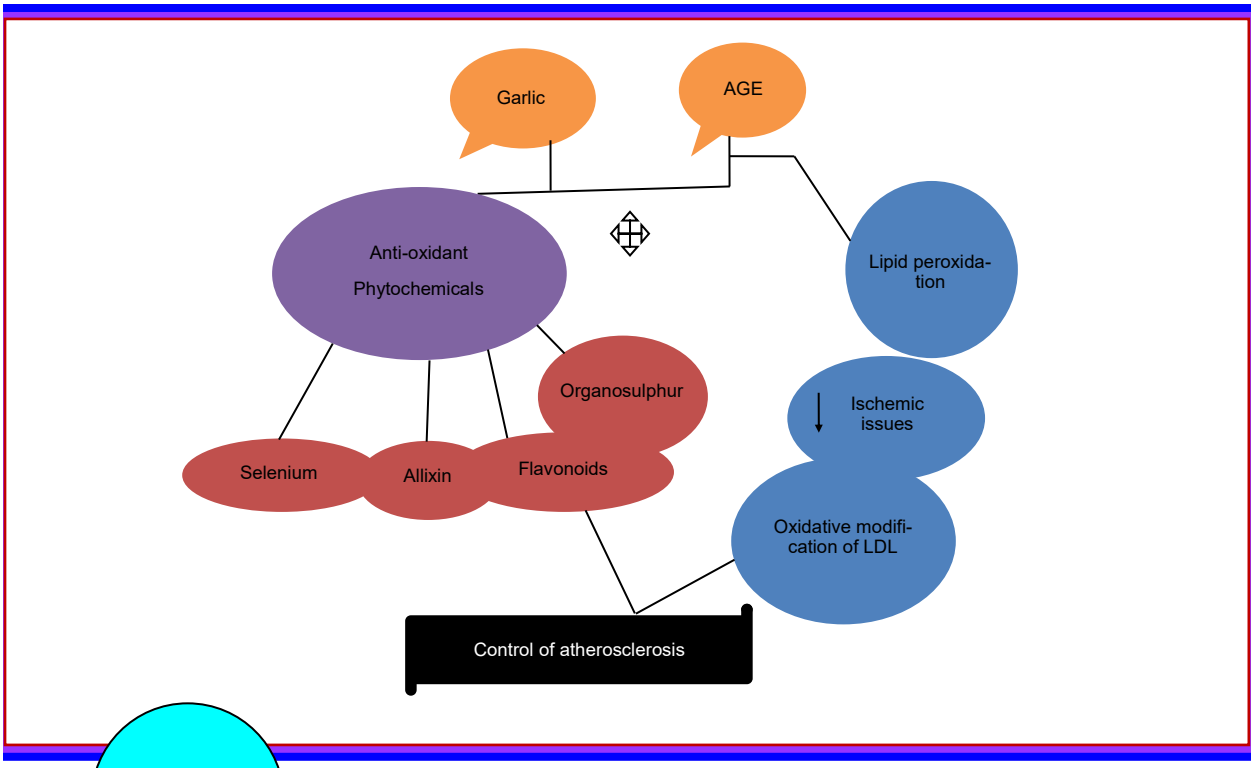

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Mini-review

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Mini-review

Potential role of medicinal plants for anti-atherosclerosis activity

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Abstract

Atherosclerosis may lead to the death of a number of people. In case of atherosclerosis, stiffness of arteries of the heart is caused by the excess deposition of lipids in the coronary arteries. The mentioned condition produces atherosclerotic plaques. When these plaques are burst then clots of blood are formed that cause coronary issues. To overcome this severe disease, extracts of many medicinal plants or spices like garlic, ginger and onion, and many others that are mentioned in this review are used to treat atherosclerosis.

Introduction

Human atherosclerosis is a complex disease with a number of problems involving vascular injury, lipid accumulation, platelet and fibrin accumulation and cellular migration and proliferation. A number of deaths had been occurred in the world due to atherosclerosis. The death rates and cost for the treatment of atherosclerosis are very high. According to the survey of World Health Organization, there is high stress on the health of world's population due to atherosclerosis. It has been found that chemical agent like homocysteine is responsible as a major cause of atherosclerosis (Ross and Harker, 1976). Endothelial injury is supposed as the basic event in the prevalence of atherosclerosis (Dong et al., 2017). Sometimes, atherosclerosis remains as a silent disease until extreme infections are observed. The prevalence of atherosclerosis is enhanced with age (van der Ende et al., 2017).

