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Assessment of Antimicrobial and Antioxidant Activity of Green Synthesis of Selenium Nanoparticles Using Acai Berry

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KEYWORDS

Acai berry, selenium, nanoparticles, oral premalignant disorders

ABSTRACT:

Aim:

This in vitro investigation aims to analyze the antioxidative and anti-inflammatory potentials of selenium nanoparticles produced via a green synthesis method employing acai berries.

Materials and Methods:

The methodology encompasses generating an aqueous extract by dissolving roughly 1 gram of acai berry powder in 50 mL of distilled water. Subsequently, the mixture undergoes heating to 60–70 °C and boiling for 15 minutes, followed by filtration and concentration. Selenium nanoparticles are then synthesized using the filtered extract and a blend of herbal components. The resultant combination is subjected to thorough testing to determine its antimicrobial and antioxidant properties.

Results:

Significant zones of inhibition are observed against both Staphylococcus aureus and Candida albicans. The newly devised fusion of selenium nanoparticles with acai berry showcases remarkable antimicrobial and anti-inflammatory capabilities.

Conclusion:

This research underscores the complementary antimicrobial and antioxidant effects achieved by amalgamating selenium nanoparticles with acai berries. These innovative fusion holds promise for future utilization as an alternate therapeutic avenue in the management of oral premalignant conditions.

Research Categories: Nanoparticles, Dentistry, Premalignant conditions

Introduction

Selenium nanoparticles have garnered recent attention for their potential health benefits, particularly their potential for combating cancer. Conditions like leukoplakia and oral submucous fibrosis are seen as precursors to oral cancer. Selenium nanoparticles have been researched for their role in preventing or mitigating

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these conditions. [(1)][2] Selenium, a crucial trace element, protects cells from oxidative stress damage by acting as an antioxidant in the body. Oxidative stress is a key contributor to various diseases, including cancer. Selenium nanoparticles possess a larger surface area than bulk selenium, enhancing their antioxidant efficacy. [(2)] Chronic inflammation is associated with diseases like oral premalignant conditions. Selenium nanoparticles have exhibited anti-inflammatory properties, potentially reducing inflammation linked to such conditions. [(3)] Apoptosis, or programmed cell death, is a natural process that eliminates abnormal or damaged cells. Selenium nanoparticles have been investigated for their potential to induce apoptosis in cancer cells, which might target and eliminate cells related to oral premalignant conditions. [(4)] Selenium's role in DNA repair and maintaining genomic stability is known. Genetic mutations and instability are often involved in oral premalignant conditions. Selenium nanoparticles could aid in maintaining proper DNA repair mechanisms, lowering the risk of cancer progression. [(5)] A strong immune system is crucial for detecting and eliminating abnormal cells tied to premalignant conditions. Selenium nanoparticles have been explored for their impact on the immune system, potentially bolstering the body's response against these conditions. (6)

In contrast to conventional medications, controlled drug delivery systems (DDS) offer several benefits as they transport drugs to specific sites, minimizing effects on essential tissues and unwanted side effects. This approach enhances therapeutic molecule accumulation at target sites, leading to reduced drug doses. This strategy is crucial when a drug's dose or concentration differs from its therapeutic or adverse effects. Nanoparticles like liposomes, polymers, dendrimers, silicon or carbon compounds, and magnetic nanoparticles have been investigated as carriers for drug delivery systems. (7)

Effective drug delivery to target sites is a significant challenge in treating many diseases due to the poor distribution and selectivity of traditional drug applications. Controlled drug delivery systems (DDS) address these issues by transporting drugs to the intended site, reducing the impact on vital tissues, and minimizing side effects. This method also maintains drug stability and concentration. Nanostructures, specifically nanoparticles with dimensions under 100 nm in at least one direction, hold promise for drug delivery due to their unique physicochemical and biological properties. They can be enhanced with active targeting molecules to improve tumor targeting and transfection efficiency. (8) (9) (10)

Nanoparticles have demonstrated their efficiency in delivering RNAi molecules due to their distinct characteristics. Incorporating active targeting molecules can enhance nanoparticles' ability to target tumors or transfect tumor cells. Nanostructures possess unique physicochemical and biological traits due to their small size, making them attractive for various biomedical applications. (11)

Materials and Methods:

Antioxidant activity:

The combined mixture is exposed to varying concentrations of 10 µl, 20 µl, 30 µl, 40 µl, and 50 µl within a solution containing 1 ml of the dpph assay. The mixture is maintained at room temperature for a duration of 10 minutes and subsequently heated at 55 degrees Celsius for 10 to 15 minutes. Following this, the solution undergoes spectrophotometric analysis, with the measurements being documented.

