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# Impact of Tigernuts on Blood Glucose and Insulin Levels in Normal Weight Male Humans

Igbinovia Edokpolor N[1*], Ohiwerei Wisdom O[2], Blackie Okosun H[3], Edebiri Ogbemudia E[4], Otaye Micheal O[5], Ohiwerei Faith O[6]
[1,4]Ambrose Alli University, Ekpoma, Edo State
[2,5,6]Ohilux Global, Ekpoma, Edo State
[3]Ambrose Alli University, Ekpoma, Edo State

**Corresponding Author:** Igbinovia Edokpolor N
Ohiwereiwisdom@gmail.com

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ABSTRACT

Tigernuts contain bioactive compounds such as sterols, alkaloids, tannins, saponins, resins, and vitamins E and C. This study examined their effects on blood glucose and insulin levels in normal-weight male subjects under resting conditions. Methods: Forty non-habitual tigernut chewers, aged 18–28 years, participated. After recording anthropometric data, subjects rested for 90 minutes. Blood glucose levels were measured using the enzymatic method of Barham and Trinder with a glucometer. Insulin levels were assessed using the ELISA Teco kit following Tiez and Andresen's method. On a separate day, the same subjects consumed 5g of tigernuts as a bolus, followed by 50ml of water. After another 90-minute rest, blood glucose and insulin levels were reassessed. Statistical analysis was conducted using GraphPad Prism Version 8.1. Results: Tigernut consumption led to a slight reduction in blood glucose levels (92.66 ± 2.156 to 89.61 ± 1.907 mg/dl), though not statistically significant. However, insulin levels showed a significant decrease ($P<0.05$, 4.220 ± 0.297 to 1.705 ± 0.061 µg/ml). Conclusion: Tigernuts demonstrated both blood glucose and insulin-lowering effects in normal-weight male subjects

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## INTRODUCTION

*Cyperus esculentus* L., commonly known as earthnut (chufa or earth almond), is a perennial tuberous plant from the sedge family (*Cyperaceae*). It is cultivated in Brazil, Spain, East Africa, several West African countries, including Nigeria and Portugal [1], and in Ukraine, where it is grown in experimental and home gardens [2,3]. The plant is valued for its small, sweet, almond-shaped tubers, which serve as a source of edible oil. These tubers, formed at the roots, have a hard shell, crispy texture, and sweet taste. Historically, chufa tubers have been consumed for their high nutritional value, containing 20–25% lipids, 20–35% starch, 12–28% sugars, and 5–9% proteins. The extracted oil has applications in food, industrial processing, and medicine [4]. Due to its biologically active compounds, earthnut tubers are considered promising for dietary, children's, and specialty foods.

## LITERATURE REVIEW

Widely cultivated in the Arabian Peninsula and other regions, *Cyperus esculentus* is an erect, fibrous-rooted perennial plant that grows between 1 and 3 feet tall, reproducing via seeds and rhizomes [5]. The edible tubers have a distinct sweet, nutty flavor and are consumed in Nigeria in various forms, including roasted, baked, dried, raw, or as a drink called *kunnu* [6]. The fat composition of these tubers is similar to olive oil, with 72% unsaturated fatty acids (oleic and linoleic acids) and 28% saturated fatty acids (palmitic and stearic acids) [7]. Extracts from *C. esculentus* have been reported to possess anti-cancer, anti-microbial, anti-diarrheal, and anti-flatulent properties and have been used in treating anemia, urinary tract infections, and hypercholesterolemia [8,9,10,11,12].

Beyond its nutritional value, *C. esculentus* tubers have other applications. In Spain, they are used to prepare a milk-like beverage called *horchata* [13]. Tigernuts are highly nutritious, cholesterol- and gluten-free [15], and are among the richest known sources of flavonoids [16]. They are abundant in water, fiber, alkaloids, digestible carbohydrates, saponins, and fatty oils (glycerides), and contain essential elements such as phosphorus, potassium, calcium, iron, zinc, magnesium, and manganese [17,18].

*Tigernut oil* is rich in monounsaturated fatty acids, resembling those found in olive, avocado, and hazelnut oils [19]. This oil contains high levels of unsaponifiable matter, phospholipids, and various bioactive compounds such as tocopherols, phytosterols, and polyphenols [20,19]. The small, round tubers, which grow along the roots, have a mild almond-like flavor and can be consumed raw, cooked, or prepared as *orxata*. Research indicates that these tubers contain phytosterols, ascorbic acid (*Vitamin C*), tocopherol (*Vitamin E*), and β-carotene [21]. These compounds, in conjunction with the tubers' unsaturated fatty acids, may contribute to their antioxidant activity.

Many plant-derived compounds have demonstrated various health benefits [22]. Medicinal plants, including *Cyperus esculentus*, have shown potential therapeutic effects [23,24,25]. Approximately 160 phytochemicals from 101 plant species have been reported to offer liver and kidney protection [26].

