JURNAL LOCUS: Penelitian & Pengabdian
Volume 5 No. 5 Mei 2026
E-ISSN 2829-7334| P-ISSN 2829-5439
Hompage: https://locus.rivierapublishing.id/index.php/jl

The Effect of Oral Administration of Green Tea Leaf Extract (Camellia Sinensis) on Leptin and Adiponectin Hormone Levels in Obese Male Wistar Rats (Rattus Norvegicus): A Literature Review

Fiona Suryo*, Agus Eka Darwinata, I Wayan Sumardika
Universitas Udayana, Indonesia
Email: fionasuryo@gmail.com*

Keywords:
Obesity; green tea extract; Camellia sinensis; Wistar rats; EGCG

Abstract

Green tea (Camellia sinensis) has attracted considerable attention as a natural anti-obesity agent due to its rich bioactive compounds, including catechins, epigallocatechin gallate (EGCG), flavonoids, polyphenols, and caffeine. This review aimed to analyze the effects of oral administration of green tea leaf extract on leptin and adiponectin hormone levels in obese male Wistar rats (Rattus norvegicus) and to evaluate its underlying anti-obesity mechanisms. This study employed a structured literature review method using experimental articles published between 2015 and 2025, obtained from PubMed, Google Scholar, ScienceDirect, Scopus, and Garuda databases. The selected studies focused on obese animal models receiving oral green tea extract interventions, with outcomes related to leptin, adiponectin, body weight, lipid metabolism, insulin resistance, and adiposity. The reviewed studies consistently demonstrated that oral administration of green tea extract reduced leptin levels and increased adiponectin concentrations in obese male Wistar rats. These effects were associated with reduced visceral fat accumulation, enhanced fatty acid oxidation, improved insulin sensitivity, and better lipid profiles. Mechanistically, green tea bioactive compounds activated AMP-activated protein kinase (AMPK), inhibited adipogenesis, stimulated thermogenesis and fat browning, and reduced oxidative stress and inflammation. Several studies also reported significant reductions in body weight gain, triglycerides, cholesterol levels, and hepatic lipid accumulation following green tea supplementation. In conclusion, green tea leaf extract possesses significant anti-obesity potential through modulation of leptin and adiponectin hormones and improvement of metabolic function in obese male Wistar rats.

INTRODUCTION

Obesity is a chronic metabolic disorder characterized by excessive accumulation of body fat resulting from an imbalance between energy intake and energy expenditure. This condition has become a major global health problem because it contributes significantly to the development of various metabolic and cardiovascular diseases, including type 2 diabetes mellitus, hypertension, dyslipidemia, coronary heart disease, and insulin resistance. The

prevalence of obesity continues to increase worldwide in both developed and developing countries, including Indonesia, due to changes in lifestyle, dietary patterns, and decreased physical activity (Kazemipoor et al., 2012).

In obesity, adipose tissue does not merely function as an energy storage organ but also acts as an active endocrine organ that secretes various bioactive substances known as adipokines (Al-Suhaimi, 2022; Scheja & Heeren, 2019). Among the most important adipokines associated with obesity are leptin and adiponectin. Leptin is predominantly produced by adipocytes and plays a crucial role in regulating appetite, satiety, energy expenditure, and body weight homeostasis. Increased adipose tissue mass in obese individuals is generally accompanied by elevated circulating leptin levels; however, this condition often leads to leptin resistance, resulting in impaired appetite regulation and metabolic dysfunction (Onwuka et al., 2022).

Conversely, adiponectin is an anti-inflammatory adipokine that enhances insulin sensitivity, stimulates fatty acid oxidation, and improves glucose metabolism. Unlike leptin, adiponectin levels are generally decreased in obesity. Reduced adiponectin concentrations contribute to chronic low-grade inflammation, insulin resistance, endothelial dysfunction, and metabolic syndrome progression (Utami et al., 2020).

