Research Article

Antimicrobial activity of the leaf extracts of *Solanum melongena* L.(the green variety)

Madhuri A. Sitap[1], Sandhya R. Tilawale[1], Naeim H. Nadaf[2], *Jai S. Ghosh[2]

1. Department of Microbiology, Dr. Ghali College, Gadhinglaj, Kolhapur, India.
2. Department of Microbiology, Shivaji University, Kolhapur, India.

ABSTRACT

In a country like India eggplant (*Solanum melongena* L.) is a common fruit consumed by majority of the people. It is usually prepared as an accompaniment to the main food like rice or roasted bread (made from wheat or sorghum flour). It can be cooked by boling, frying or even by broiling over flame. The vegetable is cultivated in all scale, right from the kitchen gardens at the backyard of any home to large size farms of few acres. Mostly it is the purple (dark or light) variety, except in the peninsular region where there is the green variety which is cultivated and relished. The health benefits of the fruits are well known. However, in this investigation the ethanolic extract of leaves of the green variety, have been found to have antimicrobial action against common wound infecting organism like *Micrococcus aureus*. It is due to the presence of a wide variety of siloxanes which are good enough to retard the growth of such wound infecting organisms. This finding is important as this extract can be used as an alternative disinfectant for first-aid dressing of minor wounds and bruises, in place of regular disinfectants like cetrimide or carbolic acid, which normally farm laborers get when working with such plants in field.

Keywords: Antimicrobials, bruises, eggplant, siloxanes, wounds

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***Address for correspondence:**
Dr. Jai S. Ghosh,
Department of Microbiology, Shivaji University, Kolhapur 416004, India.
E-mail: ghoshjai@gmail.com

INTRODUCTION

Eggplant (*Solanum melongena* L.) is commonly cultivated and consumed throughout the world [1]. In the south Asian subcontinent countries viz. India, it is cooked in various forms and relished as an accompaniment to the main food like rice or roasted bread (made from wheat or sorghum flour). The most common variety that is available easily is the purple variety (either dark or light). However, in the peninsular India, there is another variety commonly cultivated and eaten and that is the green variety.

The benefits of the purple variety is well known as the peel is rich in antimicrobials like nasunin, delphinidin [2] which are anthocyanins along with chlorogenic acids [3]. These substances are also present in the pulp of the fruit too in different quantities. However, all these are indicated against minor infections of gastro-intestinal tract. It is believed that the green variety has more of chlorogenic acids rather than the anthocyanins. Beside these, the eggplant has been reported to contain organic acid like oxalate which combines with soluble calcium in body fluids and can become a major concern for people with kidney and gall bladder ailments [4]. Another very potent glycoalkaloid found in the fruits and vegetables belonging to the family of Solanaceae, is solanine. This is also antimicrobial against many fungi and bacteria [5].

Inspite of these characteristic good features of eggplant, it is also known to cause allergy to many individuals when consumed [6]. A few proteins have been identified in the fruits which are potent allergens [7]. It is also a good source of histamines, which can cause allergy to atopic persons. It also contains nicotine [8]. Approximately, 9 Kg of eggplant contains the same amount of nicotine as that in a cigarette.

This following investigation does not deal with any of these compounds mentioned

above, as no attempts have been made to study the fruit. It involves the investigation of antimicrobial properties of the mature leaves of the plants to be used primarily as disinfectant (first aid type) in case of minor injuries like cuts and bruises to the farm laborers working with field of eggplants.

MATERIALS AND METHODS

Matured leaves of eggplant (green variety) were handpicked. No leaves that have fallen on the ground have been selected in this study. The leaves were checked visually for their health and no infected or pest infested leaves were included. Then these were washed thoroughly with good potable water to remove all visible particulate matter and dried in a hot air oven at 50^{o}C for 8 to 10 hrs. The dried leaves were then pulverized to a coarse powder which was used for solvent extraction. The solvents used were absolute ethanol and pure acetone. The extractions were carried out by shake flask method where the flasks containing the powder and the solvents were intermittently shaken for the purpose. The extracts were then filtered through Whatman filter paper having pore size 20-25 µm. The residues were then dried (over boiling water) to evaporate the solvents for calculating the solids present in the respective solutions.