Medicinal plants continue to play a crucial role in treating liver and kidney diseases [27].

The World Health Organization (WHO) recognizes diabetes mellitus as a growing non-communicable epidemic that presents significant medical and social challenges due to its complications, such as angiopathies, which negatively impact patients' quality of life and life expectancy [28,29,30,31]. As a response, pharmacotherapy is increasingly incorporating traditional medicinal practices, particularly phytopreparations [32,33,34]. Herbal remedies are being explored as either monotherapy for type 2 diabetes mellitus prevention or as part of early-stage interventions [35,36,28,29]. Thus, the search for new plant-based treatments to regulate metabolic disorders in diabetes remains a critical focus in pharmacy and medicine [29,37]. This approach is justified, as phytotherapy offers several advantages over synthetic drugs, including lower toxicity, mild pharmacological effects, and long-term use with minimal side effects [38,39,40]. There is growing interest in identifying medicinal plants with extensive historical use and minimal adverse effects [41,28]. The primary goal of using plant-based treatments is to manage metabolic disorders since plant metabolites closely resemble those found in the human body [40,42,43,38,39].

Given this background, the present study investigated the effects of *Cyperus esculentus* (*CE*) on blood glucose and insulin levels in normal-weight male human subjects. Additionally, the study sought to explore the potential mechanisms through which *CE* influences these metabolic parameters.

## METHODOLOGY

### Subjects

Forty normal-weight male volunteers (18–28 years) from Ambrose Alli University participated. They were non-habitual tigernut chewers, and their health status was assessed via questionnaires and physical examination. Informed consent and ethical approval were obtained before the study.

### Inclusion/Exclusion Criteria

Subjects with hypertension, kidney, heart conditions, ulcers, diabetes, or other health issues were excluded. Only normal-weight individuals (BMI 18.5–25.0 kg/m$^2$) were studied. Before the study, age, weight, height, BMI, blood pressure, and heart rate were recorded.

### Determination of Body mass index

Body mass index (BMI) was calculated as weight (kg) divided by height (m$^2$). Subjects removed shoes and heavy clothing before measurements, with weight recorded using a Camry balance (Italy) and height measured using a Henglida stadiometer (China). Only individuals with BMI 18.5–24.9 were included.

Control subjects arrived fasting, relaxed for 1 hour 30 minutes, and had their blood glucose and insulin levels measured. Blood glucose was assessed enzymatically using a glucometer, while insulin levels were determined with an ELISA Teco kit.

On a separate day, the same subjects consumed 5g of tigernut, followed by 50ml of water. After resting for 1 hour 30 minutes, blood samples were collected again to measure glucose and insulin levels.

**Collection of Blood Sample**

A 3ml blood sample was drawn from the medial cubital vein using a vacutainer syringe on the same day as serum collection. The sample was placed in an anticoagulant-free tube and allowed to clot for 60 minutes. Serum was then separated by centrifugation at 3,000 rpm for 10 minutes at room temperature..

**Statistical Analysis**

Statistical analyses were carried out using Graph Pad Prism Statistical Software version 8.1. The results were presented as Mean ± SEM. A P-value of less than 0.05 was considered to be statistically significant.

