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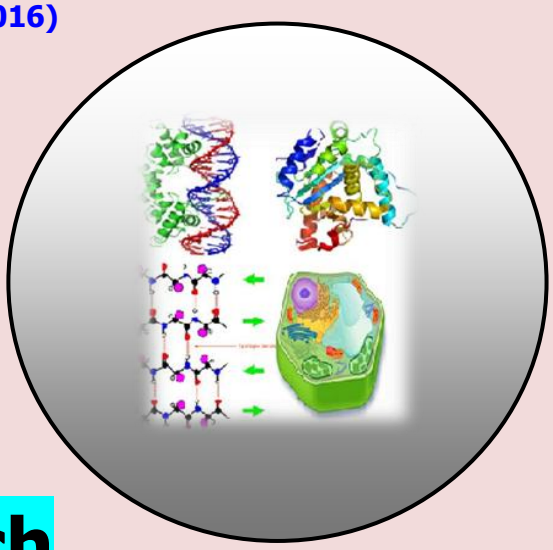

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Antidiabetic Activity of Silver Nanoparticles Synthesised from *Padinapavonica* Extract – An *In Vitro* Study

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ABSTRACT

The aim of the current work is to screen invitro inhibition of alpha-amylase and α-glucosidaseenzyme activities in silver nanoparticles synthesised from Padinapavonica extract. This in vitro study explores the antidiabetic properties of biosynthesized silver nanoparticles and it can be considered as a potential candidate for the management of type-II diabetes mellitus. The present findings exhibited a concentration dependent inhibition of α-amylase and α-glucosidase activity by the Padinapavonica extract and AgNPs. The half inhibition concentration (IC_{50}) of Padinapavonica extract, AgNPs and Acarbose tested against α-amylase were 288.79, 262.18µg/ml-1 and 246.14µg/ml-1 respectively. The half inhibition concentration (IC_{50}) of Padinapavonica extract, AgNPs and Acarbose tested against α-glucosidase were 315.23, 271.78µg/ml^{-1} and 266.72µg/ml^{-1} respectively. The results of the study revealed that the antidiabetic activity of the AgNPs is much higher than the Padinapavonica extract and near to the standard antihyperglycemic drug.
Key words: Diabetes mellitus, Padinapavonica, Silver nanoparticles, Acarbose, α-amylase and α-glucosidase.

INTRODUCTION

Diabetes mellitus results from the defects in the insulin secretion and action, this may be characterized by chronic hyperglycemia, which is connected with the carbohydrates, protein and lipid metabolism (WHO, 1999). Globally mortality rate 9% is recorded due to the diabetes. Diabetes mellitus a well-known endocrine disorder and it is most common in India now a day. The reason may be life style and genetic factors (Riserus*et al.,* 2009). Due these factors the diabetic monocytes produce increased superoxide anion. (O_2)(Venugopal*et al.,* 2002). In premature atherosclerosis and oxidative stress patient's diabetes is a major risk factor. Over the centuries, herbal drugs have served as a major source of medicines for the prevention and treatment of diseases including diabetes mellitus. There are more than 200 species of plants exhibit hypoglycemic properties, including many common plants, such as pumpkin, wheat, celery, wax gourd, lotus root and bitter melon but the basis of this activity is frequently not investigated.

There are many synthetic hypoglycemic drugs to manage post-prandial hyper-glycaemia at digestive level, glucosidase and amylase inhibitors such as acarbose, miglitol and voglibose, but these drugs may cause many side effects. During pregnancy diabetes may cause serious problems in both mother and child, however to overcome these problems synthetic agents are used vigorously these are not suitable for continuous use due to side effects (Lamer, 1985) such as development of hypoglycemia, weight gain, gastrointestinal disturbances,