The microorganisms used for the experiments, were *Escherichia coli* NCIM 2832 and *Micrococcus aureus* NCIM 5021

Initially the growth patterns of the microorganisms were observed in presence of 4 mg per ml concentration of the acetone and ethanol extracts, using a liquid medium containing 1.0% peptone and 0.5% NaCl. The microorganisms used as inoculum were 10^{8} cells per ml as final concentration. The incubations carried out were at 30^{o}C on a rotary shaker rotating at 120 r.p.m. The cell counts were taken at every half hour interval.

It was further decided to find out the in vitro, minimum inhibitory concentration (MIC) of the extracts on these two organisms as per the method of Andrews (2001) [9]. The medium used for this was the same as for growth pattern study. The experiments were carried out in 9 sets each for the two organisms. Four sets were used for 20, 9, 5.5 and 3.63 mg/ml of each acetone extracts and similar four sets were for ethanol extracts. One set was kept as positive control which contained no leaf extracts. The incubation conditions here were the same as mentioned above.

The extracts were analyzed by gas chromatography – mass spectrophotometry (GCMS) (Trace GC ultra-Polaris Q Technologies), equipped with a DB-530-m fused silica capillary column (0.25 mm, internal diameter. and 0.25 µm film thickness), attached to a mass spectrophotometer. Samples were injected in split less mode at 50°C. The column was maintained at 50°C for an initial 1.5 min, followed by heating at 140°C, then to 210°C and finally to 250°C. Helium was used as carrier gas.

Results obtained were mean of three or more determinants and the analysis of variants were carried out using the software ANOVA (software for Excel – XL Stat) at $P<0.05$.

RESULTS AND DISCUSSION

It can be noted that Gram positive micrococci were more susceptible to the leaf extract as compared to that of the Gram negative *Escherichia coli*. This is very evident from (**Figure 1**), clearly indicates that *E.coli* could not withstand this concentration. The most probable reason for this could be the fact that a lipid solvent like ethanol is able to dissolve the lipid layer on the outer surface of Gram negative organisms and making the organism more vulnerable to the action of the leaf extract.

The antibacterial activity of the peel of purple eggplant fruits have been thoroughly investigated [2] but that of the leaves is reported for the first time in this investigation. It is primarily due to the presence of a large class of siloxanes that have been detected significantly in the extracts. The Gas Chromatographic analysis supported with Mass spectrometric analysis of the ethanolic extract, clearly shows this in (**Figure 3**) and in (**Table 1**).

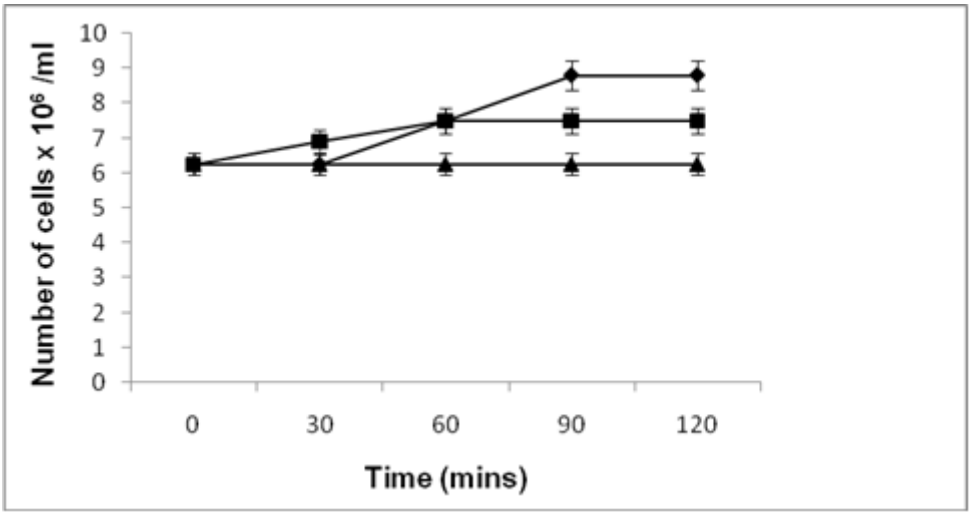

Figure 1: Growth pattern of *Micrococcus aureus* NCIM 5021, in presence of acetone and ethanolic extracts of the leaves of *Solanum melongena*

(●) No extracts: (■) Ethanol extract; (▲) Acetone extract.

where the ethanolic extract at 5.5mg/ml inhibited the growth of *M. aureus*. Figure 2