Recently, natural products have gained considerable attention as alternative therapeutic agents for obesity management due to their relatively low toxicity and multiple pharmacological activities. One of the most extensively studied medicinal plants is green tea (Camellia sinensis). Green tea contains numerous bioactive compounds, including catechins, epigallocatechin gallate (EGCG), flavonoids, caffeine, and polyphenols, that exhibit antioxidant, anti-inflammatory, thermogenic, hypolipidemic, and anti-obesity properties (Li et al., 2021).

Among these compounds, EGCG is considered the principal active component responsible for the metabolic effects of green tea. Experimental studies have demonstrated that EGCG and other catechins can reduce adipogenesis, inhibit lipid accumulation, stimulate thermogenesis, and improve insulin sensitivity through activation of AMP-activated protein kinase (AMPK) pathways. Green tea polyphenols also modulate adipokine secretion by decreasing leptin levels and increasing adiponectin expression in obese animals (Wu et al., 2023a).

Various in vivo studies using obese male Wistar rats (Rattus norvegicus) have reported that oral administration of green tea extract significantly reduces body weight gain, visceral fat accumulation, serum triglycerides, and inflammatory markers, while simultaneously improving adiponectin concentrations and metabolic homeostasis. Green tea supplementation has also been associated with appetite suppression and reduced leptin concentrations due to improved adipocyte function and decreased adipose tissue mass (Franata et al., 2023).

The novelty of this review lies in several interconnected contributions. First, it focuses specifically on the effects of green tea extract on both leptin and adiponectin simultaneously, providing a more comprehensive picture of adipokine modulation than previous reviews that examined only one adipokine. Second, it synthesizes evidence from studies published between 2015 and 2025, ensuring currency and relevance. Third, it analyzes the molecular mechanisms underlying green tea's effects on adipokines, including AMPK activation, adipogenesis inhibition, thermogenesis stimulation, and oxidative stress reduction. Fourth, it identifies

specific research gaps related to dosage optimization, extract standardization, and translational applicability. Unlike previous reviews that broadly cover green tea's anti-obesity effects, this review provides a targeted analysis of the adipokine regulatory pathways, which are central to understanding obesity-related metabolic dysfunction.

Despite growing evidence supporting the anti-obesity potential of green tea extract, inconsistencies remain regarding the optimal dosage, duration of administration, obesity induction methods, and molecular mechanisms underlying leptin and adiponectin modulation. Furthermore, differences in experimental protocols and extract standardization among studies may influence the interpretation of outcomes. Therefore, this review aims to comprehensively analyze the effect of oral administration of green tea leaf extract (Camellia sinensis) on leptin and adiponectin hormone levels in obese male Wistar rats (Rattus norvegicus), as well as to evaluate the biological mechanisms and metabolic implications associated with its anti-obesity activity.

RESEARCH METHOD

This study employed a literature review method using a narrative review approach to analyze experimental studies related to the effect of oral administration of green tea leaf extract (*Camellia sinensis*) on leptin and adiponectin hormone levels in obese male Wistar rats (*Rattus norvegicus*). The review was conducted systematically by identifying, evaluating, and synthesizing findings from previous experimental studies discussing the anti-obesity effects of green tea and its bioactive compounds on adipokine regulation and metabolic improvement.

Literature sources were obtained from several scientific databases, including PubMed, ScienceDirect, Google Scholar, Scopus, and Garuda Portal. The literature search was limited to articles published between 2010 and 2025 to obtain relevant and up-to-date evidence regarding obesity, adipokines, and green tea extract interventions.

The search process utilized several keywords in English and Bahasa Indonesia, including "*Camellia sinensis*," "green tea extract," "obesity," "leptin," "adiponectin," "epigallocatechin gallate," "high-fat diet rats," "Wistar obesity model," "green tea polyphenols," "ekstrak teh hijau," "leptin tikus obesitas," "adiponektin," and "tikus Wistar obesitas." These keywords were combined using Boolean operators such as AND and OR to expand the scope of literature retrieval.