liver toxicity etc. (Dey*et al.,* 2002). Based on the recent studies antioxidants capable of neutralizing free radicals are effective in preventing experimentally induced diabetes in animal models as well as reducing the severity of diabetic complications. Silver nanoparticles are widely used for its unique properties in catalysis, chemical sensing, biosensing, photonics, electronic and pharmaceuticals and in biomedicine especially for antibacterial agent and antiviral agent (Rai*et al.,* 2009). These properties can be extended to antidiabetic activity along with the plant extracts. The most important application of silver and silver nanoparticles is in medical industry such as tropical ointments to prevent infection against burn and open wounds. Biologic synthesis of nanoparticles by seaweed extracts is at present under exploitation as some researchers worked on it (Shanmugam *et al.,* 2013, Kathiraven *et al.,* 2015). In the present study is to screen for *in vitro* inhibition of alpha-amylase ad α-glucosidase enzyme activities of silver nanoparticles synthesized from *Padinapavonica* extract.

MATERIALS AND METHODS

Plant materials

The *Padinapavonica* were collected in August 2014 from Andaman Island, India. The collected *Padinapavonica* were dried at room temperature and coarsely powdered.

Preparation of seaweeds extract

Dried seaweed was ground well and made into fine powder. 1g of biomass was kept in a 250-ml conical flask with 100 ml of Milli Q water for 24 h. Finally, the extract was filtered with Whatman No. 1 filter paper and stored it in a refrigerated temperature for further analysis.

Synthesis of Ag nanoparticles using plant extract

For the Ag nanoparticle synthesis, 10 ml seaweed filtrate was added in 90 ml of 10^{-3} M aqueous $AgNO_3$ solutions at room temperature (Govindaraju *et al*., 2009). The bio-reduction of silver nitrate into silver nanoparticles can be confirmed by visual observation.

In vitro antidiabetic activity

In vitro α-amylase inhibition assay was carried out by the method of Apostolidis *et al.* (2007).The α-glucosidase inhibitory activity was determined according to the method described by Apostolidis *et al.* (2007).

RESULTS AND DISCUSSION

The synthesised and characterization of AgNPs from *Padinapavonica* extract showed the SEM analysis showed the particle size between 20-70nm as well the spherical structure of the nanoparticles reported in our earlier report.In the preset study to investigate the antidiabeticc activity of AgNPs tested against alpha-amylase ad α-glucosidase enzymes.

There are several possible mechanisms through which these herbs can act to control the blood glucose level (Tanira, 1994). In that one of the mechanism is that an alteration of the activity of some enzymes that are involved in glucose metabolism. The intestinal enzymes like α-amylase and α-glucosidase are found to be very important in carbohydrate digestion and glucose absorption. The suppression of the activity of such digestive enzymes would delay the degradation of starch and oligosaccharides, which would in turn cause a decrease in the absorption of glucose and consequently in the reduction of postprandial blood glucose level elevation (Davis *et al.,* 2001). Alpha amylase and glucosidase inhibitors are the potential targets in the development of lead compounds for the treatment of diabetes (Subramanian *et al.,* 2008) Thus in this study, AgNPs were used as inhibitors of these intestinal enzymes.

Inhibition of *in-vitro* α-amylase enzyme assay

Alpha amylase is an enzyme that hydrolyses alphabondsof large alpha linked polysaccharide such as glycogen and starch to yield glucose and maltose. Alphaamylase inhibitors bind to alpha-bond of polysaccharide and prevent break down of polysaccharide in mono and disaccharide (Gupta *et al*., 2012). The α-amylase inhibitors act as an anti-nutrient that obstructs the digestion and absorption of carbohydrates (Narkhede *et al*., 2011). The present findings exhibited a concentration dependent inhibition of α-amylase activity by the *Padinapavonica* extract and AgNPs. The lowest inhibition of α-amylase activity of *Padinapavonica* extract, AgNPs and Acarbose were 17.45%, 21.57% and 22.45% in the concentration of 100µg/ml respectively while the highest inhibition of α-amylase activity of *Padinapavonica* extract, AgNPs and Acarbose were 84.65%, 90.39% and 92.84 % in the concentration of 500µg/ml respectively. The greatest effect of AgNPs (500 µg/ml) was found to be near to standard Acarbose.

