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Anti-diabetic Potential of Silver Nanoparticles Derived from *Novacetimonas hansenii* Bacterial Culture: A Promising Alternative to Acarbose

Joseph Anju* and Sepperumal Umamaheswari

Department of Zoology, Thanthai Periyar Government Arts and Science College (Affiliated to Bharathidasan University), Tiruchirapalli, Tamil Nadu, India

**Corresponding Author*

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Abstract: The anti-diabetic property of silver nanoparticles (AgNPs) derived from secondary metabolites of *Novacetimonas hansenii* OR481572 bacterial culture is highly promising. The produced AgNPs were assessed for their anti-diabetic activity utilizing an α- glucosidase inhibitory test. The findings indicated that the AgNPs showed a significant 50% inhibitory effectiveness against α-glucosidase, surpassing the inhibitory impact of acarbose, a frequently prescribed α-glucosidase inhibitor. The AgNPs demonstrate greater performance in comparison to acarbose, indicating their potential as a more efficacious alternative for diabetes treatment. These findings add to the increasing amount of evidence that supports the anti-diabetic characteristics of AgNPs and their potential use in the development of nanomedicine for managing diabetes.

Keywords: AgNPs, Anti-diabetic, A-Glucosidase, *Novacetimonas hansenii*

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Introduction

Diabetes is a major global health issue, and there is an increasing demand for efficient and secure treatment. α-glucosidase is an enzyme that break down glycosidic bonds in different sugar molecules resulting in the production of mono-saccharides, oligosaccharides or glucosamine glycan. This process leads to an increase in postprandial blood glucose level. Postprandial hyperglycemia is a primary risk factor associated with the development of type II diabetics. Inhibition of glycosidase activity slows down carbohydrate digestion which reduces glucose absorption into blood, as a result blood glucose level is controlled (Feng *et al.*, 2022). Nano-particles produced from secondary metabolites of bacterial cultures exhibit great potential for dealing with diabetes and its associated problems. These nanoparticle, developed via biosynthetic methods involving bacteria and plants, have benefits such as precise control over their size, shape, biocompatibility, toxicity, and biological activity (Michael and Jaison, 2022; Karunakaran *et al*., 2023). In addition, the combined effects of silver nanoparticles and traditional diabetic medicines have shown increased effectiveness in fighting diabetes and antimicrobial resistance (Sultana *et al*., 2023). Moreover, the potential of silver nanoparticles to combat bacteria that are liable for diabetic foot ulcers emphasizes their promise as a therapeutic approach for controlling problems associated with diabetes (Ibraheem *et al*., 2023).

Utilizing the secondary metabolites of the bacterial culture in the production of nano-particles offers a fast, harmless and eco-friendly approach. It also offers a safer and alternative to conventional chemical synthesis of nanoparticles with potential applications including the development of nano medicine for diabetes treatment (Hosam and Amal, 2021). Studies have shown that these nanoparticles have anti-diabetic effects by enhancing the use of glucose, reducing the synthesis of glucose in the liver, and suppressing the activity of enzymes involved in starch digestion, such as α-amylase and α-glucosidase (Wahab and Janaswamy, 2023).

In addition it has been determined that the artificially created silver nanoparticles can interact with the aminoacids residues of important enzymes related to diabetes, hence increasing their effectiveness in treating the condition (Jini *et al*., 2022). Moreover, silver nanoparticles produced from bacterial culture filtrate have demonstrated encouraging antidiabetic effects with strong antioxidant properties, along with the capability to improve glucose uptake in cells. These properties make them more valuable rivals for pharmaceutical and biomedical purposes in diabetes treatment (Essghaier *et al*., 2023). Current studies have examined the anti-diabetic effects of silver nanoparticles (AgNPs) using different mechanisms. A study showed that AgNPs exhibited the ability to enhance glucose tolerance and lower blood glucose levels in diabetic rats, indicating their potential as an anti-diabetic treatment (Jasim *et al*., 2019). Biological characteristics of AgNPs in regulating insulin levels and decreasing hyperglycemia in animal models with diabetes have been proposed. This suggests a potential role for Ag-NPs in the treatment of diabetes mellitus (Torabian *et al*., 2022).

In the present study the anti-diabetic property of silver nanoparticles (AgNPs) derived from secondary metabolites of *Novacetimonas hansenii* OR481572 bacterial culture were assessed for their anti-diabetic activity utilizing an α-glucosidase inhibitory test.

Materials and Methods

Synthesis of silver nanoparticle

A loopful of fresh culture of *Novacetimonas hansenii* OR481572 in 100 ml of mannitol medium was incubated at 25°C for a duration of 9 days. After nine days of incubation, the culture broth was centrifuged at 8000 rpm for 15 min. Cells were removed and cells free supernatant was saved for further experiment. The fraction of secondary metabolites obtained after centrifugation was initially suspended in double distilled water at a concentration of 1 mg/ml. The bioactive solution was incorporated with a 1mM silver nitrate solution in a 1:3 ratio resulting in a final volume of 100 ml. The solution was heated to a temperature of 80 °C and permitted to perform a chemical reaction for a duration of 48 h. At this time the production of silver nanoparticles (AgNPs) was observed through a noticeable change in colour, transitioning to a deep brown shade, suggesting the reduction of silver ions. After the successful production of silver nanoparticles, the suspension was subjected to centrifugation at a speed of 15000 x g for 20 min in order to separate and procure the nanoparticles. The nanoparticles obtained were identified as NH-AgNPs and subsequently analyzed to determine their characteristics and possible applications.

