E-BOOK OF EXTENDED ABSTRACT

THE 14TH INTERNATIONAL INVENTION, INNOVATION & DESIGN COMPETITION 2025

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GREEN TEA REINVENTED: A POWERFUL SOLUTION TO HIDDEN HUNGER AND OXIDATIVE STRESS

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ABSTRACT

Hidden hunger is a condition characterized by a deficiency of essential vitamins and minerals at the cellular level despite adequate caloric intake, affecting approximately two billion people globally. These micronutrient deficiencies can impair the immune system and increase the risk of oxidative stress, contributing to the development of various degenerative and non-communicable diseases. Green tea (Camellia sinensis) is known for its high antioxidant content, particularly catechins, which have been shown to reduce oxidative stress and enhance micronutrient absorption. This study focuses on the development of a green tea extract with enhanced antioxidant properties through improved extraction techniques and nutraceutical fortification. The resulting product offers a practical solution for meeting daily antioxidant and micronutrient requirements, supporting a healthy lifestyle and offering potential health benefits, including disease prevention and therapeutic effects. Antioxidant consumption is anticipated to become a significant future trend, as antioxidants play a critical role in strengthening the body's defense mechanisms against reactive oxygen species (ROS) and in the prevention of various diseases.

Keyword: Hidden hunger, oxidative stress, antioxidants, green tea, catechins, fortification, nutraceutical.

1. INTRODUCTION

Hidden hunger is a condition characterized by a deficiency of essential vitamins and minerals at the cellular level, despite adequate food intake and the absence of visible signs of malnutrition. It is estimated that around two billion people worldwide are affected by this condition (Gani et al., 2018). Micronutrient deficiencies can weaken the immune system, reduce productivity, and impair the body's ability to cope with various health challenges, including oxidative stress. Nutrients such as polyphenols, vitamin C, vitamin E, zinc, and selenium function as antioxidants. When the body lacks these nutrients, its defense mechanisms against free radicals become compromised, thereby increasing the risk of developing various diseases.

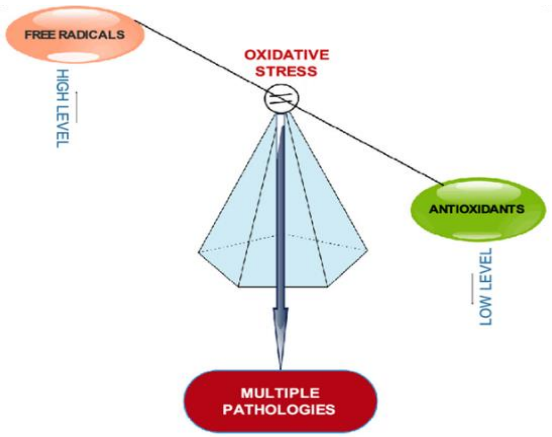

Figure 1. Consequences of Oxidative Stress Due to Antioxidant Deficiency

Oxidative stress occurs when the level of free radicals in the body exceeds the capacity of antioxidants to neutralize them. Free radicals are reactive molecules generated from exposure to air pollution, ultraviolet radiation, and chemical substances found in food and beverages. One of the most significant groups of free radicals involved in this process is reactive oxygen species (ROS). When the balance between free radicals and antioxidants is disrupted, cellular, tissue, and even DNA/RNA damage can occur. This condition, known as oxidative stress, has been shown to contribute to premature aging and the development of various degenerative diseases (Lobo et al., 2010; Preiser, 2012; Wang et al., 2024).

Fruits, vegetables, and tea are natural sources of antioxidants that help the body combat free radicals and reduce oxidative stress. The effectiveness of these antioxidants can be measured using the Oxygen Radical Absorbance Capacity (ORAC) method, which indicates a substance's ability to neutralize free radicals. A daily antioxidant intake of 3,000–5,000 ORAC units is recommended to maintain optimal health (McBride, 1999). Among these natural sources, green tea (Camellia sinensis) stands out due to its high catechin content, which not only possesses antioxidant and anti-inflammatory properties but also enhances the absorption of micronutrients (Shaukat et al., 2023).

The high prevalence of micronutrient deficiencies, which can trigger oxidative stress, has become a significant public health concern. On the other hand, green tea is widely recognized for its antioxidant compounds that have the potential to mitigate the effects of oxidative stress. Based on this premise, the present study focuses on the development of a green tea formulation with enhanced antioxidant content through extraction techniques and nutraceutical fortification. Nutraceuticals are a category of functional foods that combine nutritional and pharmaceutical elements—referring to food substances or components that provide health or medical benefits, including the prevention and treatment of diseases. This innovation is expected to offer a practical and natural solution for increasing daily antioxidant intake, while also addressing health challenges associated with modern, often unhealthy, lifestyles.