The half inhibition concentration (IC_{50}) of *Padinapavonica* extract, AgNPs and Acarbose were 290.05, 249.85µg/ml-1 and 245.45µg/ml-1 respectively. From the present study it can be concluded that AgNPs showed marked *in vitro* antidiabetic effect against the α-amylase activity (Table 1 and Fig. 1).Present finding is in agreement with Abideen and Sankar (2015) and Vishnu Kiran and Murugesan (2013) studies.

Table 1.*In vitro* α-amylase inhibition of *Padinapavonica,* AgNPs and Acarbose.

Groups	Concentrations	% of inhibition		
		Padinapavonica	AgNPs	Standard
Group I	100µg/ml	17.45±1.22	21.57±1.50	22.45 ± 1.57
Group II	200µg/ml	35.25±2.46	42.58±2.98	39.61 ± 2.77
Group III	300µg/ml	50.65±3.54	63.74±4.46	65.74 ±4.60
Group IV	400µg/ml	70.48±4.93	74.43±5.210	78.31 ± 5.48
Group V	500µg/ml	84.65±5.92	90.39±6.32	92.84 ± 6.49
IC_{50} (µg/ml)		290.05	249.85	245.45

Values are expressed as Mean ± SD for triplicates

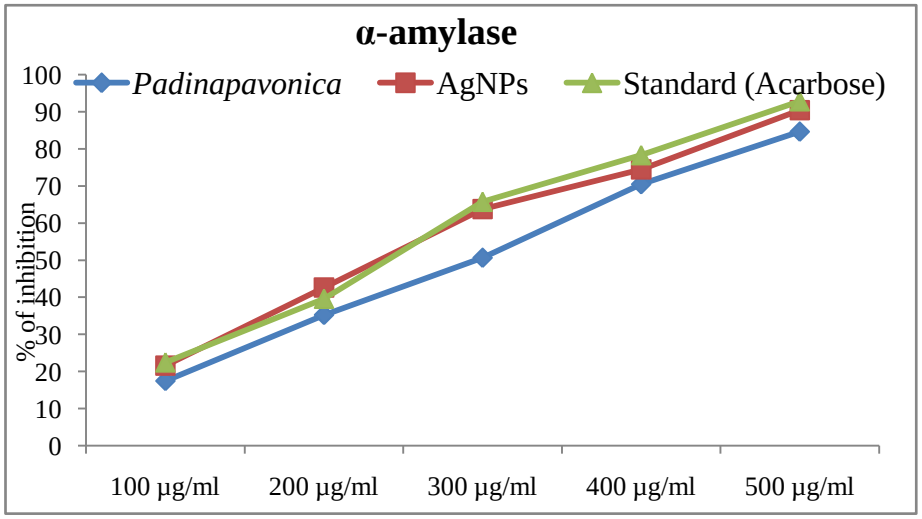

Figure 1. *In vitro* α-amylase inhibition of *Padinapavonica,* AgNPs and Acarbose.

Table 2. *In vitro* α-glucosidase inhibition *Padinapavonica,* AgNPs and Acarbose.

