International Journal of Science and Research (IJSR)
ISSN: 2319-7064
SJIF (2019): 7.583

Lantana camara: A Potential Weed Plant against Multidrug Resistant (MDR) Bacteria

Jyoti Chandola[1], Pooja Singh[2], Dr. Narotam Sharma[3]

DNA Labs A Centre for Applied Sciences, Dehradun-Uttarakhand, India

[1]M.Sc. Botany, DBS (PG) College, Dehradun, Uttarakhand, India

[2]M.Sc. Zoology, DBS (PG) College, Dehradun, Uttarakhand, India

[3]Ph.D. in Life Sciences

Abstract: ***Weed plants have always been a cause of worry for human beings ever since the set-up of agricultural civilization. They not only pose a threat against domesticated plants or forests but also to human health as they are the potential allergens capable of causing allergies, respiratory diseases which in fatal cases may even lead to death. One such specific weed Lantana camara which are now spread worldwide is the good example. Lantana camara are nowadays tested for there anti-microbial activity and also against multidrug resistant (MDR) bacteria and most of these tests have showed response against MDR in prohibiting its growth. This review paper has attempted to review some of these successfully performed tests.***

Keywords: *Lantana* camara, mutidrug-Resistance (MDR) Bacteria, antibiotic resistance

Abbreviations

MDR- Multidrug Resistance
MIC-Minimum Inhibitory Concentration
MBC-Minimum Bactericidal Concentration
Introduction

Classification
Kingdom – Plantae
Division – Angiosperm
Class – Dicotyledoneae
Sub-Class – Gamopetalae
Order – Lamiales
Family – Verbenaceae
Genus – *Lantana*
Species – *camara*

L.*camara* has spread from its native Central and South America to around 50 countries (Day, M.D. 2003), where it has has become an invasive species, L.*camara* will often out-compete other more desirable species, leading to a reduction in biodiversity (Kohli, Ravinder, K. 2006). It can also cause problems if it invades agricultural areas as a result of its toxicity to livestock, as well as its ability to form dense thickets which, if left unchecked, can greatly reduce the productivity of farmland (Ensbey, Rob).

Plant description
Lantana is a genus that belongs to the family verbenaceae about 150 species of herbs comes under this genus. The genus *Lantana* was described by Linnaeus in 1753 in Species Plantarum contains seven species, six from South America and one from Ethiopia. L.camara is a medium sized perennial aromatic shrub, attains height about 2-5 meters with quadrangular stems, prickly. The leaves are generally 3-8 cm long and 3-6 cm wide, ovate, crenate serrate, rugose above, scabrid on both sides, opposite and simple having strong odour (Rosacia, et al.; 2004). Inflorescence could be of different colours such as yellow, orange, white, red, or pink.flowers are tubular shaped having four petals arranged in cluster and changes colours depending on the maturity of plant. *Lantana camara* undergoes sequential colour change and produces yellow colour flower that contain both nectar and pollen. When pollination in the flower occurs it changes its colour from yellow to red, pink, purple, white (Barrow 1976, Mathur and Ram 1986). Butterfly, moths and thripsare noted to play mojor roles in pollination with honeybees and various birds playing minor role (Sharma, et al.; 2005). The fruit is berry like drupe arranged in clusters. The fruit is green and becomes purple black when matures. The seed inside fruit has got two embryos.

Geographical distribution
L.camara is commonly known as wild or red sage is most widespread species of this genus, growing at elevation up to 1800 m asl. In tropical, sub tropical and temprate regions. Its global distribution includes approximately 60 countries or islands groups between 35ºN and 35ºS (Day, Broughton, 2003). Many of the species of lantana are native to South America, Central America and few species species occurs naturally in Tropical Africa and Asia.Dutch explorers introduced it into the Neitherlands from Brazilin late 1600's and later explorers from other countries brought seeds to Europe, Greate Britain, North America. In 18th and 19th century, nurserymen commercialized and popularized its many colourful forms, and now it is cultivated for its flowers over 300 years. Now it has hundreds of cultivators and hybrids and distinguished morphologically, physiologically and genetically.

1. Introduction in India

In 1807 *Lantana* was initially brought in India as an ornamental In plant at the National Botanical Garden (Kohli et al.; 2006). In 19th century *Lantana* is brought in Calcutta as an ornamental hedge plant. In northwest Himalayan regions *L.camara* was introduced during 1905 in

Kathgodam district Nainital (Hakkimudin, 1929; Hiremath and Sundaram, 2005).later on this plant spreads out along roadsides, railway tracks, and open forests all over the country. It has invaded about 13.2 hectare in Indian pasture lands besides forests and fallow lands. Nowadays, *Lantana camara* plant extract and especially the extract from leaves and flowers are regularly tested against MDR bacteria. Somehow this weed could be used as a drug against many pathogens and MDRs.