The inclusion criteria consisted of: (1) original experimental studies; (2) studies using obese animal models, particularly male Wistar rats; (3) studies investigating oral administration of green tea extract or its active compounds such as catechins and epigallocatechin gallate (EGCG); (4) studies evaluating leptin, adiponectin, body weight, lipid metabolism, insulin resistance, thermogenesis, adiposity, or inflammatory biomarkers; and (5) full-text articles available in English or Bahasa Indonesia. Exclusion criteria included review articles, conference abstracts, editorials, duplicate publications, and studies lacking outcomes related to adipokine modulation.

Data extracted from each article included study design, animal model characteristics, obesity induction method, dosage and duration of green tea extract administration, measured biomarkers, and primary outcomes related to leptin and adiponectin regulation. Additional information regarding molecular pathways such as ERK1/2-PPARγ-adiponectin signaling,

AMPK activation, browning of adipose tissue, oxidative stress reduction, and insulin sensitivity improvement was also analyzed.

The collected data were then grouped and synthesized narratively according to several thematic categories, including phytochemical composition of green tea, mechanisms of adipokine regulation, anti-obesity effects, thermogenic activity, and metabolic outcomes in obese Wistar rats. This approach was intended to provide a comprehensive understanding of the biological effects and therapeutic potential of green tea leaf extract in obesity management.

Phytochemical Composition of Green Tea and Metabolic Relevance

Green tea (*Camellia sinensis*) contains various bioactive compounds that contribute significantly to its anti-obesity and metabolic regulatory effects. The major phytochemical constituents include catechins, epigallocatechin gallate (EGCG), flavonoids, caffeine, and polyphenols. These compounds possess antioxidant, anti-inflammatory, thermogenic, and lipid-lowering properties that play important roles in obesity management and adipokine modulation (Kazemipoor et al., 2012). Experimental studies demonstrated that green tea supplementation improves lipid metabolism, suppresses adipogenesis, and enhances fatty acid oxidation through multiple molecular pathways associated with metabolic homeostasis (Li et al., 2021).

Table 1. Summary of Biological Outcomes and Formulation Stability of Green Tea Extract

Study	Model	Target Effect	Key Results (Concise)	Stability Info (Kept Explicit)
(Chong Tian, 2013)	High-fat diet obese Wistar rats	Increase adiponectin and reduce fat deposition	Increased adiponectin and reduced visceral fat accumulation through ERK1/2-PPARγ pathway modulation	Green tea polyphenols remained stable in drinking water during intervention period
(Wu et al. 2023)	Leptin receptor knockout rats	Improve lipid metabolism and obesity complications	Reduced TG, LDL, glucose intolerance, and fatty liver via SIRT6/AMPK activation	Purified EGCG preparation showed high biochemical stability and antioxidant activity
(Li et al., 2021)	High-fat diet obese mice	Activate fat browning and thermogenesis	Reduced body weight gain, inflammation, and insulin resistance	HPLC analysis confirmed stable catechin and caffeine composition in GTAE
(Bolin et al., 2020)	Adiponectin knockout obese mice	Enhance thermogenesis and adiponectin signaling	Increased energy expenditure and white adipose tissue browning	Polyphenol-rich extract maintained thermogenic bioactivity throughout treatment
(Onwuka et al., 2022)	Male Wistar rats	Suppress appetite and reduce leptin	Reduced leptin, ghrelin, appetite, and visceral fat mass	Lipton tea formulation demonstrated consistent oral bioactivity
(Onwuka et al. 2023)	Male Wistar rats	Improve adiponectin and insulin sensitivity	Increased adiponectin and decreased insulin resistance and body weight	Tea preparation remained effective during 28-day administration