Groups	Concentrations	% of inhibition		
		Padinapavonica	AgNPs	Standard Acarbose
Group I	100µg/ml	17.54±1.22	19.65±1.37	20.45 ± 1.43
Group II	200µg/ml	33.45±2.34	42.13±2.94	34.45 ± 2.41
Group III	300µg/ml	51.74±3.62	57.35±4.01	62.35 ± 4.36
Group IV	400µg/ml	66.65±4.66	72.84±5.09	76.45 ± 5.35
Group V	500µg/ml	74.35±5.20	82.67±5.78	84.65 ± 5.92
IC_{50} (µg/ml)		308.58	268.49	266.56

Values are expressed as Mean ± SD for triplicate

Inhibition of *in-vitro* α-glucosidase enzyme assay

The intestinal α-glucosidases hydrolyze complex carbohydrates toglucose and other monosaccharides in the small intestine. Inhibition of these enzyme systems helps toreduce the rate of digestion of carbohydrates (Bhat *et al*., 2011).The present findings exhibited a concentration dependent inhibition of α-glucosidases activity by the *Padinapavonica* extract and AgNPs. The lowest inhibition of α- glucosidase activity of *Padinapavonica* extract, AgNPs and Acarbose were 17.54%, 19.65% and 20.45 % in the concentration of 100µg/ml respectively while the highest inhibition of α-glucosidase activity of *Padinapavonica* extract, AgNPs and Acarbose were 74.35%, 82.67% and 84.65 % in the concentration of 500µg/ml respectively.

The greatest effect of AgNPs (500 µg/ml) was found to be near to standard Acarbose. The half inhibition concentration (IC_{50}) of *Padinapavonica* extract, AgNPs and Acarbose were 308.58, 268.49µg/ml^{-1} and 266.56µg/ml^{-1} respectively. From the present study it can be concluded that AgNPs showed marked *in vitro* antidiabetic effect against the α-glucosidase activity (Table 2 and Fig. 2). Present finding is in agreement with Abideen and Sankar (2015) and Vishnu Kiran and Murugesan (2013) studies.

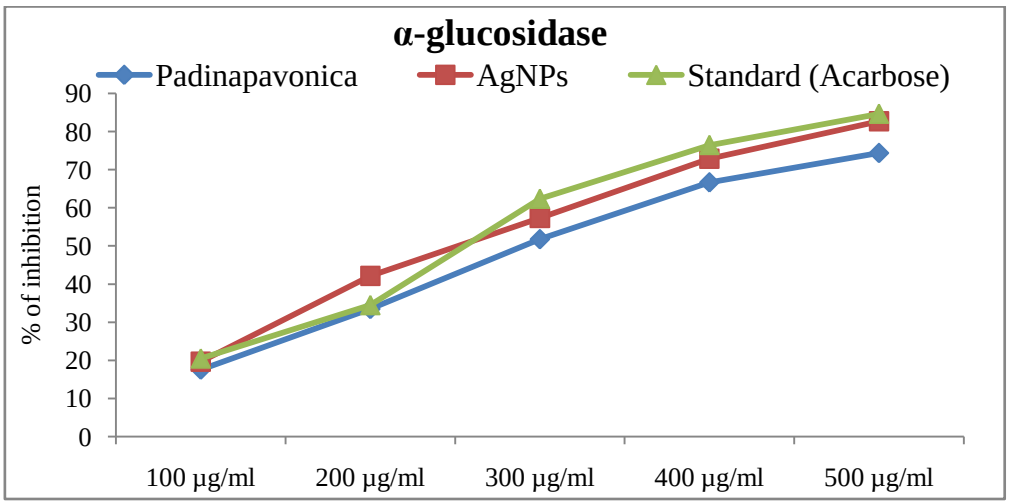

Figure 2.*In vitro*α-glucosidase inhibition of *Padinapavonica,* AgNPs and Acarbose.

CONCLUSION

The synthesized AgNPs possess potential antidiabetic activity as compared to *Padinapavonica* extract and near to commercial drug Acarbose and hence clearly proved their pharmaceutical and medicinal importance.

REFERENCES

Abideen, S. andSankar, M.V. 2015. *In-vitro* Screening of Antidiabetic and Antimicrobial Activity against Green Synthesized $AgNO_3$ using Seaweeds. *J Nanomed Nanotechnol.* 6: 1-5.