2. Review

Some of the most clinical significant bacteria involved in drug-resistant infections include *Acinetobacter baumannii, P.aeruginosa, Escherichia coli, Klebsiella pneumonia* resistant to ß-lactamases, along with methicillin-resistant *Staphylococcus aureus* (MRSA), vancomycin-resistant *Staphylococcus aureus (*VRSA) and *Mycobacterium tuberculosis* (Alekshun and Levy 2007). The anti-tubercular activity of this plant against muti-drug resistant tubercle bacilli has been reported from Mexico (Jimenez-ArellanesA et.al. 2003).Taking recourse to plants for new chemicals, from well-known and lesser-known weeds as anti-microbials would be a prudent alternative, not least because the *Streptomyces* source of antibiotics is exhausted but also because a large amount of pure phytochemicals has been serving the health domain holistically. Indeed the many natural phytochemicals in crude extracts encourages the preparation of complementary drugs for targeting MDR pathogens. Dichloromethane leaf extracts registered maximum size of inhibition against MRSA (29mm) and P. *mirabilis* (29mm). Similarly, the methanolic leaf extract registered the maximum size of inhibition against VRE (29mm) the petroleum leaf extract and aqueous leaf extract registered very low antibacterial activity compared with the other solvent extracts. Leaf extracts using methanol or dichloromethane had the best control activity over 3 gram positive and 5 gram negative clinically isolated MDR bacteria in this study (Debasmita Dubey, Rabindra N. Padhy 2013).The methanolic extracts of *L. camara* particularly had better anti-bacterial activities in comparison to two other solvent extracts (acetone and chloroform), as well as other plants used (Udayprakash et al.2011).

Previous studies using extracts from *Lantana* species showed that they were able to inhibit the growth of gram positive strains, however, in this study, the anti-bacterial activity against gram negative bacteria was verified mainly *P. aeruginosa. (*Barreto FS et al. 2010).It is important to note that plant derived pure compounds had the similar effect as the plant extract and thus been promptly substituted in many cases as the important ingredient in medicines (Houghton PJ 2001). Interestingly, researchers and clinicians pay great attention to plant derived secondary metabolites because of their antibiotic activity without conferring any antibiotic resistance. Hence, plant-based antimicrobials have widely been used as preventive and curative solutions against multi-drug resistant pathogens (Ramesh Subramani et al. 2017). Alcoholic extract of *Lantana* leaves exhibited stronger anti-microbial activity in comparison with acetone extract inhibiting the growth of *Staphylococccus aureus* with maximum inhibiting zone of 25.6 as referenced against Gentamycin sulphate (33.00), the anti-microbial activity may be due to the presence of triterpene secondary metabolite in the extract (Ashish Saraf et al. 2011) In *Lantana camara* leaves, distilled water extract showed no inhibitory effect on *Escherichia coli. Lantana camara* is most effective against *Escherichia coli* and *Bacillus subtilis* among solvents used it is most effective in ethanol, methanol and acetone, the order of effectiveness of solvent phase for extraction of effective anti-microbial on the basis of zone of inhibition is, *E.coli*-Ethanol>Methanol>Acetone>Distilled water and for *B.subtilis*-Acetone>Methanol>Ethanol>Distilled water, therefore, present work highlights the use of solvent extracted leaves extracts of *L.camara* containing a highly potential anti-microbial property (Garima Bhardwaj et al. 2015). The methanolic leaf extract of *L.camara* presented the highest antibiotic effect among all parts of plant especially against Gram positive *Bacillus cereus* (zone of inhibition 13.0 ± 0.0mm, MIC/MBC 9.4 ± 4.4mg/ml) and Gram negative *Salmonella typhi* (zone of inhibition 13.5 ± 2.1mm, MIC/MBC 12.5 ± 0.0mg/ml) and in terms of antibacterial activity, leaf extract of *L.camara* is the most potent part of plant followed by flower and root and contrasting with chloramphenicol, the microbial inhibition effectiveness of *L.camara* extracts even for leaf is not robust, therefore, as a general, *L.camara* extracts have the best action against Gram negative *Salmonella typhi*, but leaf extract is more specific toward Gram positive *Bacillus cereus* and efficient growth control of these two bacteria might confirm the folk medicine application of this plant in gastrointestinal diseases (Badakshan Mahdi Pour et al. 2009). It was reported that ethanol extract of leaves of *Lantana camara* were moderately active against *Staphylococcus aureus*, *Pseudomonas aeruginosa* and *Escherichia coli*, however, in this study, the ethanol extract was showing strong anti-bacterial activity against Gram positive bacteria *Bacillus subtilis* NCIM 5433, *Staphylococcus aureus* NCIM 5257, there was no inhibition observed against Gram negative bacteria *Escherichia coli* and *Pseudomonas aeruginosa.* (Kulkarni NN et al. 2019).A plethora of evidence has shown antimicrobial potentials of *Lantana* species and has reported its antibacterial properties against *Escherichia coli, Staphylococcus aureus, S. saprohiticus, Pseudomonas aeruginosa, Salmonella typhimurim (*Barreto et al. 2010, Inbaraj et et al. 2014, Mostafa et al. 2017). With reference to the combinational effect of *Lantana* and antibiotics, the *Lantana* leaves and root extracts in association with aminoglycosides had been investigated and reported to have synergistic antimicrobial effect against *E.coli* and *S.aureus* (Sousa and Costa 2012). This study is the only evidence reported so far, demonstrating the synergistic antimicrobial efficacy of *Lantana* with aminoglycosides. Hence, further research is required to explore the combinational potential of *Lantana* extracts and other therapeutic antimicrobials against antibiotic resistant pathogenic and opportunistic bacterial species. The preliminary analysis of the antibacterial potential of methanolic extract of *Lantana* leaves revealed significantly ineffective antibacterial activity against *Enterobacter fecalis* and *Salmonella typhi*, whereas, the extract has a significantly inhibitory effect against the bacterial culture of *E.coli, S.aureus* and *P.vulgaris.* in comparison to the standard antibiotics, lethanolic extract of LF (*Lantana* Flower) has shown potential antibacterial