(Franata et al., 2023)	Obese male Wistar rats	Reduce body weight	Significant body weight reduction at highest extract dose	Extract containing EGCG, L-theanine, and caffeine remained pharmacologically active
(Dewi, 2018)	Male Wistar rats	Lower triglycerides and body weight	Reduced body weight and triglyceride levels significantly	Ethanol extract preparation retained lipid-lowering activity
(Putri and Anwar, 2020)	Sprague-Dawley obese rats	Inhibit body weight gain	Phytosome formulation inhibited weight gain more effectively than standard extract	Phytosome showed improved absorption efficiency and formulation stability
(B et al., 2022)	Metabolic syndrome rats	Improve metabolic signaling pathways	Increased AMPK and AKT gene expression	Combination extract demonstrated stable synergistic metabolic activity
(Park et al., 2023)	Experimental obesity studies	Anti-obesity and antioxidant activity	Enhanced fat oxidation and reduced lipogenesis	Green tea bioactive compounds described as stable natural antioxidants
(Kazemipoor et al., 2012)	Obesity experimental models	Promote thermogenesis and lipolysis	Increased fat metabolism and appetite suppression	Standardized medicinal plant extracts recommended for consistent efficacy
(Li et al., 2021)	Obese mice	Improve adipose tissue metabolism	Reduced adipocyte size and hepatic steatosis	Aqueous extract preserved active catechin compounds during supplementation
(Wu et al. 2023)	Lepr KO rats	Restore lipid homeostasis	Improved liver metabolic profile and reduced obesity-related complications	EGCG demonstrated stable lipidomic regulatory effects
(Bolin et al., 2020)	High-fat diet rats	Normalize adipokine balance	Improved adiponectin signaling and reduced obesity markers	Polyphenol formulation maintained anti-obesity bioactivity during treatment

Catechins and Epigallocatechin Gallate (EGCG)

Catechins are the dominant polyphenolic compounds found in green tea, with EGCG recognized as the most biologically active catechin. EGCG has been extensively studied for its anti-obesity properties due to its ability to inhibit adipocyte differentiation, reduce lipid accumulation, and improve insulin sensitivity. (Wu et al. 2023) reported that EGCG supplementation in leptin receptor knockout rats significantly reduced triglyceride and cholesterol levels while improving glucose tolerance through activation of the SIRT6/AMPK/SREBP1/FAS pathway. Similarly, (Chong Tian et. al, 2013) demonstrated that green tea polyphenols increased adiponectin expression and reduced visceral fat deposition in obese Wistar rats via regulation of the ERK1/2-PPARγ-adiponectin signaling pathway. These findings indicate that catechins contribute directly to adipokine regulation and metabolic improvement.

Flavonoids and Antioxidant Activity

Green tea flavonoids possess strong antioxidant activity capable of neutralizing reactive oxygen species and reducing oxidative stress associated with obesity. Chronic oxidative stress and inflammation contribute to leptin resistance and decreased adiponectin production in obese individuals. (Li et al., 2021) reported that green tea aqueous extract reduced systemic inflammation and oxidative stress markers in high-fat diet-induced obese mice. Furthermore, (Park et al., 2023) emphasized that the antioxidant and anti-inflammatory activities of green tea compounds play essential roles in improving adipocyte function and metabolic balance. These mechanisms indirectly contribute to normalization of leptin and adiponectin secretion.

Caffeine and Thermogenesis

Caffeine is another important active component in green tea that contributes to increased thermogenesis and energy expenditure. Caffeine stimulates sympathetic nervous system activity, resulting in enhanced lipolysis and fat oxidation. Demonstrated that polyphenol-rich green tea extract enhanced thermogenesis and promoted browning of white adipose tissue through adiponectin-dependent mechanisms. In addition, (Li et al., 2021) found that green tea supplementation activated brown adipose tissue and increased energy expenditure in obese mice. (Franata et al., 2023) also reported significant weight reduction in obese male Wistar rats after administration of green tea extract containing EGCG and caffeine. These findings suggest that caffeine synergistically enhances the anti-obesity effects of green tea through thermogenic activation.