With the risk factors of atherosclerosis, many remedies also exist to treat atherosclerosis (Stocker and Keaney 2004). No doubt, the use of conventional drugs like aspirin and statin help to cure this disease but they cause the severe side effects like swelling, stomach pain. Conventional drugs are costly. There is a need to find out the cheaper and safer way to treat it.

Researchers have found the solution to treat this disease by the use of extracts of medicinal plants (Adegbola, 2017). In this review, the medicinal plants used to treat atherosclerosis are discussed.

Effects of Medicinal Plants

Gynostemma pentaphyllum

The constituents of *G. pentaphyllum* are the vital component of a Chinese medicine named "HG" (Hong-Qu and gypenosides) which is used for the treatment of atherosclerosis.

In a clinical study, four groups of atherosclerotic rats were made in which one group was maintained as a control, the second group was given just Hong-Qu, the third group was given gypenosides and the forth group was given the mixture of Hong-Qu and gypenosides. By clinical analysis, it was found that the effects of the mixture of HG were more significant for the control of atherosclerosis than other groups. Therefore, *G. pentaphyllum* can be used for anti-atherosclerotic activity (Gou et al., 2017).

The saponins obtained from the *G. pentaphyllum* reduce the cholesterol level by modulation of the absorption from intestine by lowering the solubilization of micelles (Liu et al., 2016).

Triticum aestivum

T. aestivum (wheatgrass) can be used to treat atherosclerosis. For evidence, a study was completed on 48 Long-Evans rats of which some were normal and some were hypercholesterolemic. Rats were divided into different groups on the basis of giving different concentrations of laboratory food, distilled water, cholesterol and juice of wheatgrass. The results showed that rats which were given 20 mL concentration of wheatgrass juice reduced the blood cholesterol level (Afroz et al., 2014).

This plant produces more potentiated effects by increasing HDL (high-density lipoproteins) level which ultimately helps in the reduction of atherosclerosis. To confirm this, a study was done on rats in which increasing of level of HDL was observed by administration of wheatgrass juice (Afroz et al., 2015).

Panax ginseng

Ginseng (*P. ginseng)* is a herb that is used to treat cancer, diabetes, hypertension and atherosclerosis. The effect of ginseng is due to the presence of ginsenosides. There are several types of ginsenosides of which Rb1, Rg1, Rg3, Rh1, Re, and Rd are important for the reduction of atherosclerosis (Lee and Kim, 2014).

In a study, atherogenic rats were divided into different groups on the basis of giving different treatments like control group, exercise group, Korean red ginseng (KRG) given group and both exercise and KRG given group. Results showed that the group that was treated with both KRG and exercise revealed more reduction of atherosclerosis than other groups (Lee et al., 2014).

Solanum tuberosum

S. tuberosum (potato) has a therapeutic activity to treat atherosclerosis by the activation of adiponectin (Berberich et al., 2005). Potato components play a pivotal role for the maintenance of metabolic functions in the human body due to the presence of constituents like dietary fibers, potassium and vitamin C. General analysis on the health of a large population had been done to observe the benefits of potatoes by its consumption. There was improvement of cardiac disease. However, proper clinical trials are still not done on potatoes for the treatment of cardiovascular diseases. The anti-atherogenic activity of potato is reported (McGill et al., 2013).

Allium sativum

Allinase enzyme: Higher lipid level in the blood can be treated by taking garlic in foods. Garlic is well potentiated due to the presence of allinase enzyme that is used for medicinal purposes to treat the cardiovascular diseases. The lipid lowering effect in the plasma, inhibition of accumulation of platelets, stoppage of formation of blood clots and lowering of blood pressure may be regulated by garlic in food. The extract of garlic is used to treat atherosclerosis as shown in Figure 1 (Rahman, 2001).