**RESULT**

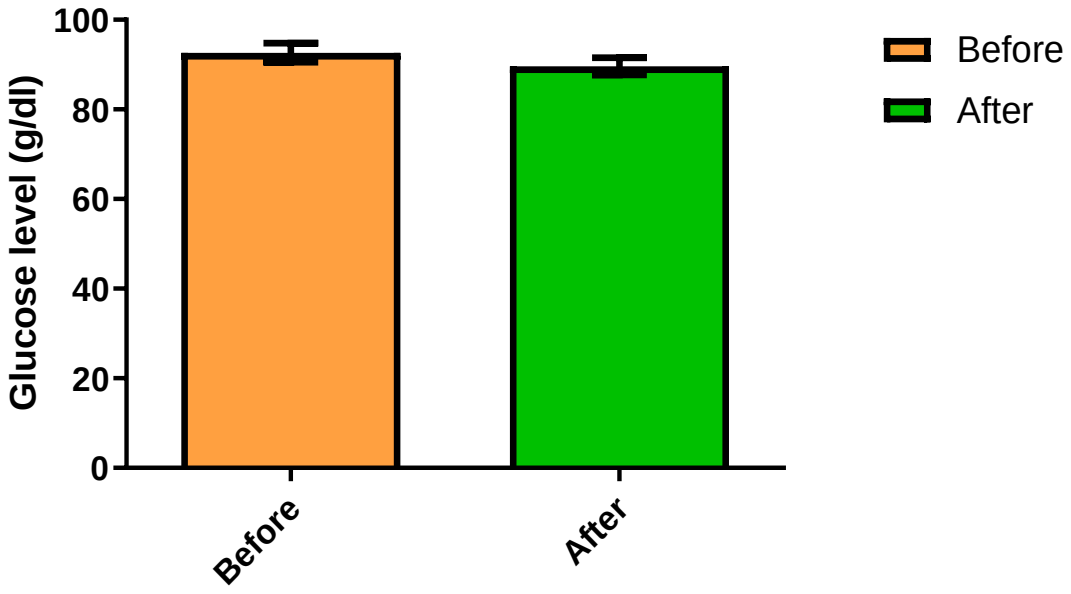


Fig: I Showing the Effect of Tigernut Consumption on Glucose Level in Young Adult Individuals

There was no significant difference after consumption of Tiger nut compared with before consumption

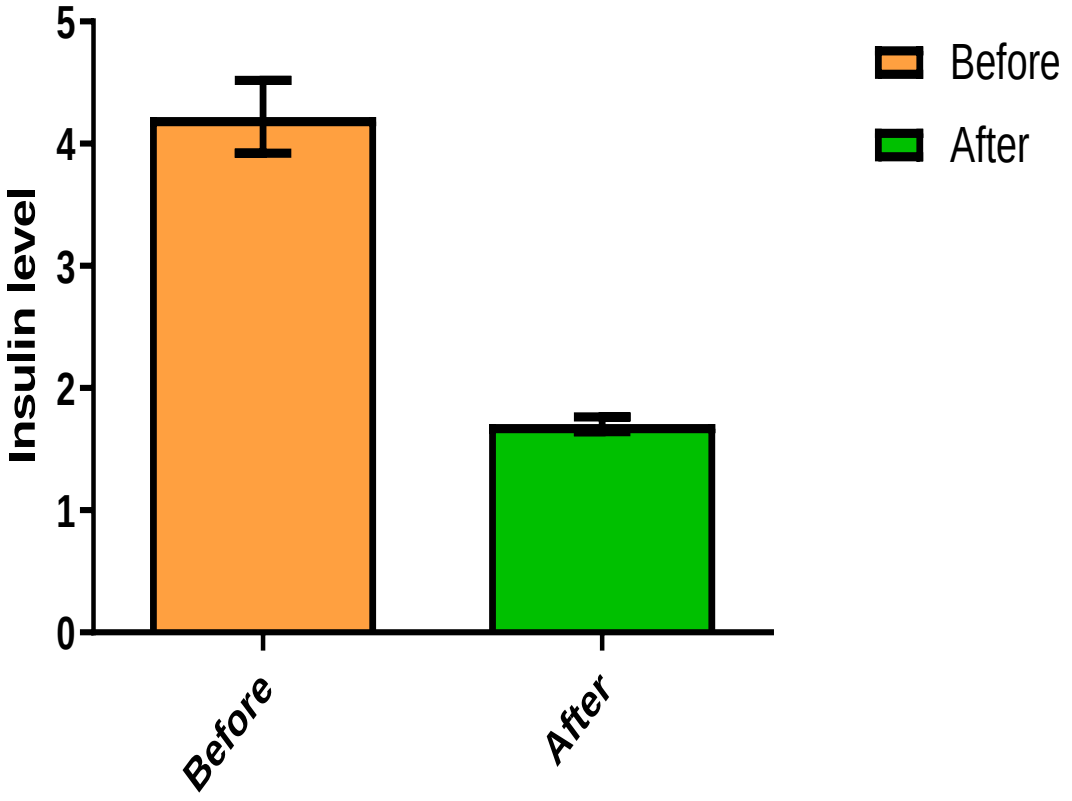


Fig II: Shows the Effect of Tiger Nut Consumption on Insulin Level in Young Adult Individuals

There was a significant decrease after consumption of Tiger nut compared with before consumption.

**DISCUSSION**

The study examined the potential impact of tigernuts on blood glucose and insulin levels in normal-weight male subjects under resting conditions, as well as the possible mechanisms involved. Results indicated that tigernuts reduced blood glucose levels post-consumption (from 92.66 ± 2.156 to 89.61 ± 1.907 mg/dl), though this reduction was not statistically significant. However, a significant decrease ($P < 0.05$) in insulin levels was observed (from 4.220 ± 0.297 to 1.705 ± 0.061 µg/ml).

