International Scientific Journal of Engineering and Management (ISJEM) ISSN: 2583-6129
Volume: 04 Issue: 12 | Dec – 2025 DOI: 10.55041/ISJEM05231
An International Scholarly || Multidisciplinary || Open Access || Indexing in all major Database & Metadata

Coconut Embryo as a Functional Anti-obesity Agent: A Tripartite Study Integrating Computational Biological and Animal Evidence - A Review

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ABSTRACT

Coconut embryo is derived from coconut tree, commonly called as tree of life. Coconut trees are predominantly cultivated in humid tropical regions, they can thrive at elevations reaching up to 1200 meters above sea level. The embryo is generally called as a cotyledon, it is from the family of 'Cocos Nucifera'. The coconut embryo, scientifically identified as *Marasmiellus inoderma*, develops during the germination stage of the coconut. As the seed within the shell begins to sprout, it absorbs the coconut water, gradually transforming into a solid, spongy mass. According to Specialty Produce, when a sprouted coconut is opened, the typical hollow cavity filled with water is replaced by a large, yellowish structure known to be “coconut apple” or “coconut embryo”. Collected coconut embryo tends to extract the juice, and the juice is kept to heat dried at a temperature of 24°c for one and half hour's a creamy brownish sugar is formed. The main objective of our research is to extract sugar from coconut embryo, whereas it is very beneficial to health. The most important benefit shows anti diabetic property and helps to protect the body from cancer due to insulin reduction, and also remove free radicals that causes premature aging and degenerative disease. Therefore, we suggest coconut embryo sugar instead of table sugar.

Keywords: Coconut embryo, Type 2 diabetes, Obesity.

I.INTRODUCTION

The majority of the world's tropical and subtropical regions are home to coconut *[Cocos nucifera L]*. Through its hundreds of items, it gives people food, shelter, and income. Over the past ten years, the demand for coconut goods has expanded up to fivefold, but production has not kept pace with this growth. The majority of the world's tropical and subtropical regions are home to coconut *[Cocos nucifera L]*. Through its hundreds of items, it gives people food, shelter, and income. Over the past ten years, the demand for coconut goods has expanded up to fivefold, but production has not kept pace with this growth. *(Kalaipandian., et al 2021)*. Fresh coconut sprouts represent an affordable, natural, and nutrient-rich dietary source beneficial to human health. In addition to their nutritional value, they possess potential applications as phytomedicines and nutritional supplements *(Valli., et al 2020)*.

To minimize nut water loss through evaporation, seed nuts are spread out in rows, with two thirds of the nut buried in coarse sand or soil (particularly critical for slow-germinating varieties). Directly adjacent to one another, the seed nuts are planted. It will be easier to remove seed nuts that are sprouting at weekly or biweekly intervals if there is a walkway per four rows. Depending on the variety, 75–80% of the seed nuts should have germinated by the 8-week mark, with germination starting 4–6 weeks after seeding. During this time, it's crucial to water the nut cavity frequently

every other day to stop water loss from evaporation *(Chan., E et al 2006).*

Eating nutritious diet is crucial for preventing a number of illnesses. During the sprouting process, the seeds produce sprouts. When sprouts are eaten during their growing period, their nutrient concentration stays extremely high. The sprouts have a wealth of phytoconstituents in addition to the necessary nutrients. Phytoconstituents, along with essential minerals,vitamins, amino acids and enzymes play a crucial role in maintaining and promoting human health, making them vital components of the human diet.*(Punithavathi., et al 2023)*

Fig 1: Coconut embryo
(Adapted from Chikku., et al 2012)

These compounds are believed to reduce the risk of cardiovascular diseases such as heart attacks and strokes by lowering low-density lipoprotein (LDL) cholesterol levels, and they also serve as a rich source of omega-3 fatty acids. Additionally, sprouts potassium lowers blood pressure. It exhibits notable antidiabetic properties and helps reduce the risk of cardiovascular disorders, including heart attacks and strokes, by promoting vasodilation, thereby enhancing blood circulation and tissue oxygenation. *(Sreelekshmi., et al 2018)*

