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Promising Effects of *Solanum virginianum* L Seed Extracts against the Oral Pathogens

Rajaselvam J.[1], Sobiya M.[2] and Elaya Perumal U.[3]*
[1]Assistant Professor, Department of Zoology, Vivekananda College, Agastheeswaram, Kanyakumari (Tamil Nadu), India.
[2]Master's Student, Department of Zoology, Vivekananda College, Agastheeswaram, Kanyakumari (Tamil Nadu), India.
[3]Chief Scientist, Annakkili Amma Research Institute (AARI), Medavakkam, Chennai (Tamil Nadu), India.

(Corresponding author: Elaya Perumal U.)*
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ABSTRACT: Dental caries is one of the emerging diseases in the world. It can be treated with antibiotics, but consumption of such synthetic antibiotics often could cause adverse effects on human health. To resolve these issues researchers, search natural resources for alternative sources. This study was done for analysing the antibacterial activity of *Solanum virginianum* L. seed extracts against the oral pathogens *Staphylococcus mutans*, *Lactobacillus acidophilus*, *Pseudomonas aeruginosa*, *Streptococcus oralis,* and *Streptococcus mitis*. In this study, *S. virginianum* L. seeds were collected and shade dried before making powder, and then the Acetone, Ethanol and Water were used for the extraction. Primary phytochemical constituents of the extracts were analysed and the antimicrobial activity was tested against the oral pathogens. The presence of phytochemicals could be the reason for the antimicrobial activity. Among all extracts, the aqueous extract showed the lowest activity against all the used bacteria. Acetone extract showed a maximum inhibitory zone against the bacteria *S. mitis* (35 mm) than the others. This study proves that *S. virginianum* seed extracts have active components to treat oral caries.

Keywords: Antimicrobial activity, Dental Cariogenic Bacteria, Dental pathogens, oral caries, phytochemical, *Solanum virginianum.*

INTRODUCTION

Natural resources are essential in the development of novel therapeutic agents for human health (Sener and Kilic 2019; Elaya Perumal and Sundararaj 2020). According to World Health Organization (WHO), estimation 80% of the global population accepted the traditional system of medicine for their primary health care (Purohit and Vyas 2004). Since ancient medicine, nature has provided medicinal agents. The majority of the traditional medicines used in healthcare are attained from plant sources (Kala *et al.,* 2004).

Primary and secondary metabolites such as flavonoids, tannins, and alkaloids from plants have antibacterial properties. Medicinal plants are the alternative source for the treatment of infectious disorders with mild side effects and detoxification (Anshika and Neeraj 2011; Gamboe *et al.,* 2008; Ncube and Van Staden 2015; Omar *et al.,* 2018).

Dental caries is the most prevalent chronic infectious disease in the oral cavity throughout the world, especially in Asian and Latin American countries (Peres *et al.,* 2019; Anusavice, 2002; World Health Organization, 2002). It is a microbial infection in human populations, prevalent in 60-80% of Children (Loesche, 1986; Petersen *et al.,* 2005) than the Adults which is leading to a loss of teeth or disintegration (Shobha Tandon *et al.,* 2010; Kanso *et al.,* 2006). Millions of bacteria colonies on the tooth surface and form a biofilm which is known as plague (Forssten *et al.,* 2010).

Streptococcus spp.*, Granulicatella* spp., and *Veillonella* spp. are found in the oral cavity of healthy humans (Aas *et al.,* 2005; Dewhirst *et al.,* 2010), but in favourable conditions, they can also cause caries, endodontic infections, period on titis, and tonsillitis like oral-maxillofacial infections and dental infections (Doving *et al.,* 2020; Scannapieco, 2013; Wade, 2013). Although *Streptococcus mutans* is the most important acidogenic-aciduric bacterial species responsible for the formation of dental caries (Conrads and About 2018; Nedumgottil, 2018). *S. aureus* is associated with dental implant infection and has established a high tolerance to common antimicrobial treatments (Wang and Ren 2017).

Dental caries are associated with bacterial infections; therefore, the antibacterial treatment seems to be appropriate for the recovery of inflamed tissues (Steinberg and Friedman 1998). Although a variety of chemical agents are commercially accessible, they can affect the oral microbiota and cause unpleasant side effects like nausea, diarrhoea, and tooth discolouration (Chung *et al.,* 2006).

Overcoming these side effects, herbal products used against oral infection have more inhibitory effects on the

dental pathogen. The search for alternative products continues and natural phytochemicals isolated from plants used in traditional medicine are considered to be good alternatives to synthetic chemicals (Muroi and Kubo 1993; Prabhu *et al.,* 2006). Nowadays various plants and various plant extracts are used traditionally for dental care (Barira Islam *et al.,* 2007; Daljit Singh Arora and Gurinder Jeet Kaur 2007).

