE extracted from it have a positive effect on the reduction of body weight and body fat. The results of many studies provide consistent conclusions regarding the effects of green tea on body weight, body fat and metabolic processes. In most studies, there was a reduction in body weight, subcutaneous and visceral fat and an increase in fat oxidation. It should be noted that the greatest benefits of supplementation were seen in those who regularly exercised and only supported themselves with green tea.

Many groups may benefit from green tea supplementation. It has been shown to have a potential positive effect in polycystic ovarian syndrome, but this requires further research. Another target group for green tea supplementation is the large group of diabetics, people with metabolic syndrome and those at risk of developing such complications. It seems that good efficacy of green tea can also be obtained among children and adolescents. This is an important finding, as more and more children and adolescents are becoming overweight and obese.

Green tea can be a good supplement, provided regular physical activity and an adequate calorie deficit are practised. Supplementation alone will not be sufficient to achieve results in terms of high weight and fat loss.
Its high safety profile and few adverse events allow it to be used in most patients, making it a universal supplement. In the future, researchers should focus on testing matcha for its properties. Despite its growing popularity, we do not have a large amount of research on it.
In conclusion, most studies have shown a positive role for green tea and its ingredients in weight and body fat reduction. Green tea is well researched and stands out for its safety of use.

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Author's contribution:

Conceptualization: Anita Ptak, Michał Szyc
Methodology: Michał Szyc, Anita Ptak
Software: Michał Szyc
Check: Anita Ptak
Formal analysis: Michał Szyc, Anita Ptak
Investigation: Michał Szyc, Anita Ptak
Resources: Michał Szyc, Anita Ptak
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