(Fig 1.a) (Fig. 1.b) (Fig. 1.c)

Anti-microbial activity:

The assessment of antimicrobial efficacy is performed using the agar-well diffusion method.

The assessment of the activity is conducted by utilizing culture media that includes Candida albicans, Streptococcus mutans, Lactobacillus, Staphylococcus aureus, and Faecalis. (fig. 2)

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Figure 1. a

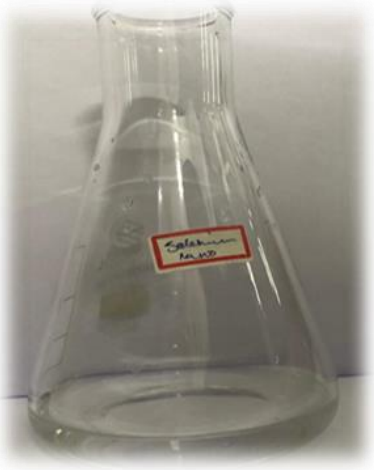

Figure 1.b

Figure 1.c

Results and Discussion:

The zone of inhibition is well appreciated in Staphylococcus aureus and Candida albicans. The new formulation of selenium nanoparticles and acai berry has significant anti-inflammatory and antimicrobial activity. (fig. 3; fig. 4).

A specific quantity of particular metals is required by humans to function normally. The majority of metals play crucial roles in enzymes as cofactors or prostheses, catalyzing particular processes. Sodium, potassium, magnesium, copper, vanadium, chromium, manganese, iron, cobalt, nickel, zinc, molybdenum, and cadmium are the important metals for humans. (12) Lack of a specific, necessary metal results in anemia symptoms. Anemia can be a result of malnutrition or dysfunctional metabolic pathways, which are frequently the result of a genetic abnormality.

Here are some examples of various types of metal anemia: Iron deficiency leads to common simple anemia (iron deficiency), which causes the loss of heme proteins that are necessary for oxygen transport or consumption (such as hemoglobin, myoglobin, etc.). (13) Lack of vitamin B-12 (which contains a cobalt complex known as cobalamin) causes pernicious anemia, which in turn affects how red blood cells work. (14) Growth retardation can result from anemia due to a zinc deficiency, which is primarily a dietary issue. Infants with a poor diet can have a copper deficiency, causing anemia, which can culminate in heart disease.(15)

Selenium, also known as selenoprotein, is a crucial component of many proteins and enzymes in our body. This facilitates DNA replication and guards against infection and cell damage. In addition to supporting our immune system, thyroid function, and reproduction, selenium also aids in the cellular damage caused by free radicals. Potent antioxidants like selenium help minimize oxidative stress. They function by scavenging surplus free radicals and shielding cells from oxidative stress-related cell damage. Selenium is a unique substance that improves the quality of life for cancer patients. A few studies have also shown that selenium reduces the risk of heart disease by lowering the C-reactive protein that is produced when there is inflammation. Selenium has also been linked to a reduction in oxidative stress, which is thought to play a role in Alzheimer's disease, according to a few studies. (16) Due to the abundance of selenium in the thyroid gland and the fact that it protects the thyroid gland from oxidative damage and hormone production, a few observational studies also suggest that selenium is also connected with thyroid gland function. Selenium is helpful, according to some research. A few studies have shown that selenium helps improve Hashimoto's disease. (17).Limitations of selenium include selenium toxicity, which causes nausea, vomiting, a facial rash, hair loss, and muscle soreness. (18)Due to its high degree of absorption, increased bioavailability, great particle dispersion, and lesser toxicity, nanoselenium has recently gained enormous interest in research. (19)