Tigernuts contain bioactive compounds such as sterols, alkaloids, tannins, saponins, resins, and vitamins E and C.[44] They are nutrient-rich, comprising 22.14–44.92% lipids, 3.28–8.45% proteins, 23.21–48.12% starch, 8.26–15.47% fiber, and 1.60–2.60% ash.[45] The tubers are a valuable source of edible oils, predominantly monounsaturated fatty acids, with a nutritional profile similar to olive oil.[46] Given their high lipid content (22.14–44.92%), tigernut oil is considered highly suitable for human consumption, with a composition akin to olive oil, which is widely regarded as the healthiest dietary fat.[47] Additionally, tigernuts contain essential minerals such as sodium, potassium,

calcium, iron, magnesium, zinc, copper, and phosphorus.[48,49] The oil's antioxidant properties enhance its oxidative stability compared to other vegetable oils.[50] Furthermore, alkaloids, saponins, tannins, and phenols in tigernuts exhibit antibacterial and anti-inflammatory effects.[51]

Tigernuts are composed of 77.49–80.01% essential fatty acids and 31.32–34.03 mg/100 g essential amino acids.[52] The tubers are rich in disaccharide *D-saccharose*, which hydrolyzes into *D-glucose*, *D-galactose*, *D-xylose*, and *D-arabinose*.[44] Notably, most studies investigating the effects of tigernuts on blood glucose have been conducted on animals. This study is among the few human-based investigations, potentially pioneering in its field. Comparisons with previous animal studies indicate that tigernuts consistently lowered blood glucose levels upon administration, aligning with the present study's findings, despite the non-statistical significance of the reduction.

Further supporting evidence from [53] demonstrated that *C. esculentus* oil significantly contributed to weight reduction and blood sugar control. Additionally, [33] reported that a concentrated earthnut extract exhibited a dose-dependent hypoglycemic effect, with an effective dose estimated at 200 mg/kg in animal experiments. Research by [54] found that streptozotocin-induced diabetic rats fed with tigernut tubers exhibited considerable hypoglycemia and hypolipidemia. Moreover, [55] suggested that tigernut milk could be beneficial for diabetic individuals and aid in weight management due to its high fiber content. The presence of digestive enzymes such as catalase, lipase, and amylase in tigernuts also supports their role in treating indigestion, constipation, flatulence, and diarrhea.

Regarding insulin levels, previous studies have largely focused on animal experiments. Some researchers previously reported that tigernuts contain high levels of *L-arginine*, which stimulates insulin secretion.[56] This study initially expected an increase in insulin levels; however, the findings revealed a significant reduction, possibly indicating that only the necessary amount of insulin for glucose regulation was produced, regardless of the observed decrease. Insulin is a crucial hormone for metabolism, and its secretion is tightly regulated by metabolic demands. Along with glucose, certain amino acids and fatty acids influence insulin release, and tigernuts are abundant in these compounds. The possibility exists that the bioactive components in tigernuts led to *β-cell* burnout or inhibition, ultimately contributing to the observed insulin reduction.

Comparisons with previous animal-based research suggest that insulin secretion could be associated with various biochemical mechanisms, supporting the current study's findings that tigernuts significantly lowered ($P < 0.05$) blood insulin levels after consumption. Potential mechanisms for tigernuts' effect on glucose levels include their high *L-arginine* content, which promotes insulin release.[10] Additionally, [57] reported that *C. esculentus* seed extract inhibits *a-glucosidase* and *a-amylase*, reducing or even preventing starch hydrolysis into free glucose. Their study suggested that the enzymes exhibit a higher affinity for *C. esculentus* than for their natural substrates, effectively modulating carbohydrate breakdown. Other potential mechanisms include (i) stabilized

glycated hemoglobin, (ii) glucose-6-phosphate dehydrogenase regulation, (iii) inhibited *a-amylase* activity, (iv) improved lipid profiles, and (v) enhanced antioxidant capacity. These findings suggest that *C. esculentus* oil may serve as a therapeutic agent or dietary supplement for managing type 2 diabetes.[53]

## CONCLUSIONS AND RECOMMENDATIONS

In summary, tigernuts were found to reduce blood glucose and insulin levels in normal-weight human subjects. The mechanisms underlying these effects are likely multifactorial, and several potential explanations have been proposed above.

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### Conflict of Interest

The authors declare that we have no financial or personal relationship(s) which may have inappropriately influenced us in writing this paper.

### Author Contributions

1. Igbinovia, Edokpolor N. conceptualized the research, was involved in data curation and supervision of the research
2. Ohiwerei, Wisdom O. was involved in the formal analysis, investigation, methodology and reviewing of the manuscript
3. Olugbenga, Mary A. was involved in funding acquisition, providing essential materials and reagents for the research
4. Otaye, Micheal O. was involved in validation of the research and writing of the initial manuscript
5. Festus, Oloruntoba O. was involved in funding acquisition and provision of essential materials and reagents for the research
6. Echekwube Marylyn E. was involved in the preparation of the initial manuscript and data visualization
7. Ibhadode Adesuwa was involved in investigation and review of the manuscript

**Data Availability Statement:** The data that support the findings of this study are available on request from the corresponding author. The data are not publicly available due to patient confidentiality.

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