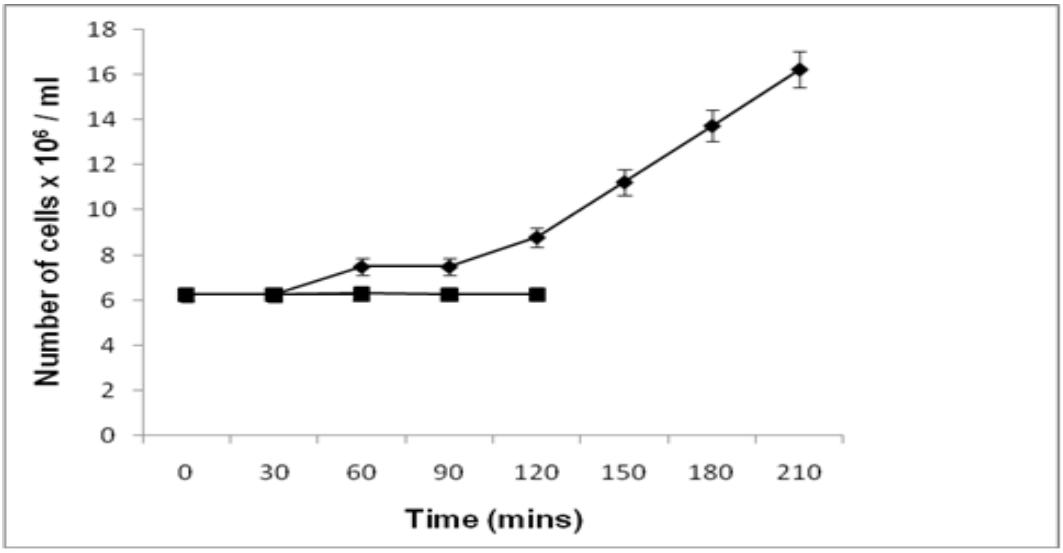

Figure 2: Growth pattern of *Escherichia coli* NCIM 2832, in presence of acetone and ethanolic extracts of the leaves of *Solanum melongena.*

(●) No extracts: **(■)** Ethanol extract; **(▲)** Acetone extract

The acetone extract of the leaves showed similar spectrum (therefore, the results are not mentioned). The antibacterial properties of siloxanes have been earlier reported by Lessoy *et al* (2012) [10], when they had discovered these in conventional seed oils.

(**Tables 2a and 2b**) further supports the findings of this investigation when the Minimum Inhibitory Concentration (MIC) points that a mere 5.5.mg/ml of the plant extract in ethanol is capable of inhibiting both the *Micrococcus aureus* and *E.coli* in vitro. The acetone extract does the same job even at a very low concentration of 3.63mg/ml.

CONCLUSION

The primary objective of this study was to find out a suitable disinfectant to treat minor wounds like bruises for the farm workers working in fields of eggplant where the prickles on the leaf and stalk of certain varieties can cause slight scratches or bruises of certain exposed parts of the body. These, if left unattended, sometime can be the cause of major disease like tetanus. It is not always possible to carry standard antiseptic substances like triclosan or

cetrimide in the farm. These may be stored at home of the farmers and may be used if the fields of cultivation are pretty close by to the home of the farmers. However, most of the fields are quite far away from the home. Not only this, it is often not possible to get potable water to wash such wounds on the farm. Therefore, in an attempt to find an alternative first-aid antiseptic which is readily available and can be easily used in such circumstances, the leaf extracts of the eggplant has been found to be quite effective. These extracts will prevent the growth of common wound infecting organism like *M. aureus.* Again, there are certain exceptions to such a use of leaf extract as certain individuals have been found to possess allergic manifestation to eggplant and caution must be exercised in such exceptional cases which are very rare.