α- Glucosidase Inhibitory Assay

The α-glucosidase inhibitory assay was adapted

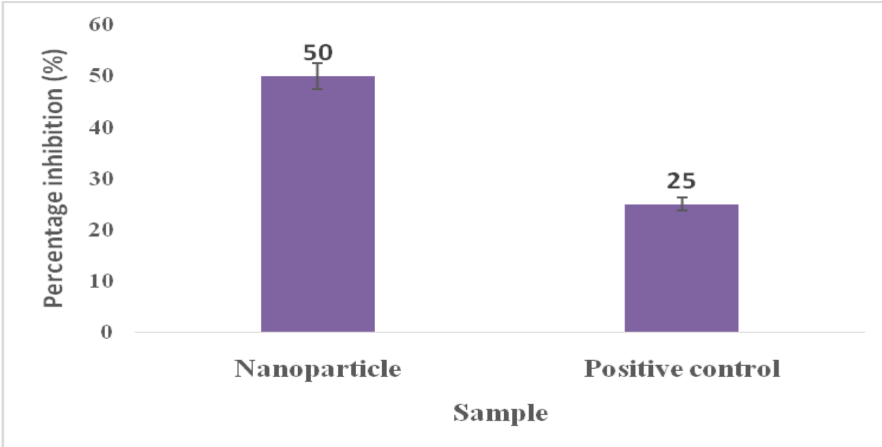

Fig. 1: Anti-diabetic effect of positive control and test.

with modification. From the nanoparticles produced a particular concentration (100 mg) were prepared in 10 mM potassium phosphate buffer (pH 6.8). To test tubes reaction mixture containing 2 ml (20 mg) of nanoparticles, 2 ml α-glucosidase (0.5 U/m) and 2 ml of 10 mM potassium phosphate buffer (pH 6.8) were pre-incubated at 37°C for 15 min before adding 2 ml of 5 mM p-nitrophenol α-D-glucopyranoside substrate. The mixture was then incubated at 37°C. After 15 min, 2 ml of stop solution containing 200 mM sodium carbonate was added. Then the absorbance at 405 nm was recorded using the colorimeter. The positive control sample was the mixture of the enzyme and substrate with inhibitors like acarbose. The negative control contains 2 ml of distilled water instead of inhibitor. Acarbose, a prescribed drug for α-glucosidase inhibition, was also used for comparison purpose (Shanak *et al.*, 2021).

$$\% \text{ inhibition} = \frac{\text{AC-AT}}{\text{AC}} \times 100$$

Where AC= absorbance of control; AT = absorbance of test.

Results and Discussion

Silver nanoparticles formation from the secondary metabolites of Novacetimonas hansenii

The formation of silver nanoparticles after mixing 1 mM silver nitrate and aqueous solution of the secondary metabolites of *Novacetimonas hansenii* OR481572 which shows a colour change into deep brown shade. In a similar study the endophytic bacterium *Bacillus cereus* isolated from the *Garcinia xanthochymus* was used to synthesize the silver nanoparticles (AgNPs)(Sunkar and Nachiyar, 2012)

α- Glucosidase inhibition assay of AgNPs from Novacetimonas hansenii

The AgNPs from *Novacetimonas hansenii* demonstrates an inhibitory effect on α-glucosidase (Fig.1). α-Glucosidase inhibitors play a vital role in the control of conditions such as diabetes by decelerating the breakdown of carbohydrates, therefore decreasing postprandial hyperglycemia. The assay likely performed according to recognized protocols described by Saratale et al. (2017) showed that nanoparticles effectively suppress α-glucosidase activity.

The nanoparticles have demonstrated a significant inhibitory effect, as evidenced by their 50% inhibitory efficacy at a specified concentration. This exceeds the inhibitory impact of acarbose, a frequently prescribed α-glucosidase inhibitor. Silver nanoparticles showed anti-diabetic activity via α-glucosidase inhibition (Awote *et al.*, 2023). Acarbose functions by competitively blocking α-glucosidase enzymes located in the small intestines. This action slows down the process of converting complex carbohydrates into glucose. The comparison between the inhibitors produced from nanoparticles and acarbose indicates a potentially higher effectiveness of the former.

Conclusion

The present study concluded that nanoparticles produced from bacterial secondary metabolites have a higher level of α-glucosidase inhibitory activity compared to acarbose. This conclusion is in line with the known modes of action of α-glucosidase inhibitors. This emphasizes the potential of microbial secondary metabolites as a reservoir of innovative therapeutic agents for the management of disorders associated with glucose metabolism. It can be concluded that nanoparticles extracted from secondary metabolites of bacteria *Novacetimonas hansenii* OR481572 have α-glucosidase inhibitory activity when compared to the drug.

Conflict of Interest

The authors declare no conflicts of interest.

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