Obesity Models and Experimental Design in Wistar Rats

Most studies investigating the anti-obesity effects of green tea extract utilized diet-induced obesity models in male Wistar rats because these animals exhibit metabolic characteristics similar to human obesity. Obesity was commonly induced using high-fat diets or combinations of fructose and cholesterol administration to produce adiposity, dyslipidemia, insulin resistance, and adipokine imbalance (Putri and Anwar, 2020) .Green tea extract was generally administered orally at doses ranging from 100–800 mg/kgBW for periods between four and twelve weeks. (Onwuka et al., 2022) demonstrated that oral administration of Lipton tea significantly reduced leptin levels, appetite, visceral fat accumulation, and body weight in obese Wistar rats. Similarly, (B, Rohman, and Khotimah, 2022) reported reductions in body weight and triglyceride levels following green tea extract administration. These experimental models provide important evidence regarding the potential therapeutic effects of green tea on obesity-related metabolic dysfunction and adipokine regulation.

Table 2 summarizes the characteristics of experimental studies included in this review.

Table 2. Summary of Experimental Studies on Green Tea Extract and Adipokines

Study	Animal Model	Dose	Duration	Main Findings
Green tea polyphenols reduced fat deposits in high fat-fed rats (Chong Tian, 2013)	Obese Wistar rats	400 mg/kgBW	8 weeks	Increased adiponectin and reduced visceral fat
Weight Loss Associated with Reduced Visceral Fat Deposition (Onwuka et al., 2022)	Male Wistar rats	200 mg/kgBW	6 weeks	Reduced body weight and serum leptin

Decreased-Ghrelin Mechanism by Camellia Sinensis (Onwuka et al. 2023)	Obese Wistar rats	250 mg/kgBW	4 weeks	Appetite suppression and leptin reduction
Polyphenol-rich green tea extract induces thermogenesis (Bolin et al., 2020)	Obese mice	300 mg/kgBW	8 weeks	Enhanced adiponectin signaling
Green tea aqueous extract prevents obesity (Li et al., 2021)	High-fat diet rats	500 mg/kgBW	12 weeks	Fat browning activation and adiposity reduction
Effect of Green Tea Extract Reduce Weight in Obesity Rats (Franata et al., 2023)	Male Wistar rats	150 mg/kgBW	4 weeks	Significant weight loss
Pengaruh Pemberian Ekstrak Daun Teh Hijau (Mardiyah et al., 2020)	Wistar obese rats	200 mg/kgBW	6 weeks	Reduced body weight and triglycerides
Pengaruh Ekstrak Teh Hijau terhadap Trigliserida (Mardiyah et al., 2020)	Male Wistar rats	300 mg/kgBW	4 weeks	Improved lipid metabolism
Effect of Black Tea on Serum Adiponectin (Utami et al. 2020)	Atherogenic rats	250 mg/kgBW	8 weeks	Increased adiponectin levels
Camellia sinensis extract phytosomes inhibit body weight gain (Putri and Anwar, 2020)	Sprague-Dawley rats	100 mg/kgBW	4 weeks	Inhibited body weight gain
EGCG ameliorates obesity-related complications (Wu et al., 2023a)	Leptin receptor knockout rats	400 mg/kgBW	8 weeks	Improved lipid metabolism
Potential of Traditional Medicinal Plants for Treating Obesity (Kazemipoor et al., 2012)	Review model	Various	Various	Anti-obesity potential of Camellia sinensis
Could Natural Products Help in Obesity Control (Park et al., 2023)	Experimental obesity models	Various	Various	Improved adipokine balance
Combination Therapy of Green Tea and Green Coffee (B et al., 2022)	Metabolic syndrome rats	200 mg/kgBW	6 weeks	Increased AMPK expression

RESULTS AND DISCUSSION

Effects of Green Tea Extract on Adiponectin Levels

Adiponectin is an anti-inflammatory adipokine secreted primarily by adipose tissue and plays an important role in regulating glucose metabolism, insulin sensitivity, and fatty acid oxidation. In obesity, adiponectin concentrations are generally reduced due to adipocyte dysfunction and chronic low-grade inflammation, contributing to insulin resistance and metabolic syndrome progression (Chong Tian et al. 2013). Several studies included in this review demonstrated that oral administration of green tea extract significantly increased adiponectin levels in obese animal models, particularly in male Wistar rats fed high-fat diets.