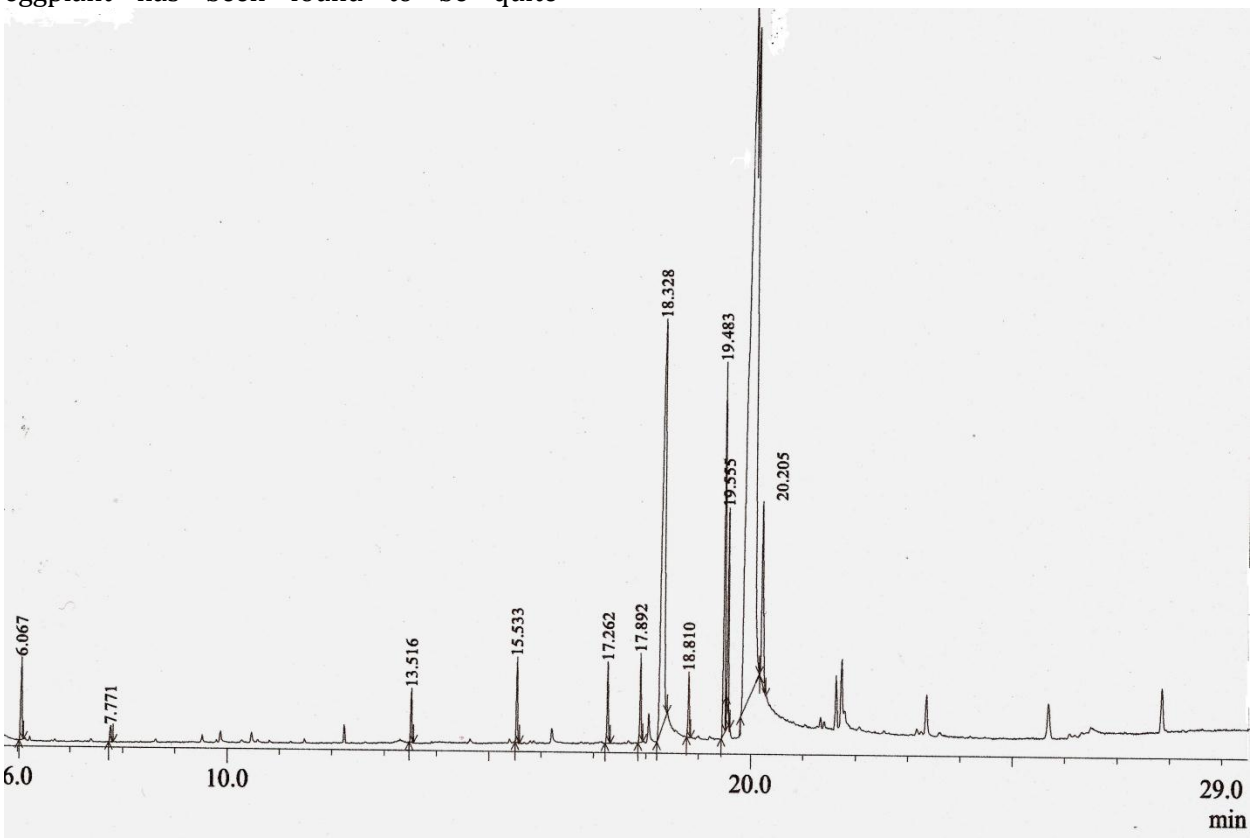

Figure 3: Gas Chromatograph analysis of the ethanolic extract of the leaves of *Solanum melongena,* using Thermal Conductivity Detector

Table 1: Substances corresponding to the peaks of Gas Chromatograph (Figure 3.) as identified by mass spectrophotometer

Serial No. of Peaks	Retention Time (min)	Percent area	Name of compound
1.	6.067	1.37	1-methyl-3-(1-methylethyl) Benzene
2.	7.771	0.27	4-Caranol
3.	13.516	0.73	Tetradecamethyl cycloheptasiloxane
4.	15.533	1.19	Hexadecamethyl cyclooctasiloxane
5.	17.262	1.27	Octadecamethyl cyclononasiloxane
6.	17.892	1.31	Palmitic acid methyl ester
7.	18.328	16.03	Glycerol 1,3-di palmitate
8.	18.810	0.96	Hexadecamethyl heptasiloxane
9.	19.483	5.84	Oleic acid methyl ester
10.	19.555	2.49	Linoleic acid methyl ester
11.	20.006	64.78	Cyclopropanebutyric acid methyl ester
12.	20.205	3.76	Stearic acid methyl ester

Table 2 a: Minimum Inhibitory Concentration of acetone and ethanol extract of the leaves for *Micrococcus aureus* NCIM 5021

Quantity of extract (mg)	Cells x 10^5/ ml	
	Acetone extract	Ethanol extract
0 (initial)	23	23
20	0	0
9	0	0
5.5	0	5
3.63	0	9

Table 2 b: Minimum Inhibitory Concentration of acetone and ethanol extract of the leaves for *Escherichia coli* NCIM 2832

Quantity of extract (mg)		
	Cells x 10^5/ ml	
	Acetone extract	Ethanol extract
0 (initial)	23	23
20	0	0
9	0	0
5.5	0	0
3.63	0	7

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