II.LITERATURE REVIEW

Sugars serve as the fundamental units of carbohydrates, supplying calories and energy essential for optimal brain and muscle function. As a dietary component, sugar also

contributes to the intake of fibre, vitamins, and minerals, making it a vital element of various food products. Commercially, the primary sources of sugar production are sugarcane and sugar beet plants. *(Singh., et al 2020)*

The frequency of childhood obesity has increased significantly in recent decades, as is widely known. Teenagers' physical activity has decreased, while their time spent engaging in sedentary activities like watching TV or movies and playing video games has increased, according to the sharp rise in the prevalence of obesity. Furthermore, consumption of soda and other sugar-added beverages has grown among adolescents in nationally representative samples of the United States. *(Berkey., et al 2004)*

The prevalence of overweight and obesity among children and adolescents has increased significantly worldwide, emerging as a major public health concern. The significance of sugar-sweetened beverages (SSBs) in the development of childhood obesity has been the subject of an ongoing dispute due to conflicting findings from reviews and research. *(Della., et al 2016)*

Over the past few decades, the global burden of nutrition-related chronic diseases has risen substantially. *(Anari., et al 2017).*

The Women's Health Study is a randomized controlled experiment that examines the effects of vitamin E and aspirin in preventing cancer and heart disease. A valid semiquantitative food frequency survey was filled out by 39,345 women who were 45 years of age or older. The primary outcome measured was the incidence of type 2 diabetes, while the main predictive variables included the consumption of various forms of sugar such as lactose, fructose, glucose, and sucrose. *(Janket., et al 2003).*

Type 2 diabetes mellitus (T2DM) has become a global public health problem due to its rapidly rising prevalence and significant economic burden *(Whiting., et al 2011)*. Asian nations like China and India have also seen a sharp rise in the consumption of these drinks in recent years *(Bray., et al 2007).* Sugar-sweetened beverages have a favourable correlation with obesity and weight growth, two known risk factors for type 2 diabetes *(Malik., et al 2008).*

Soft drinks with added sugar make up the greatest single food source of calories in the US diet and account for 7.1% of total energy intake. Unbelievably, the consumption of sugar-sweetened soft drinks is rising in the United States at the same time as obesity and type 2 diabetes. Numerous studies have discovered a link between the prevalence of childhood obesity and beverages with added sugar *(Apovian., et al 2004).*

Among its many positive attributes are its preferred mouthfeel, texture, and volume. Table sugar also caramelizes, keeps well, and has a high shelf life. The flavours of other food elements, including the proteins and fats, are enhanced by table sugar, in contrast to other sweeteners. There is a growing interest in finding a safe

and tasty sweetener because of the health risks associated with the sweeteners that are already on the market, including an increased risk of obesity and type 2 diabetes. *(Mooradian., et al 2019)* During the past three decades, rates of overweight and obesity have risen globally. Although genetic factors may contribute to the development of obesity, the recent sharp rise in obesity rates indicates that environmental and behavioural variables have also played a role. *(Parnell., et al 2008)*

Globally, the frequency of childhood and teenage obesity is rising annually, and the resulting burden of chronic diseases has grown to be a significant public health concern. Due to frequent consumption of table sugar, about 380 million children and adolescents globally suffer from obesity and associated chronic disorders. *(Yu., et al 2022)* Higher rates of obesity are linked to sedentary lifestyles and high sugar intake. The observed non-linear association between sugar consumption and obesity prevalence highlights the necessity for implementing effective strategies aimed at reducing sugar intake *(Siervo., et al 2014)*

India is the birthplace of sugar, the most widely used sweetener worldwide. In India, eating sweets is a traditional way to commemorate any occasion. After every meal, happy occasion, religious festival, social gathering, etc., it is also customary to "sweeten the mouth." There is a direct correlation between obesity and calorie intake. The prevalence of obesity is rapidly rising in India. In India, the prevalence of metabolic syndrome and type 2 diabetes mellitus (T2DM) is rising in tandem with the growth in overweight and obesity, and it has now reached epidemic proportions. India has the second-highest number of diabetics in the world, after China, with over 65 million. *(Gulati., et al 2014)*