Apostolidis, E., Kwon, Y.I. and Shetty, K.2007. Inhibitory potential of herb, fruit, and fungus enriched cheese against key enzymes linked to type 2 diabetes and hypertension. *Inn Food SciEmerg Technol.* 8: 46-54.

Bhat, M., Zinjarde, S.S., Bhargava, S.Y., Kumar, A.R. and Joshi, B.N. 2011. Antidiabetic Indian Plants: A good source of potent amylase inhibitors. *Evi Based Complement Alternate Med.* 810207.

Davis, S.N. andGranner, D.K.2001. Insulin, oral hypoglycemic agents and the pharmacology of endocrine pancreas, In: Brunton LL, Lazo JS, Parker KL (Ed.), Goodman and Gilman's: Thepharmacological basis of therapeutics, 11th ed. McGraw-Hill Medical Publication Division, NewYork. Pp. 1706–1707.

Dey, L., Anoja, S.A. and Yuan, C-S. 2002. Alternative therapies for type 2 diabetes. *Alternative Med. Rev.*7:45–58.

Govindaraju, K., Kiruthiga, V., Ganesh Kumar, V. andSingaravelu, G. 2009. Extracellular synthesis of silver nanoparticles by a marine alga *Sargassumwightiigrevilli* and their antibacterial effects. *J NanosciNanotechnol.* 9:1–5.

Gupta, D., Chandrashekar., Richard L., Yogendra and Gupta, N. 2012. *In-vitro*antidiabetic activity of stem bark of *Bauhinia purpurea*Linn. *Der PharmaLett.* 4: 614–661.

Kathiraven, T., Sundaramanickam, A.,Shanmugam, N., Balasubramanian, T. 2015. Green synthesis of silver nanoparticles using marine algae *Caulerparacemosa* and their antibacterial activity against some human pathogens. *ApplNanosci.* 5: 499–504.

Lamer, J. 1985. The Pharmacological Basis of Therapeutics,"7th ed.,MacMillan, New York.

Narkhede, M.B., Ajimire, P.V., Wagh, A.E., Manoj Mohan., Shivashanmugam, A.T. 2011. In *vitro*antidiabetic activity of *Caesalpinadigyna* (R.) methanol root extract. *Asian Journal of Plant Science and Research.* 1(2): 101-106.

Rai, M., Yadav, A. and Gade, A. 2009. Silver nanoparticles as a new generation of antimicrobials. *Biotechnol. Adv.* 27: 76-83.

Riserus, U., Willett, W.C. and Hu, F.B. 2009. Dietary fats and prevention of type 2 diabetes.*Progress in LipidResearch,*48(1): 44–51.

Shanmugam, N., Rajkamal, P., Cholan, S., Kannadasan, N., Sathishkumar, K., Viruthagiri, G.and Sundaramanickam, A. 2013. Biosynthesis of silver nanoparticles from the marine seaweed *Sargassum*wightiiand their antibacterial activity against some human pathogens. *ApplNanosci.* 4:13204-013-0271.

Subramanian, R., Asmawi, A.Z. and Sadikun, A. 2008. *In vitro* alpha-glucosidase and alpha-amylase enzyme inhibitory effects of *Andrographispaniculata* extract and andrographolide. *ActaBiochim Pol.* 55: 391–398.

Tanira, M.O.M. 1994. Antidiabetic medicinal plants: a review of the present status and future directions. *Int. J. Diabetes.* 2(1),15-22.

Venugopal, S.K., Devaraj S., Yang T. and Jialal I.2002. Diabetes, 51, 3049-3054

Vishnu Kiran, M. and Murugesan, S. 2013. Biogenic silver nanoparticles by Halymeniaporyphyroides and its *in vitro* anti-diabetic efficacy. *Journal of Chemical and Pharmaceutical Research.* 5(12):1001-1008

World Health Organization 1999. Definition, diagnosis and classification of diabetes mellitus and its complications. Report of WHO consultation. Geneva.Pp. 66.

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