2. METHODOLOGY

This innovation employs a combination of extraction techniques and nutraceutical fortification to develop a green tea extract with enhanced antioxidant content, thereby meeting the body's daily antioxidant intake requirements.

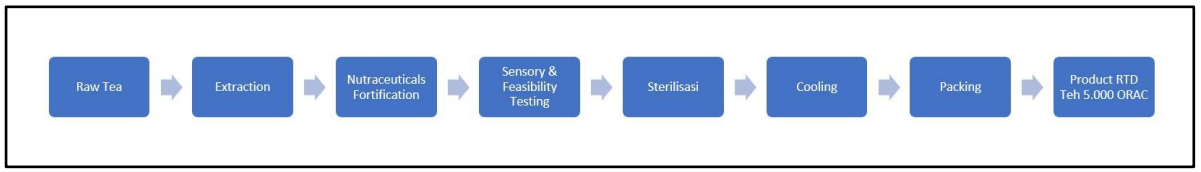

Figure 2. Combined Process of Extraction Methods and Nutraceutical Fortification

3. FINDINGS

The analysis of this innovation has resulted in a research-based nutraceutical functional food product aimed at addressing hidden hunger, or micronutrient deficiency at the cellular level, which can trigger oxidative stress and reduce life productivity. This product offers advantages such as fulfilling daily polyphenol and antioxidant requirements, providing a low glycemic index (LGI), and delivering other essential nutraceutical components. The innovation benefits daily antioxidant intake without adding dietary burden, owing to a green tea extract formulation developed through a combination of extraction and nutraceutical fortification methods. This formulation yields antioxidant compounds providing the body with an antioxidant capacity ranging from 3,000 to 5,000 ORAC units per day.

The antioxidant compounds in this green tea extraction innovation include polyphenols such as catechins, specifically epigallocatechin gallate (EGCG), epigallocatechin (EGC), epicatechin gallate (ECG), and epicatechin (EC), all of which are known for their strong antioxidant activity and ability to neutralize free radicals (Wang et al., 2024). Analysis of a single cup of green tea (approximately 240–250 mL) revealed an average catechin content of 304 mg, with 187 mg of this amount being epigallocatechin (EGC), the most active antioxidant catechin (Hu et al., 2018, pp. 412–433). In addition to its antioxidant activity, EGCG in green tea also exhibits anti-inflammatory properties that can reduce oxidative stress levels in the body. This contributes to enhanced efficiency in the absorption and utilization of micronutrients and supports the function of enzymes that require vitamins and minerals as cofactors (Shaukat et al., 2023).