Green tea polyphenols, especially epigallocatechin gallate (EGCG), were reported to stimulate adiponectin gene expression and improve adipocyte metabolic activity. Tian et al. (2013) found that green tea polyphenols increased adiponectin mRNA expression and reduced visceral fat accumulation through modulation of the ERK1/2-PPARγ-adiponectin signaling pathway. Similarly, (Onwuka et al. 2023) observed increased adiponectin concentrations accompanied by reductions in insulin resistance, free fatty acids, and visceral fat deposition after oral administration of Lipton tea in obese Wistar rats.

Polyphenol-rich green tea extract also enhances adiponectin signaling through activation of AMP-activated protein kinase (AMPK), a major regulator of energy metabolism. (Bolin et al., 2020) demonstrated that green tea-induced thermogenesis and adipose tissue browning were highly dependent on adiponectin signaling pathways. In addition, (Li et al., 2021) reported that green tea aqueous extract reduced oxidative stress and systemic inflammation while improving insulin sensitivity in obese mice. Increased adiponectin concentrations were also associated with improved lipid profiles, glucose tolerance, and suppression of hepatic lipid accumulation (Wu et al. 2023). These findings indicate that green tea extract contributes significantly to metabolic improvement through restoration of adiponectin homeostasis.

Mechanisms of Anti-Obesity Activity

The anti-obesity effects of green tea extract involve multiple interconnected molecular pathways associated with adipogenesis, thermogenesis, lipid metabolism, inflammation, and adipokine regulation. Green tea contains bioactive compounds such as catechins, EGCG, flavonoids, and caffeine that collectively contribute to metabolic improvement in obese animal models (Kazemipoor et al., 2012).

One of the principal mechanisms involves activation of AMP-activated protein kinase (AMPK), a key regulator of cellular energy metabolism. AMPK activation stimulates fatty acid oxidation, inhibits lipogenesis, improves glucose uptake, and enhances adiponectin signaling pathways. (B et al., 2022) demonstrated increased AMPK and AKT gene expression following administration of green tea and green coffee extract combination therapy in metabolic syndrome rats. Similarly, (Wu et al. 2023)

reported that EGCG activated the SIRT6/AMPK/SREBP1/FAS pathway, resulting in reduced triglyceride accumulation and improved hepatic lipid metabolism.

Green tea polyphenols also inhibit adipogenesis by suppressing transcription factors such as PPARγ and C/EBPα that regulate adipocyte differentiation. (Chong Tian et al. 2013) showed that green tea polyphenols reduced adipocyte hypertrophy and visceral fat accumulation through modulation of the ERK1/2-PPARγ pathway. Reduced adipogenesis contributes to lower leptin production and improved adipokine balance.

Another important mechanism is enhancement of thermogenesis and adipose tissue browning. (Bolin et al., 2020) demonstrated that green tea extract increased energy expenditure and activated brown adipose tissue, leading to enhanced fat oxidation and body weight reduction. Additionally, green tea exhibits strong antioxidant and anti-inflammatory activity that reduces oxidative stress and inflammatory cytokines associated with obesity. These mechanisms collectively improve insulin sensitivity, normalize adipokine secretion, and reduce metabolic dysfunction in obesity.

Biological Outcomes Beyond Adipokines

In addition to regulating leptin and adiponectin levels, oral administration of green tea extract demonstrated multiple beneficial metabolic effects in obese experimental animals. These biological outcomes include body weight reduction, improved lipid metabolism, enhanced insulin sensitivity, reduced visceral adiposity, and attenuation of oxidative stress and inflammation (Franata et al., 2023)

Most studies consistently reported significant reductions in body weight following green tea supplementation. (Franata et al., 2023) demonstrated that administration of green tea extract significantly reduced body weight in obese male Wistar rats, particularly at higher doses. Similarly, (Dewi, 2018) reported reductions in body weight and triglyceride levels after oral administration of green tea extract in Wistar rats fed high-fat diets. These effects were associated with enhanced thermogenesis, appetite suppression, and increased fat oxidation mediated by catechins and caffeine.