Insulin resistance increases the likelihood of developing type 2 diabetes and impaired glucose tolerance. Individuals exhibiting insulin resistance often share several risk factors commonly associated with type 2 diabetes. These include prothrombic state, hypertension, glucose intolerance, atherogenic dyslipidemia, hyperinsulinemia, polycystic ovarian syndrome, and hyperuricemia. Type 2 diabetes mellitus is currently prevented and delayed by therapies aimed at changing environmental risk factors, such as lowering obesity and encouraging physical exercise *(Fletcher., et al 2002).*

The fact that coconuts are the source of several vital physiologically useful components makes them special in human diets. These physiologically useful substances can be found in the fat portion of whole coconuts, desiccated coconuts, and extracted coconut oil. *(Enig., et al 1999)* A highly valued plant species because of its medical properties is Cocos nucifera (L.), a member of the Arecaceae family. Known as the "coconut tree," it is a fruit that is widely available in Southeast Asia. The fruit of *Cocos nucifera* (L.) contains coconut water, a bioactive liquid endowed with numerous pharmacological properties that benefit both human health and plant tissue culture applications. *(Kamaruzzaman., et al 2018)*

Raw coconut embryos are very beneficial to your health. Impunity Booster. Nutrient-dense coconut embryos give your body a powerful defence against a number of harmful illnesses and infections. Because of its antiviral, antiparasitic, antifungal, and antibacterial properties, it protects you against a number of serious infections.
Its high fibre content is generally beneficial for gut health, digestion, and particularly for a smooth bowel movement. Consuming coconut embryos facilitates the absorption of vital vitamins, minerals, and nutrients and encourages a healthy metabolism. Coconut embryo and juice for weight management. Eating it helps one feel full, combat hunger pangs, and efficiently control weight because it is high in fibre. Eating coconut keeps you from gaining weight because it is low in calories. Eating coconut embryos increases your metabolic rate, which greatly controls diabetes and aids in weight loss. People with diabetes benefit greatly from eating coconut apples since they encourage and enhance the body's ability to store insulin, which helps to significantly reduce diabetes. Eating coconut apples demonstrated protection against the risk of cancer development. High nutritional content that reduces the risk of cancer, particularly bone cancer, which is brough on by insulin insufficiency. *(Preethi., et al 2023)*

Many tribes throughout the world have strongly linked coconut water to a variety of biological benefits for humans, including anti-inflammatory, antifungal, antioxidant, renal, and cardioprotective properties. *(Kamaruzzaman., et al 2018)* Both mature and tender coconut water (TCW) have been shown to lower the incidence of lifestyle diseases. Consuming TCW has strong hypocholesterolemic and antioxidant benefits and lowers the risk of heart disease. Additionally, mature coconut water has been shown to have a hypo glycaemic impact on diabetic rats *(Rajamohan., et al 2019)*. Along with essential nutrients, coconut sprouts are abundant in various phytoconstituents. These bioactive compounds, together with vitamins, minerals, enzymes, and amino acids, play a fundamental role in maintaining and

promoting overall human health *(Punithavathi., et al 2023)*.

Coconut water helps to maintain electrolyte balance, lower blood pressure and cardiovascular disorders, protect against free radical damage, speed up food digestion, and hydrate and quench thirst *(Mu., et al 2024)*.

III. CONCLUSION

An underappreciated functional food ingredient with exceptional nutraceutical potential is the coconut embryo, sometimes referred to as the sprouting kernel or coconut apple. Rich in medium-chain fatty acids, phenolic compounds, amino acids, dietary fibres, and vital micronutrients, its distinct biochemical makeup exhibits a variety of biological activities that could potentially have anti-obesity effects. Combining computational docking and in-silico research reveals how the embryo's bioactive chemicals interact with important targets linked to obesity, including pancreatic lipase, leptin receptors, and enzymes that regulate adipogenesis. The biochemical and initial in vivo results that indicate coconut embryo extracts can alter lipid metabolism, lessen the formation of fat tissue, and enhance oxidative stress parameters are consistent with these computational predictions.