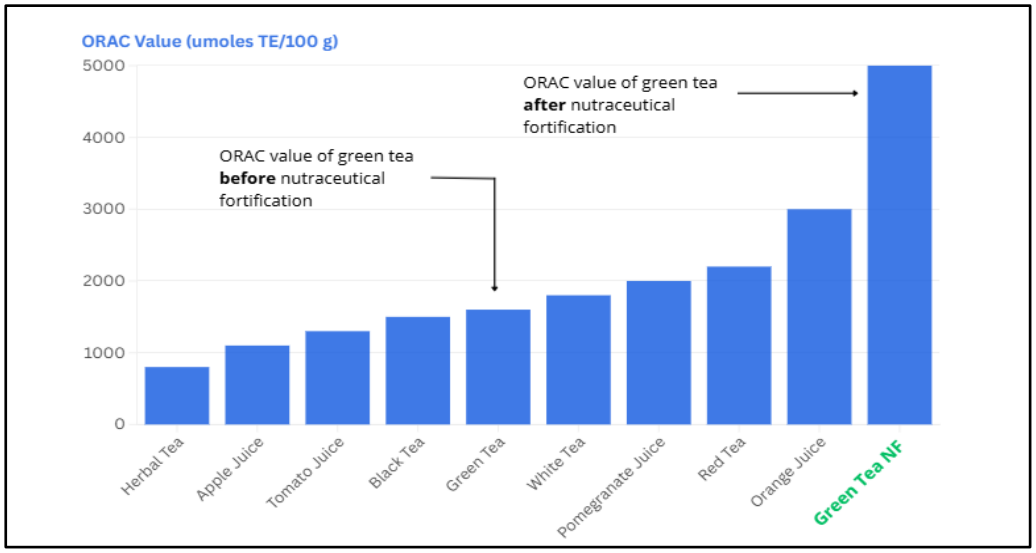

Figure 3. ORAC Levels of Beverages and Nutraceutical-Fortified Green Tea

To optimize the consumption of antioxidant-rich green tea extract beverages, we incorporated nutraceutical fortification using sugarcane polyphenol extract. This addition aims to enhance the polyphenol content, other micronutrients, and the overall ORAC value of the product. In its natural state, green tea contains only 72 mg of polyphenols per 100 mL and has an ORAC value of approximately 1600 per 100 mL. After nutraceutical fortification with sugarcane polyphenol extract, the polyphenol content increased significantly to 569 mg per 100 mL, while the ORAC value surged to 5000 per 100 mL—surpassing all other beverages included in this comparison. These findings confirm that green tea fortified with sugarcane polyphenol extract exhibits substantially higher antioxidant potential, making it a superior functional beverage for supporting health, combating oxidative stress, and enhancing life productivity.

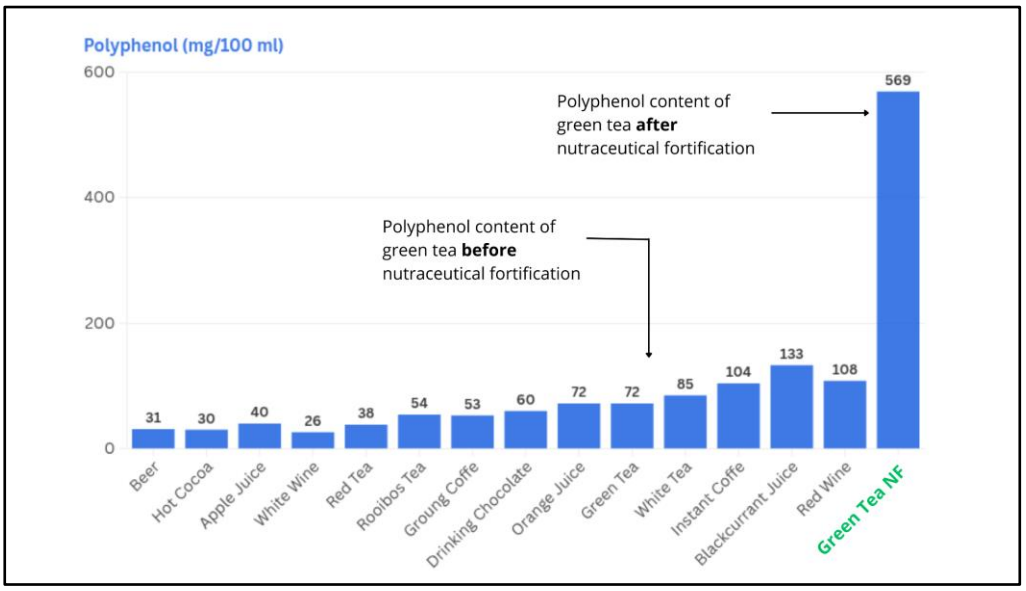

Figure 4. Polyphenol Levels of Beverages and Nutraceutical-Fortified Green Tea

The final product is presented in a ready-to-consume packaging, making it a practical and flexible option for fulfilling daily micronutrient and antioxidant requirements. With its convenient packaging, this product serves as an innovative example of a ready-to-drink green tea beverage, where a single 250 mL bottle provides an ideal solution for modern lifestyles.

4. CONCLUSION

This study developed a green tea extract product enriched with antioxidants through extraction and nutraceutical fortification methods. The product aims to address hidden hunger, which can trigger oxidative stress and reduce life productivity, by containing active compounds such as polyphenols, catechins, and EGCG that effectively neutralize free radicals. Presented in a ready-to-drink (RTD) format, this product offers a practical and flexible solution to meet daily antioxidant micronutrient needs, support a healthy lifestyle, and enhance micronutrient absorption efficiency without increasing dietary burden. This innovation provides health and medical benefits, including disease prevention and treatment, amid the challenges of modern lifestyles.

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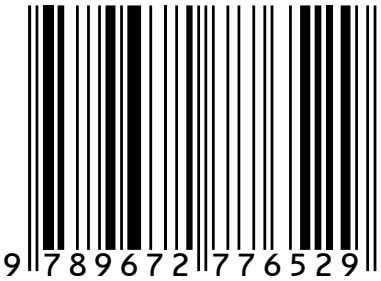

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