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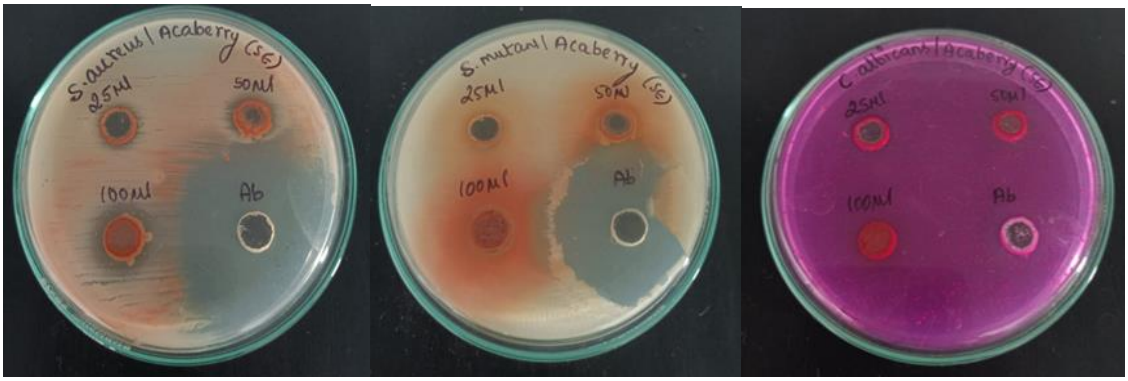
In this work, a palm species type that is becoming more and more popular because of its increased antioxidant and anti-inflammation effects, the acai berry, which is a staple fruit of Brazil, is utilized in the manufacturing of nanotechnology. The combination formulation will replace the antioxidants used in premalignant lesions, which is a good development. Nutritional deficits are treated with selenium, which functions by supplying necessary nutrients.

Acai berries are filled with numerous types of polyphenolic chemicals, which are known for their antioxidant and anti-inflammatory activities. Acai berries are also loaded with antioxidants. (20)20) The presence of polyphenols in acai berries enables them to function as effective scavengers of free radicals. Unstable molecules known as free radicals have the potential to induce oxidative stress, inflicting harm upon cellular structures and provoking inflammation, which in turn contributes to the development of several pathological conditions.

Polyphenols neutralize these free radicals, reducing oxidative stress. Certain polyphenols have the ability to disrupt signaling pathways associated with inflammation. It is plausible that these substances possess the ability to impede the synthesis of pro-inflammatory molecules such as cytokines and chemokines, thereby leading to a decrease in inflammation. Acai berries possess a class of polyphenols that are responsible for their vibrant purple hue. Anthocyanins possess robust antioxidant characteristics. Anthocyanins have notable efficacy in the elimination of reactive oxygen species (ROS), which are exceedingly reactive molecules that lead to the occurrence of oxidative stress. Anthocyanins mitigate cellular and tissue oxidative damage by neutralizing reactive oxygen species (ROS). (21)

Anthocyanins have the potential to regulate enzymes and signaling pathways that are implicated in the process of inflammation, resulting in a decrease in inflammatory reactions. Acai berries are known to possess omega-3, omega-6, and omega-9 fatty acids. Omega-3 fatty acids have notable anti-inflammatory effects. Omega-3 fatty acids possess the ability to modulate the synthesis of pro-inflammatory and anti-inflammatory molecules, thereby promoting a more precise and regulated inflammatory reaction. (22) Acai berries possess a notable nutritional profile, being rich in several vitamins and minerals, such as vitamin C and vitamin E, both of which exhibit significant antioxidant properties. Vitamins C and E have the ability to directly counteract the harmful effects of free radicals, thereby mitigating cellular harm resulting from oxidative stress (23). Acai berries possess dietary fiber, which has the potential to indirectly contribute to the mitigation of inflammation. Dietary fiber is known to provide support for the maintenance of a healthy gut microbiota, which in turn plays a significant role in the regulation of the immune system and the control of inflammation.(24)