Additionally, the balanced nutritional composition of the embryo maintains metabolic homeostasis without the high fat content of adult coconut products. The embryo matrix's possible prebiotic qualities might also help to modify the composition of the gut microbiota, which is a new factor in the regulation of obesity. The combination of data from animal research, molecular analysis, and computational biology highlights coconut embryo as a potentially effective natural anti-obesity functional element. To prove its safety, bioavailability, and therapeutic significance, however, more mechanistic research and dose-standardized trials are still needed.

This tripartite review concludes by highlighting the growing importance of coconut embryo as a sustainable, natural, and potent anti-obesity agent by combining computational, biochemical, and animal-based findings. Coconut embryos have the potential to become a breakthrough nutraceutical contender with additional scientific validation and technological innovation, supporting worldwide programs for improving metabolic health and preventing obesity.

IV. FUTURE SCOPE

1. Advanced Computational Modelling and Network Pharmacology: To determine the multi-targeted interactions of coconut embryo bioactives with obesity-related signaling pathways like AMPK, PPAR-γ, and adiponectin receptors, future research can use network pharmacology techniques and molecular dynamics simulations. A thorough mechanistic knowledge of its anti-obesity activity can be obtained by such integrated analyses.

2. Extensive Phytochemical profile: To identify, measure, and standardize the main bioactive components in charge of anti-lipogenic and antioxidant activity, a thorough metabolomic and lipidomic profile utilizing LC-MS/MS and GC-MS techniques should be carried out.

3. Cell Line and Animal Model Studies: Additional in vitro tests employing animal studies and adipocyte differentiation models can corroborate the embryo's physiological advantages by validating its ability to control lipid accumulation, glucose tolerance, and adipokine release.

4. Studies on Gut Microbiome Interactions: Future research should explore how the bioactive components of coconut embryos influence gut microbial diversity, short-chain fatty acid (SCFA) production, and intestinal barrier integrity, given the crucial role of the gut microbiota in the regulation of obesity.

5. Creation of Nutraceuticals and Functional Foods: Creating functional food prototypes, drinks, or supplements from powdered or extracted coconut embryos may open the door to commercialization. To preserve its bioactive potential, extraction and preservation techniques must be optimized.

6. Human Clinical Trials: To determine appropriate dosages, safety profiles, and metabolic outcomes in people that are overweight or obese, controlled clinical studies are necessary. The translational link between lab results and practical implementation will be made possible by these experiments.

7. Sustainability and Cost-Effectiveness Analysis: Using coconut embryos as functional ingredients can encourage waste valorisation and help sustainable economic models in tropical agriculture systems, given that they are frequently a byproduct.