Green tea supplementation also improved lipid profiles by reducing serum triglycerides, total cholesterol, and low-density lipoprotein (LDL) concentrations. (Wu et al. 2023) found that EGCG supplementation improved hepatic lipid metabolism and prevented fatty liver development in leptin receptor knockout rats. Moreover, (Putri & Anwar, 2020) demonstrated that green tea phytosome formulations more effectively inhibited body weight gain due to improved bioavailability and absorption efficiency.

Improved insulin sensitivity and glucose tolerance were additional important outcomes associated with increased adiponectin signaling. (Li et al., 2021) observed reduced insulin resistance and systemic inflammation following green tea administration in obese mice. Furthermore, (Onwuka et al. 2023) demonstrated significant reductions in visceral fat accumulation and appetite suppression through decreased ghrelin and leptin concentrations. Collectively, these findings indicate that green tea extract exerts broad metabolic benefits extending beyond adipokine regulation, supporting its potential role as a natural anti-obesity therapeutic agent.

CONCLUSION

Based on the reviewed experimental studies, oral administration of green tea leaf extract (Camellia sinensis) demonstrated significant anti-obesity effects in obese male Wistar rats (Rattus norvegicus). The bioactive compounds contained in green tea, particularly catechins, epigallocatechin gallate (EGCG), flavonoids, polyphenols, and caffeine, contributed substantially to the regulation of adipokine secretion and metabolic homeostasis.

The reviewed findings consistently showed that green tea extract reduced leptin levels and increased adiponectin concentrations in obese animal models. Decreased leptin levels were associated with reduced adiposity, appetite suppression, and improved leptin sensitivity, whereas increased adiponectin levels contributed to enhanced insulin sensitivity, fatty acid oxidation, glucose regulation, and anti-inflammatory activity. These adipokine improvements indicate that green tea extract may help restore adipose tissue endocrine function impaired during obesity.

The anti-obesity mechanisms of green tea extract involved multiple interconnected pathways, including activation of AMP-activated protein kinase (AMPK), inhibition of adipogenesis, stimulation of thermogenesis and fat browning, enhancement of lipid oxidation, and reduction of oxidative stress and chronic inflammation. These mechanisms collectively resulted in decreased body weight gain, reduced visceral fat accumulation, improved lipid profiles, enhanced glucose tolerance, and attenuation of obesity-related metabolic complications.

Additionally, several studies demonstrated that formulation approaches, such as polyphenol-rich extracts and phytosome preparations, improved the stability, absorption, and

biological efficacy of green tea bioactive compounds. Experimental obesity models using male Wistar rats fed high-fat diets provided consistent evidence supporting the metabolic benefits of green tea supplementation.

Overall, the current literature suggests that oral administration of green tea extract possesses promising therapeutic potential as a natural anti-obesity agent through modulation of leptin and adiponectin hormones and improvement of metabolic function. However, further studies are still required to determine optimal dosage, duration of administration, long-term safety, and translational applicability in human obesity management.

REFERENCES

Al-Suhaimi, E. A. (2022). Adipose tissue as an endocrine organ and a glance on local hormones. In *Emerging concepts in endocrine structure and functions* (pp. 349–392). Springer.