Medicinal plants confer antimicrobial activity against oral bacteria (Joathan *et al.,* 2000; Smullen *et al.*, 2007). The utilization of *Psidium guajava* leaves to maintain oral hygiene, dried fruit of *Terminalia chebula* as an anti-inflammatory agent, stem of *Achyranthes aspera* for toothache therapy, and stem of *Mimusops elengi* to strengthen the gums are revealed in the literature review on folkloric medicine (Fathilah *et al.,* 1998; Jagtap and Karkera 1999; Manandhar, 2002; Ali *et al*., 2008).

To find out a better solution for the prevention of dental caries the selected medicinal plant in this study is *Solanum virginianum* L., which is also called Surettense nightshade, which belongs to the family Solanaceae. It is a perennial plant, with spine or under shrub found all over India and has various medicinal properties against cough, chest pain, vomiting, hair fall, anti-inflammatory activity, hypoglycemic activity, anti-filarial, apoptosis - Inducing activity etc. The plant has a greater number of phytochemicals such as glycosides and saponins. Plants also contain some nutrients like carbohydrates, fatty acids, and amino acids. Dried fruit ash can be used to relieve toothaches (Prashith Kekuda *et al.,* 2017). Considering these facts *Solanum virginianum* L seeds were experimented against the oral cavity pathogens *Staphylococcus mutans*, *Lactobacillus acidophilus*, *Pseudomonas aeruginosa*, *Streptococcus oralis*, and *Streptococcus mitis* and in the treatment of oral caries.

MATERIALS AND METHODS

Collection and preparation of plant materials. The healthy and disease-free seeds of *Solanum virginianum* L. were collected from Avaraikulam Village, Tirunelveli district, Tamil Nadu, India (Fig. 1).

Fig. 1. *Solanum virginianum* plant.

The plant specimen was identified by Botanist, Dr. Elaya Perumal. U., Chief Scientist, Annakkili Amma Research Institute (AARI), Chennai. Collected seeds were rinsed thrice with distilled water. For ten days, the seeds were shade dried at room temperature. The shade-dried materials were powdered using the homogenizer.

Preparation of plant Extract. The air-dried seed powder (10g/100ml) was extracted by cold extraction method using different solvents such as distilled water (aqueous), acetone and ethanol for 72 hours. The extracts were filtered through Whatmann No. 1 filter paper and then concentrated and transferred to sterilized vials and stored at 4 °C.

Antibacterial assay. Antibacterial assay was carried out using the disc diffusion method against the bacteria *Staphylococcus mutans*, *Lactobacillus acidophilus*, *Pseudomonas aeruginosa*, *Streptococcus oralis,* and *Streptococcus mitis* (Bauer *et al.*, 1966; Perez *et al.,* 1990; Jenkins and Schuetz 2012). The diameter of the zone of inhibition was measured in millimetres (mm).

Preliminary phytochemical Screening. The preliminary phytochemical analysis of the extracts was carried out to determine the presence of saponins, tannins, coumarins, Quinones, steroids, terpenoids, carbohydrates and phenols using standard procedures referred to in the earlier studies (Sowanthriya Shanmugam *et al.,* 2022; Mace, 2006; Harbone, 1973).

RESULTS AND DISCUSSION

The present study was carried out to evaluate the preliminary phytochemical analysis and antimicrobial activity of *S. virginianum* L. seed extracts against oral pathogens such as *St. mutans*, *St. mitis*, *St. oralis*, *L. acidophilus* and *P. aeruginosa.* Recently, natural products have been experimentally investigated to inhibit the growth of dental plaque microorganisms (Iyer *et al.,* 2017). Various studies have been conducted using *S. xanthocarpum* and *P. lentiscus* showed effective antimicrobial properties against oral microflora and periodontal pathogens (Paraschos *et al.,* 2007; Aksoy *et al.,* 2007; Divya *et al.,* 2012; Abbas *et al.,* 2014; Pol *et al.,* 2016; Ali Roozegar *et al.,* 2016; Koychev *et al.,* 2017).

In the Current investigation, the extracts of *S.virginianum* L. seeds expressed promising results in inhibiting the growth of oral bacterial strains (*S. mitis*, *L. acidophilus*, *S. oralis*, *S. mutans* and *P. aeroginosa.* The acetonic seed extracts of *S. virginianum* had the highest antimicrobial activity against the dental pathogen *Streptococcus mitis* (35 mm) followed by *Lactobacillus acidophilus* (30 mm), *Streptococcus mutans* (28 mm), *Streptococcus oralis* (25 mm) and *Pseudomonas aeruginosa* (23mm) whereas the Standard antibiotics exhibited the values of 28 mm, 35 mm, 28 mm, 18 mm, 20 mm respectively (Table 1). However, the acetone extract of *S. virginianum* L. seed has the highest antibacterial activity against *S. mitis* (35mm) than the other extracts (ethanol and aqueous extracts). Similarly, the results were supported by earlier research results that stated that *Nigella sativa* L. had more potent activity against *S. mitis* and *S. mutans* (Rezaei *et al.,* 2017; Mohammed *et al.,* 2012).