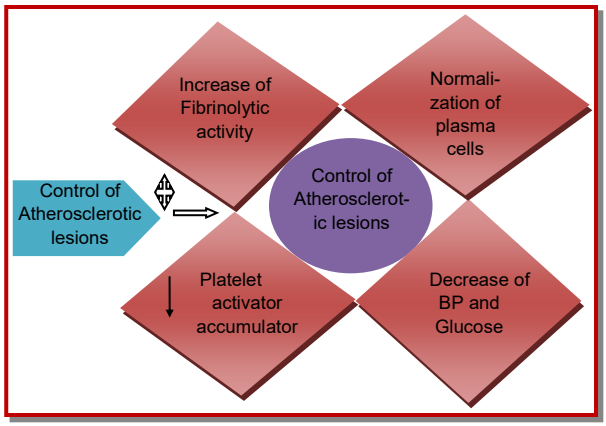

Figure 1: Allinase enzyme from garlic helps in enhancement of fibrinolytic activity, normalization of plasma cells, decrease platelet activator accumulator and decrease of blood pressure and glucose

Plasma anti-oxidant activity: Oxidatory inhibitor phytochemicals that are present in the garlic play an important role to increase the HDL level. The compounds of garlic like selenium, flavonoids, allixin, water and lipid soluble organosulphur are responsible to reduce the oxidative activities. S-allylcysteine and other water soluble compounds of garlic also regulate the anti-oxidant effects. Peroxidation of lipids and HDL are regulated by the extract of garlic as shown in Figure 2 (Gorinstein et al., 2007).

Byrsonima crassifolia

Polyphenolic compounds are present in the fruit, leaf and bark of *B. crassifolia* (Silva et al., 2007). By taking polyphenols containing diets, a number of diseases like atherosclerosis and other cardiac diseases can be treated. A clinical trial was conducted on 1139 people. The different doses of nuts, olive oil were given to the people and data was collected after one year. Parameters like inflammation, therapeutic plasma exchange were tested. The therapeutic plasma exchange parameter lipid was almost at a decreased rate than other parameters. Diastolic and systolic blood pressures were also reported at decreased rate by the analysis of data. Lipid metabolism, cardiac risk factors and blood pressure can be controlled by taking sufficient amount of polyphenols (Medina-Remón et al., 2017).

Niacin: Niacin (vitamin B3) obtained from the various plants including *B. crassifolia* plays a potential role to

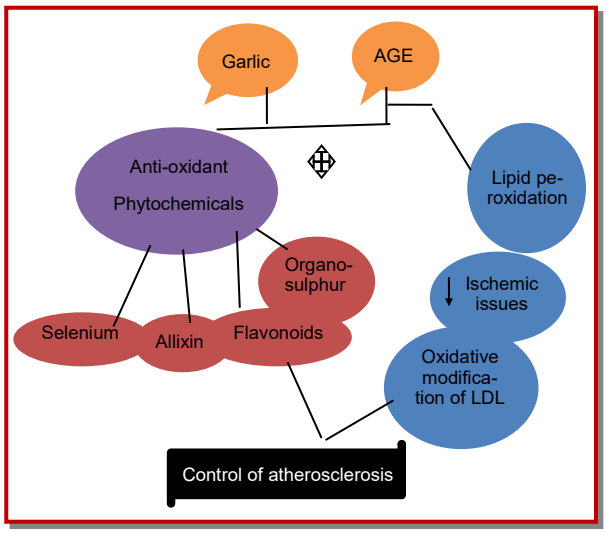

Figure 2: Garlic and AGE play role in the production of anti-oxidant phytochemicals like selenium, allixin, flavonoids and organosulphur. AGE is also responsible to inhibit lipid peroxidation, oxidative modification of LDL and decreasing of ischemic issues

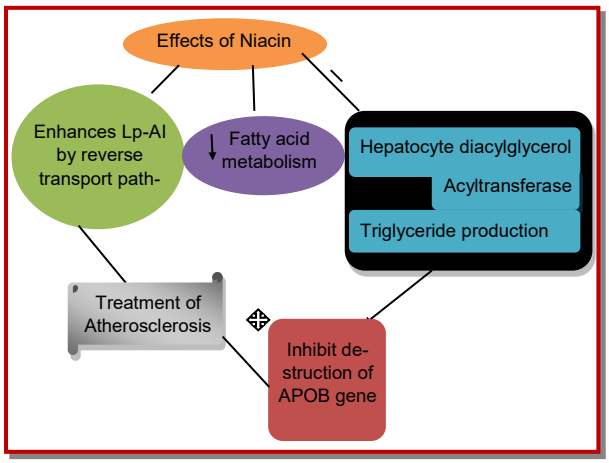

Figure 3: Niacin plays a role for the enhancement of Lp-Al by reverse transport pathway, decrease fatty acid metabolism like hepatocyte diacylglycerol, acyltransferase, and triglyceride production. These lipid control factors inhibit the destruction of APOB gene. This APOB gene and level of Lp-Al collectively control the atherosclerosis