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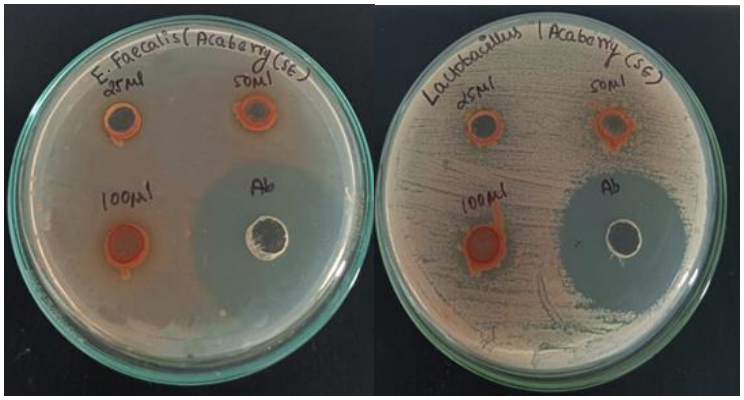

Antimicrobial activity Figure 2

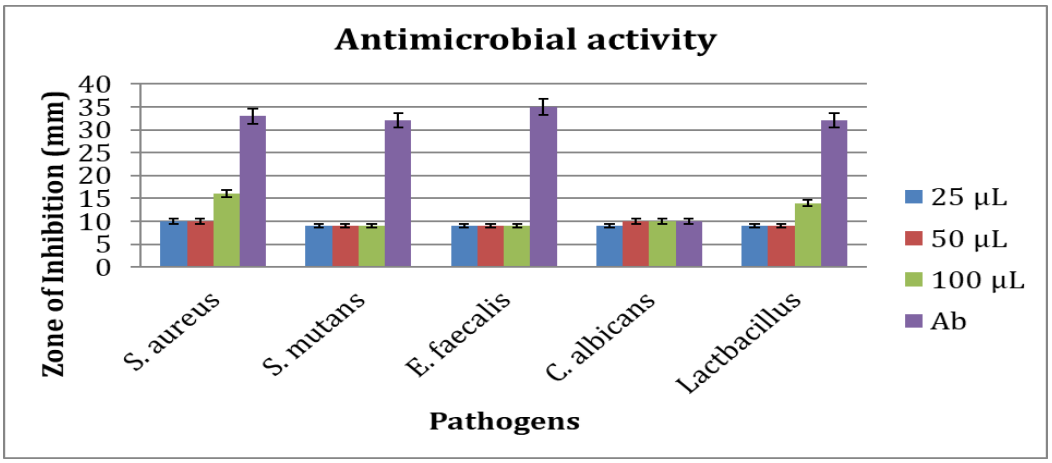

Figure 3

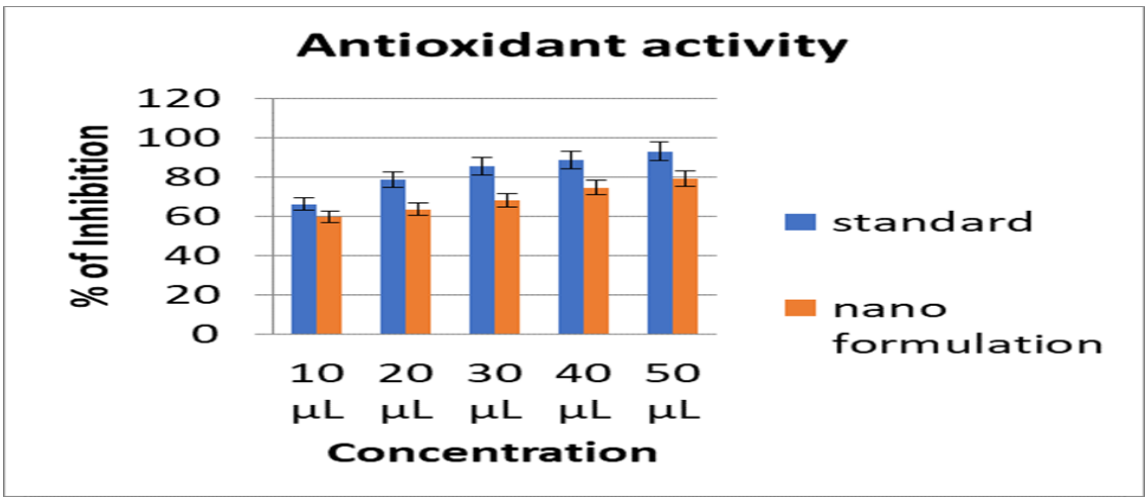

Figure 4

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