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TOWARDS SUSTAINABLE BIOTECHNOLOGY: GREEN SYNTHESIS TECHNIQUES FOR GOLD AND SILVER NANOPARTICLES

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Abstract: Green synthesis offers a sustainable alternative by utilizing biological materials such as plant extracts, microorganisms, and biopolymers. Plant extracts provide natural agents for reducing and stabilizing nanoparticles, while microbes like bacteria, fungi, and algae reduce metal ions and stabilize nanoparticles. Biopolymers like chitosan and starch enhance both sustainability and biocompatibility. Green-synthesized gold and silver nanoparticles exhibit enhanced biocompatibility, strong antimicrobial activity, and properties suitable for medical devices, drug delivery, and diagnostic imaging. Green synthesis not only promotes sustainable production but also advances biomedical applications.

• Introduction

The nanomaterial industry is crucial for technological and biomedical applications, but faces environmental and biocompatibility challenges due to toxic chemicals and waste from traditional synthesis methods.

❖ Biotechnology applications of gold and silver leaf production

✓ Microbial synthesis

Researchers have explored using microorganisms to extract gold and silver from ores. This process involves using bacteria like *Acidithiobacillus ferrooxidans* to oxidize and extract gold from low-grade ores.

✓ Nanobiotechnology

Use biological processes for the synthesis of gold and silver nanoparticles, which can be used to produce ultra-thin and uniform films.

✓ Bioremediation

Using plants (phytomining) or microbes to accumulate and concentrate gold and silver from waste streams, which can then be harvested and processed into edible forms.

❖ Eco-friendly synthesis of edible gold

✓ High purity gold raw materials (22-24 karats)

- necessary purification to remove contaminants, the raw material for edible gold is minimum 99.9% pure gold
- melting and flattening
- gold is hammered, usually by hand, into thin sheets or foils, a few microns thick
- then is cut into small sheets, flakes, or dust
- edible gold is carefully packaged under sterile conditions to avoid contamination
- FSSC 22000 certification of international food safety

✓ Applications

- Culinary use: decorate luxury food and beverages such as chocolates, pastries, cakes, champagne, and even sushi
- Cosmetic use: incorporated into high-end cosmetic products, such as face masks and lotions, due to its perceived benefits for the skin.

❖ Challenges, advantages, disadvantages

✓ Gold leaf

- non-toxic and safe for consumption in small quantities
- adds a luxurious appearance to food and decorations
- does not react with other substances in food
- But
- very expensive due to the high value of gold
- mining and refining gold is environmentally damaging and resource-intensive

✓ Edible silver

- silver has natural antimicrobial properties which can be beneficial
- adds a shiny, attractive finish to food items
- But
- generally less expensive than gold
- silver can tarnish when exposed to sulfur compounds, potentially affecting appearance
- although generally safe in small quantities, excessive consumption can lead to argyria, a condition where the skin turns blue-grey.