control the lipid level in plasma metabolism of lipoproteins and atherosclerotic lesions as shown in (Figure 3).

Some important pathways like less deposition of triglycerides in the fatty tissues and liver tissues can be regulated by niacin (Ganji et al., 2003). Niacin helps to reduce the deposition of lipoproteins with the addition of some other useful drugs like statin (a useful drug that is used to lower the cholesterol level). By the combination of these vitamins and drugs, triglycerides formation in liver cells can be lowered and less secretion of lipoproteins can be done. So, this report shows that niacin can also be used as potentiated drug to treat the atherosclerosis (Meyers et al., 2004).

Zingiber officinale

To prove the evidence that *Z. officinale* (ginger) can be used to treat atherosclerosis, a clinical trial was completed on rat that was suffering from hyperlipidemic condition. The suspension of *Z. officinale* was formed and its two doses 35 mg and 70 mg per kg were given to half hyperlipidemic rats and remaining half were maintained as the control. The whole experiment was ended after 10 weeks. In this experiment, the set doses were given by intubation process in the liver. There were significant reductions in lipid deposition and cholesterol level in the treated group. When these results were compared with that group of rats that were not received the ginger, have high deposition lipid and cholesterol level as compared to those that received the ginger solution. So, this report shows that ginger solution can be used to cure atherosclerosis (Murugaiah et al., 1999). In another study, for the treatment of mice for atherosclerosis, a ginger powder was given to the mice on the trial bases and results shown that less atherosclerosis, lipid metabolism and cholesterol efflux (Verma et al., 2004).

Quercus infectoria

Oak is considered as an useful plant to reduce the cholesterol level and atherosclerosis. A study on this plant was done which was performed on 36 white rabbits of New Zealand. The experiment was continued for 45 days in which about rabbits were classified into different groups on the basis of different treatments and doses. After 45 days, hyperlipidemic and atherosclerotic rabbits with *Q. infectoria*-treated group showed the significant reductions in cholesterol level and lipid deposition (Gholamhoseinian et al., 2012).

Q. infectoria has high potential to treat atherosclerosis due to the presence of highly potentiated compounds like gallic acid, ellagic acid and tannins. Its leaves play a pivotal role to secrete the above acids that also show a strong anti-oxidant activity (Khennouf et al., 2003).

Pulicaria gnaphalodes

As *P. gnaphalodes* has phenolic and anti-oxidant compounds, the plant plays a pivotal role to control the atherosclerosis. The active organs of this plant are leaves that have high concentrations of flavonoids and anthocyanin that help as the remedy for atherosclerosis. Methanolic extract is best for the remedy for atherosclerosis (Kamkar et al., 2013).

Origanum majorana

O. majorana leaves have phenolic compounds like carvacrol, thymol methyl ether that help in the

reduction of the formation of foam cells. Ultimately, atherosclerosis can be cured (García-Risco et al., 2017). Ursolic acid and carnosic acids are the other constituents of this plant. As atherosclerosis is caused due to the production of excess leptin (hormone formed by adipose cells). So, to reduce these risk factors a clinical trial was done on rat which had the hyperlipidemic problem. In this trial, a suitable dose of this plant was given to these rats and results showed the significant reduction in atherosclerosis and lipid deposition (Yu and Tzeng 2009).

Portulaca oleracea

A study was completed on Wistar rats which were divided into different groups on the basis of different treatments. The results showed the significant reduction in cholesterol level in those rats that were treated with an alcoholic extract of this plant but less reduction in lipid deposition (Changizi-Ashtiyani et al., 2013). As in the leaves of this plant have omega fatty acids that can help for reduction of hyperlipidemia. So, to check its effects, the above compounds were applied on the atherogenic mice and results shown the reduction of atherosclerosis in mice. So, the mentioned plant can help in the reduction of atherosclerosis disease (Lee et al., 2012).