The antimicrobial activity of *S. mitis* may be due to the presence of bioactive compounds saponins, flavonoids, steroids etc. (Rezaei *et al*., 2017). The inhibitory effect of aqueous extract of seed *S. virginianum* L. on bacterial

growth was most noticeable with *Streptococcus mitis* (25 mm) followed by *Lactobacillus acidophilus* (20 mm), *Streptococcus oralis* (18 mm), *Streptococcus mutans* (16 mm) and *Pseudomonas aeruginosa* (12 mm) (Table 1).

The antimicrobial activity of *S. virginianum* L. seed extract was compared to standard antibiotics as shown in Table 1.

Table 1: Chloramphenicol.

Microorganisms	Zone of inhibition in mm			
	Aqueous	Acetone	Ethanol	Standard (Chloramphenicol)
S. mutans	16	28	28	28
S. oralis	18	25	21	18
S. mitis	25	35	22	28
P. aeruginosa	12	23	14	20
L. acidophillus	20	30	16	35

The ethanolic seed extracts of *S. virginianum* L. had strong antimicrobial activity on *Streptococcus mutans* (28 mm) followed by *Streptococcus mitis* (22 mm), *Streptococcus oralis* (21 mm), *Lactobacillus acidophilus* (16 mm) and *Pseudomonas aeruginosa* (14 mm) (Table 1). Similarly, the neem extract has shown antimicrobial activity against *S. mutans* and *E. faecalis* (Bohora *et al.,* 2010; Prashant *et al.,* 2007). Oraon *et al.* (2020), investigated the leaves of mint, coriander leaves and Tulsi exhibited the highest antibacterial activity against *S. mutans*.

The present study on preliminary phytochemical analysis of *S. virginianum* (Table 2) revealed that the aqueous, acetone and ethanolic extract showed the maximum phytochemical constituents (Terpenoids, quinones, steroids, coumarin, saponin and carbohydrate). The polarity of solvent affects the quantity and composition of secondary metabolites of an extract. Many bioactive compounds are not water-soluble and these organic solvent extracts of plants are more effective (Parekh *et al.,* 2006).

Preliminary phytochemical screening of *S. virginianum* L seed extract showed a wide range of biochemical constituents. Saponins, coumarins, Quinones, steroids, terpenoids and carbohydrates were detected in acetone, ethanol and aqueous extracts (Table 2).

Preliminary Phytochemical constituents of *S. virginianum* L. seed extracts are shown in Table 2.

Table 2.

Phytochemical	Solvent extract		
	Aqueous	Acetone	Ethanol
Terpenoids	+	+	+
Tannins	-	-	-
Carbohydrate	-	-	+
Quinones	+	+	+
Steroids	+	+	+
Coumarins	+	+	+
Saponins	+	+	+

The presence of phytochemical substances may be responsible for the antibacterial activity of the *S. virginianum* L. seed extract against the dental strains of *S. mutans*, *S. oralis*, *S. mitis*, *L. acidophilus* and *P. aeruginosa* in this study. The bioactive compounds isolated from plant extracts often have inhibitory effects on pathogenic organisms (Anshika and Neeraj 2011; Meng *et al.,* 2000; Sharma *et al.*, 2011). Thus, this study proves that the bioactive compounds from *S. virginianum* L. seeds can be isolated to develop the drug to treat oral caries.

CONCLUSIONS

Nowadays herbal medicines are gaining popularity due to their cost-effectiveness, availability and effectiveness against a wide variety of microbial infections and eco-friendly nature. The results of our study show that *Solanum virginianum* L seed exhibits antimicrobial activity against dental cariogenic microbial flora such as *Streptococcus mitis*, *Lactobacillus acidophilus*, *Streptococcus mutans*, *Streptococcus oralis* and *Pseudomonas aeruginosa*. The results of our study revealed that the seed of *S. virginianum* L shows the presence of phytochemical compounds (flavonoids, saponins, coumarins, quinones, steroids, glycosides, proteins and carbohydrates). This study emphasized the promising cariogenic antimicrobial effect of *S. virginianum* L seed against the five important oral microorganisms compared to standard antimicrobial medicine. These findings give scientific insight into the traditional use of *Solanum virginianum* L seed as a mouthwash, a practice believed to prevent dental caries.

FUTURE SCOPE

The bioactive compounds from seeds of *Solanum virginianum* L can be isolated and further research can be performed on the separated compounds. Based on this there is a scope for developing new nature-based drugs against cariogenic bacteria.

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Conflict of Interest. None.

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