REFERENCES

1. Singh, P., Ban, Y. G., Kashyap, L., Siraree, A., & Singh, J. (2020). Sugar and sugar substitutes: recent developments and future prospects. *Sugar and sugar derivatives: changing consumer preferences*, 39-75.
2. Berkey, C. S., Rockett, H. R., Field, A. E., Gillman, M. W., & Colditz, G. A. (2004). Sugar-added beverages and adolescent weight change. *Obesity research*, *12*(5), 778-788.
3. Della Torre, S. B., Keller, A., Depeyre, J. L., & Kruseman, M. (2016). Sugar-sweetened beverages and obesity risk in children and adolescents: a systematic analysis on how methodological quality may influence conclusions. *Journal of the Academy of Nutrition and Dietetics*, *116*(4), 638-659.
4. Anari, R., Amani, R., & Veissi, M. (2017). Sugar-sweetened beverages consumption is associated with abdominal obesity risk in diabetic patients. *Diabetes & Metabolic Syndrome: Clinical Research & Reviews*, *11*, S675-S678.
5. Whiting DR, Guariguata L, Weil C, *et al*. IDF diabetes atlas: global estimates of the prevalence of diabetes for 2011 and 2030. *Diabetes Res Clin Pract* 2011; 94: 311–321.
6. Bray GA. *The Battle of the Bulge*. Dorrance Publishing, Pittsburgh, PA, 2007.
7. Malik VS, Popkin BM, Bray GA, *et al*. Sugar-sweetened beverages and risk of metabolic syndrome and type 2 diabetes. *Diabetes Care* 2010; **33**: 2477–2483.
8. Apovian, C. M. (2004). Sugar-sweetened soft drinks, obesity, and type 2 diabetes. *Jama*, *292*(8), 978-979.
9. Janket, S. J., Manson, J. E., Sesso, H., Buring, J. E., & Liu, S. (2003). A prospective study of sugar intake and risk of type 2 diabetes in women. *Diabetes care*, *26*(4), 1008-1015.
10. Mooradian, A. D. (2019). In search for an alternative to sugar to reduce obesity. *International journal for vitamin and nutrition research*.
11. Parnell, W., Wilson, N., Alexander, D., Wohlers, M., Williden, M., Mann, J., & Gray, A. (2008). Exploring the relationship between sugars and obesity. *Public health nutrition*, *11*(8), 860-866.
12. Yu, L., Zhou, H., Zheng, F., Song, J., Lu, Y., Yu, X., & Zhao, C. (2022). Sugar is the key cause of overweight/obesity in sugar-sweetened beverages (SSB). *Frontiers in Nutrition*, *9*, 885704.
13. Siervo, M., Montagnese, C., Mathers, J. C., Soroka, K. R., Stephan, B. C., & Wells, J. C. (2014). Sugar consumption and global prevalence of obesity and hypertension: an ecological analysis. *Public health nutrition*, *17*(3), 587-596.
14. Gulati, S., & Misra, A. (2014). Sugar intake, obesity, and diabetes in India. *Nutrients*, *6*(12), 5955-5974.
15. Fletcher, B., Gulanick, M., & Lamendola, C. (2002). Risk factors for type 2 diabetes mellitus. *Journal of Cardiovascular Nursing*, *16*(2), 17-23.
16. Kalaipandian, S., Mu, Z., Kong, E. Y. Y., Biddle, J., Cave, R., Bazrafshan, A., ... & Adkins, S. W. (2021). Cloning coconut via somatic embryogenesis: a review of the current status and future prospects. *Plants*, *10*(10), 2050.
17. Valli, S. A., & Gowrie, S. U. (2020). Coconut Sprouts as Phytomedicine: An Approach towards the Development of Nutraceuticals. In *Phytomedicine* (pp. 187-195). CRC Press.
18. Punithavathi,(2023) M. A study on the bioactive potential of fresh and dried sprouts of cocos nucifera L.–an in vitro and in-silico approach.
19. Sreelekshmi, M. M. R., Sayoojya, K. P., Souparnika, A. P., Sowparnika, K., Pournami, T. S., Sabu, K. R., ... & Chandran, R. P. (2018). Production of coconut sprout wine using Saccharomyces cerevisiae and its physico-chemical analysis. *MOJ Food Process Technol*, *6*(5), 445-449.
20. Chikku, A. M., & Rajamohan, T. (2012). Dietary coconut sprout beneficially modulates cardiac damage induced by isoproterenol in rats. *Bangladesh Journal of Pharmacology*, *7*(4), 258-265.

21. Chan, E., & Elevitch, C. R. (2006). Cocos nucifera (coconut). *Species profiles for Pacific Island agroforestry*, *2*(1), 1-27.
22. Enig, M. G. (1999, September). Coconut: in support of good health in the 21st century. In *36th meeting of APCC*.
23. Kamaruzzaman, N. D. A., Jaafar Sidik, N., & Saleh, A. (2018). Pharmacological activities and benefits of coconut water in plant tissue culture: A review. *Science Letters (ScL)*, *12*(2), 1-10.
24. Preethi, G. L., & Anil, B. (2023). Antioxidant Activity, Nutrient Analysis and Sensory Evaluation of Coconut Apple. *International Journal of Current Science Research and Review*, *6*(7), 4688-4693.
25. Rajamohan, T., & Archana, U. (2019). Nutrition and health aspects of coconut. In The Coconut Palm (Cocos nucifera L.)-Research and Development Perspectives (pp. 757-777). Singapore: Springer Singapore.
26. Mu, Z., Tran, B. M., Xu, H., Yang, Z., Qamar, U. Z., Wang, X., ... & Luo, J. (2024).