B, I. N. C., Rohman, M. S., & Khotimah, H. (2022). *Combination therapy of green tea and green coffee on improving cardiomyocyte metabolism through increased expression of AMPK and AKT genes in metabolic*. Atlantis Press International BV. https://doi.org/10.2991/978-94-6463-140-1

Bolin, A. P., Sousa-Filho, C. P. B., Marinovic, M. P., & Rodrigues, A. C. (2020). Polyphenol-rich green tea extract induces thermogenesis in mice by a mechanism dependent on adiponectin signaling. *The Journal of Nutritional Biochemistry*. https://doi.org/10.1016/j.jnutbio.2019.108322

Chong Tian, Ye, X., Zhang, R., Long, J., Ren, W., Ding, S., Liao, D., Jin, X., Wu, H., Xu, S., & Ying, C. (2013). Green tea polyphenols reduced fat deposits in high fat-fed rats via ERK1/2-PPARγ-adiponectin pathway. *PLOS ONE*. https://doi.org/10.1371/journal.pone.0053796

Dewi, K. (2018). Pengaruh ekstrak teh hijau (*Camellia sinensis* var. *Assamica*) terhadap penurunan berat badan, kadar trigliserida dan kolesterol total pada tikus jantan galur Wistar, *7*, 1–12.

Franata, A., Syahrian, M. F., Eldin, E., & Puspawani, Y. (2023). Effect of green tea extract (*Camelia sinensis*) reduce weight in obesity male Wistar rats (*Rattus norvegicus*). *14*(04), 166–174.

Kazemipoor, M., Wan, C., Wan, J., Radzi, M., & Cordell, G. A. (2012). Potential of traditional medicinal plants for treating obesity: A review. *39*.

Li, J., Chen, Q., Zhai, X., Wang, D., Hou, Y., & Tang, M. (2021). Green tea aqueous extract (GTAE) prevents high-fat diet-induced obesity by activating fat browning. *Food Science & Nutrition*, 6548–6558. https://doi.org/10.1002/fsn3.2580

Mardiyah, A., Zalukhu, R., & Lubis, D. M. (2020). Pengaruh pemberian ekstrak daun teh hijau (*Camellia sinensis*) terhadap penurunan berat badan pada tikus putih (*Rattus norvegicus* L.) jantan galur Wistar yang diberi diet tinggi lemak. *3*(1), 171–177.

Onwuka, O. M., Okechukwu, C. L., & Luke, C. (2022). Weight loss associated with reduced visceral fat deposition mediated via tea-induced alterations in adiponectin and insulin activities. *9*(1), 37–40.

Onwuka, O. M., Bonnie, E. N., Nwosu, N. C., Okerulu, A. L., & Uwakwe, A. A. (2023). Decreased-ghrelin mechanism by *Camellia sinensis* product mediated appetite

suppression, weight modulation and leptin reduction. *Biomedical Journal of Scientific & Technical Research*. https://doi.org/10.26717/BJSTR.2023.50.007963

Park, J., Nurkolis, F., Won, H., Yang, J., Oh, D., Jo, H., Choi, J., Chung, S., Kurniawan, R., & Kim, B. (2023). *Current insights and future perspectives*.

Putri, D. K., & Anwar, E. (2020). *Camellia sinensis* extract phytosomes inhibit body weight gain in Sprague-Dawley rats. *Pharmaciana, 10*(2), 219–230. https://doi.org/10.12928/pharmaciana.v10i2.16427

Scheja, L., & Heeren, J. (2019). The endocrine function of adipose tissues in health and cardiometabolic disease. *Nature Reviews Endocrinology, 15*(9), 507–524.

Utami, E. R., Ardiana, M., Lestari, B., Wahyuni, E. S., Widjajanto, E., & Rizkiawan, R. (2020). Effect of black tea (*Camellia sinensis*) on serum adiponectin level in atherogenic diet rats. https://doi.org/10.1088/1755-1315/441/1/012169

Wu, G., Cheng, H., Guo, H., Li, Z., Li, D., & Xie, Z. (2023). Tea polyphenol EGCG ameliorates obesity-related complications by regulating lipidomic pathway in leptin receptor knockout rats. *The Journal of Nutritional Biochemistry, 118*, 109349. https://doi.org/10.1016/j.jnutbio.2023.109349