Trachyspermum copticum

This plant is also known as Ajwain. The methanol extract from the seeds of this plant possesses a great anti-oxidant activity and in the leaves of this plant has a compound like diphenylpicryl hydrazyl that has antiradical activity. So, by the combination of above activities, atherosclerosis can be controlled (Prashanth et al., 2012). The study was done on Albino rats by giving the powder form of this plant. Results have shown the significant reduction in the cholesterol level, lipid deposition and atherosclerosis by hindering the effects of HMG-CoA reductase in rat (Javed et al., 2009).

Nigella sativa

In Eastern countries, *N. sativa* is used at large scale level for the treatment of cancer and diabetes. An experiment was done on rabbits by dividing them into different groups on the basis of treatments. The treatments were of powder and oil from the seeds of this plant. When these treatments were given to the hypercholesterolemic rabbits, then reductions in the lipid storage and atherosclerosis were seen (Al-Naqeep et al., 2011).

N. sativa has useful therapeutic effects against hyperlipidemia. The seeds of *N. sativa* have metabolites that have anti-oxidant activities. These beneficial effects can help in the reduction of atherosclerosis (Sabzghabaee et al., 2012).

Sesamum indicum

As leaves of *S. indicum* have lipoprotein, lignin, sesamolinol, and sesamol oil, so this plant can help in the reduction of atherosclerosis lesions (Bhaskaran et al., 2006). To confirm this fact, molecular modifications were done in the female mice by introducing sesame oil. The results were collected after three months of giving treatment. The results were seen to be more positive like less cholesterol level, less lipid profile and reduction in atherosclerosis. In this experiment, it was seen that the disturbed metabolic and molecular functions were healed by the introduction of this oil. This oil introduced healthy genes like ApoE, ABCA1 *etc*. When disturbance comes in these genes then atherosclerosis is caused. But due to the introduction of this oil, normal metabolic and molecular functions can be activated (Narasimhulu et al., 2015).

Allium latifolium

Leaves of *A. latifolium* have flavonoids that help in the reduction of lipid peroxidation. To prove this, an experiment was done on the hyperglycemia rat and results shown the reduced lipid profiling (Ibegbulem and Chikezie, 2013). *A. latifolium* is the best remedy against atherosclerosis (Heidarian et al., 2013).

Bunium persicum

This is an edible plant and also known as black zira. The leaves and fruits of this plant have many important metabolites like butylated hydroxyanisole that help in the reduction of atherosclerosis lesions (Ali et al., 2014). Due to the presence of mentioned compounds in this plant, it is used to treat the oxidative stresses also as well as the reduction of cholesterol level and excess lipid deposition (Khazdair et al., 2017).

Olea europaea

This plant has high antiatherogenic ability due to the presence of polyphenols in its leaves which help in the reduction of lipid deposition (De Bock et al., 2013). This plant has activities against hyperlipidemia (Bahramsoltani et al., 2017).

Punica granatum

Punica granatum, also known as pomegranate, is much effective against the formation of foam cells (Fats cells). Experiments were done on the atherosclerotic mice by giving the extract of pomegranate and after 20 days' results showed the anti-atherosclerotic activity. So, pomegranate extract with beneficial metabolites can reduce the production of foam cells (Rom et al., 2017). Another clinical trial on mice that was atherogenic was done by giving the juice of pomegranate. The results were more positive by showing the maximum reduction in cholesterol level, lipid deposition, atherosclerosis disease and triacylglycerol (Estrada-Luna et al., 2017).

Coriandrum sativum

Ethanolic extract from the seeds of (*Coriandrum sativum*) coriander shows the anti-oxidant activity. Many experiments had been done by which it is proved that this plant is much potentiated against foam cells formation and ensured that we can use this plant as antiatherosclerotic activity safely (Farah et al., 2015). Its aqueous extract was also given to atherogenic rat which shown best results against atherosclerosis as well as low lipoproteins formation (Aissaoui et al., 2011).

Anethum graveolens

Anethum graveolens is commonly known as dill or dillweed. Iranian people believe that the aerial parts dillweed have the hypolipidemic effect. The powdered form of the plant and essential oil obtained from the plant have shown significant lipid-lowering effects in the rat (Hajhashemi and Abbasi 2008). A clinical trial on hyperlipidemic patients shows that dill tablet (6 tablets daily) for 2 months have reduced the serum total cholesterol level up to 18% (Mirhosseini et al., 2014).

Hypocholesterolemic effect of dillweed in rats is probably mediated through the suppression of endogenous cholesterol biosynthesis by inhibition of the activity of HMG-CoA reductase (Yazdanparast and Bahramikia 2008). The study on golden hamster shows that dill extract and dill tablet have hypocholesterolemic properties by inhibition of HMG-CoA reductase activity (Abbasi Oshaghi et al., 2015). This plant has some protective values against atherosclerosis (Setorki et al., 2013).

Curcuma longa

Turmeric plant can be used as a potentiated plant to treat the hyperlipidemia and atherosclerosis due to the presence of bisdemethoxycurcumin in the rhizome of this plant (Shin et al., 2014). The ethanolic extract was given to the atherogenic rabbit and positive results were shown (Quiles et al., 1998).

Terminalia arjuna

As this plant has useful compounds like flavonoids by which it has strong ability of anti-oxidant, anti-atherosclerotic etc. So, to prove this fact, a clinical trial was done on rabbits that were suffered in high atherogenic conditions. These were divided into different groups on the base of different treatments. Ultimately, the rabbits that were given an ethanolic extract of this plant shown more valuable results like reduction of atherosclerosis and some other cardiac problems (Subramaniam et al., 2011).

Emblica officinalis

This plant is best known as for the formation of such marketed products by which lipid deposition and atherosclerosis can be reduced. For the product formation firstly slurry is formed by the addition of extract of this plant with water that has no minerals. After this, pectinase is applied to this slurry and then filtered for the formation of a solution. Concentration of this solution is enhanced by the addition of some other compounds. Finally, the product is formed that is used for the treatment of cardiovascular, hepatic, renal and atherosclerosis (Antony, 2017). A study was done on using model organism rat. The rats were divided into six groups on the base of different treatments. The experiment was continued till 21 days. When results were collected, then there were significant reductions in the lipoproteins deposition, atherosclerosis in those groups which were treated with ethanolic extract of this mentioned plant (Kanthe et al., 2017).

Premna integrifolia

In earlier times, a drug named as "Dhasamula" was prepared for the medicinal value for the treatment of many disorders like cardiac, liver, kidney and hyperlipidemia, etc by the use of this mentioned plant. In this regard, by seeing the above curements by this plant, a study was done on the rats that were atherogenic. The experiment was done on 60 Wistar rats. Six groups of them were made and in these first was maintained as control, the second was treated with high-fat diet, next three were treated with high-fat diet with the addition of hydroalcoholic extract of this mentioned plant and the last one was treated with atorvastatin. The experiment was run for 30 days. After 30 days many viable results were collected in which there were highly reductions in atherosclerosis, lipid deposition, HMG-Co reductase and other some other factors that are highly induced for the development of atherosclerosis. This plant is proved as potential for anti -atherosclerotic activities (Subramani et al., 2017).

Zanthoxylum heitzii

This plant is used as potential medicine to treat atherosclerosis and other cardiovascular diseases. A study was completed on rats that had normal cholesterol level. These were divided into six groups and each group having 10 rats. In these five groups were giving high cholesterol diet and 61 was treated with normal diet. The cholesterol induced rats were also taking distilled water with the addition of about 300 mg/kg aqueous extract of stem bark of this mentioned plant. The results were more valuable when analyzed in cholesterolemic rats. These results showed a reduction in atherosclerosis and lipid profiling. This trial concluded that this plant can be used as a medicinal agent to treat atherosclerosis (Ntchapda et al., 2015).

Conclusion

Atherosclerosis occurs due to the increased cholesterol

level in the inner walls of arteries, and at the genetic level. It may be caused by the disturbance of some normal mechanisms as mentioned above which can be abolished by applying different medicinal constituents of different plants. It is concluded that by implication of these treatments, atherosclerotic lesions can be controlled and its prevalence can be decreased.

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Conflict of Interest

The authors have no collisions of interest to disclose

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