efficacy with a significantly ZOI (Zone of Inhibition) (38±1.414) observed against *S.aureus* (P≤0.05), in this study, we observed that the flower extract has also inhibited the growth of *E.fecalis (*25±1.414) and it is noteworthy that the efficacy of *Lantana* flower extracts against *E.fecalis* has not been reported earlier, the combinational discs of LL/CPL (*Lantana* Leaf/Ciprofloxacin), LL/NOR (Norfloxacin), LL/TET (Tetracycline) and LL/NLX (Nalidixic acid) showed a synergistic effect against *S.typhi (*ZOI between 18±0.707 and 28±1.414mm), however, the combinational disc of LL/STR (Streptomycin) had an antagonistic effect against all the test bacterial strains *Enterobacter fecalis, Staphylococcus aureus, Escherichia coli, Proteus vulgaris* and *Salmonella typhi*) and it was noticed that when the combinational disc of LL/NOR and LL/CPL were used against *E.fecalis* and *S.typhi* respectively, there was a significant increase in ZOI recorded between 12.5 and 35% with respect to the individual ZOI of NOR and CPL against *E.fecalis* and *S.typhi*, the combinational disc of LF/STR showed a synergistic antibacterial effect with the maximum zone of inhibition observed against *S.aureus* and *S.typhi* (ZOI of 40±0.707mm and 24±0.539mm, respectively) and an increase of 20% in the ZOI with respect to its individual inhibitory effect (P≤0.05), likewise, LF/NOR combinational disc also showed a synergistic effect against *E.coli* and *P.vulgaris* with Zoi between 34±1.414 and 36mm respectively and it is identified in the present study that the methanolic extract of *L.camara* leaves enhanced the antimicrobial efficacy of STR, NOR, TET, NXL and CPL antibiotics and increased the the ZOI against *S.typhi, E.fecalis, S.aureus, E.coli* and *P.vulgaris* respectively, there was non-significant difference observed in the MIC (Minimum Inhibitory Concentration) of *Lantana* leaves and flower extracts and antibiotics (P≥0.05), the MIC of LL and LF was depicted between 31.25-125µg/ml and 31.25-250µg/ml, with the concentration of 31.25µg/ml showed 100% lethal effect against *P.vulgaris* and *S.aureus* respectively and for antibiotics, the MIC was observed between 62.5µg/ml and 500µg/ml and in present investigation, *Lantana* flower alone and in combination with antibiotics and have depicted that the *L.camara* flower has a significant antibacterial activity with antibacterial concentration (Jigisha Anand et al. 2018).Notably, only leaf ethanolic fraction and essential oil among four extracts of *L.camara* leaves showed antibacterial activity against *B.subtilis, S.aureus, E.coli* and *Salmonella gallinarum*, the MIC of essential oil ranges from 312.5µg/ml-10, 000µg/ml better than leaf ethanolic leaf fraction at 1, 250µg/ml-5, 000µg/ml, the lowest MIC of essential oil was against *B.subtilis* (Gram positive) at 312.5µg/ml and 2, 500µg/ml against *E.coli* (Gram negative) and conversely, it takes an MIC of 1, 250µg/ml and 5, oooµg/ml for leaf ethanolic fraction to inhibit the same organisms, *B.subtilis* is remarkably the most susceptible organism and *S.gallinarum* is least susceptible for both extracts, Gram positive are more sensitive to the extracts than their counterpart (Jo-Ann T. Salada et al. 2015).The antibacterial activity of methanol, ethanol crude extracts and water extracts of leaves of *L.camara* was investigated against two Gram positive (*B.subtilis* and *S.aureus*) and two Gram negative (*P.aeruginosa* and *K.pneumoniae*) bacterial strains, the methanol and ethanol extracts of *L.camara* exhibited the maximum zone of inhibition 21.7mm and 19.7mm against Gram positive strains *S.aureus* and 20mm and 17.7mm zone of inhibition against Gram negative strains *P.aeruginosa* and showed minimum antibacterial activity against *B.subtilis* and *K.pneumoniae*. The results revealed that aqueous leaf extracts of *L.camara* has minimum antibacterial activity against four bacterial strains as compared to methanol and ethanol solvents (Rabia Naz, Asghari Bano. 2013).Antimicrobial activities of the plant extract (aqueous) of *L.camara* showed bactericidal activities against MRSA (Methicillin Resistant *Staphylococcus aureus*) isolates with the oven dried extracts recording the highest effect. Initial MRSA number observed in the stock reduces drastically from 3.1×10^5 CFU/ml (Colony Forming Unit) in a dayzero to <1CFU/ml in day 5 when the *L.camara* extracts were introduced and in general, it was seen that lower concentrations of *L.camara* has greater antibacterial effect than higher concentrations of *L.camara* aqueous extract so in this study, it was seen that MRSA isolates were sensitive to *L.camara* aqueous leaves extract, although, the bactericidal activity of the extract varied between the oven dried extract and that of the air dried extract, it was observed that, in both instances, as the concentrations decreased, the antimicrobial potential of the extracts increased, the difference in the activity of the oven and air dried extract maybe partly attributed to the differences in the amount of phytochemicals (Clement Yaw Effah et al. 2018).The essential oil from *L.camara* shows activity against *B.subtilis* ATCC 6633, *S.aureus* ATCC 6538, *E.coli* ATCC 8739 and *Sarcina lutea* ATCC 9341 at MICs values of 500, 500, 500 and <250µg/ml, respectively. It shows activity against *P.aeruginosa* ATCC 9027 but at high concentration with MIC of 5000µg/ml. In addition, all the values of IZ were lower than the positive control used (tetracycline). The tested oils of *L.camara* showed weak activities against *Agrobacterium tumefaciens* ATCC 1593-2 and *Pectobacterium carotovorum* subsp. *Carotovorum* ATCC 39048 at 1000µg/ml, in addition, the antibacterial activities of the essential oils suggest its usefulness in the treatment of various infectious diseases caused by the tested bacteria (Hosam O. Elansary et al. 2012).Antimicrobial potency of flavonoids (free and bound) and crude alkaloids of *L.camara*was assessed by inhibition zone, activity index, minimum inhibitory concentration and minimum bactericidal/fungicidal concentration and bound flavonoids of flower showed pronounced activity against *E.coli* MTCC 46 (IZ 15.33±0.333mm, AI 0.766±0.017) and *Proteus mirabilis* MTCC 1425 (IZ 15.66±0.882mm, AI 0.652±0.350) with low MIC values (0.156mg/ml and 0.078mg/ml, respectively) and bound flavonoids of root showed good activity against *Candida albicans* MTCC 183 (IZ 31.66±0.882mm, AI 3.16±0.008) with MIC value of 0.078mg/ml, whereas bound flavonoids of root and flower were highly active against *S.aureus* MTCC 87 (IZ 19.33±0.667mm, AI 0.773±0.027 and IZ 17.66±0.333mm, AI 0.706±0.013, respectively) with MIC values of 0.039mg/ml and 0.078mg/ml respectively and in the current investigation, *L.camara* showed its antimicrobial potency against test pathogens, which are being involved in a number of human diseases (B. Sharma and P. Kumar. 2009).The antibacterial activities of various extract of *L.camara* flower against different bacterial strains were studied. Ethyl acetate extract produced zone of inhibition 32mm, 32mm, and 33mm against *Pseudomonas,*

Staphylococcus aureus and *Bacillus subtilis* respectively, which was found to be statically highly significant as compared to positive control (Fcal-124.6, Df-10, SED-1.154, SEM±-0.816, CD at 5%-2.357), ethyl acetate showed zone of inhibition of 34mm and 35mm against *S.typhi* and *E.coli*, the value 35mm was important as compared to positive control whereas, 34mm was found to be satisfactory, the value of zone of inhibition for ethanol extract was found 34mm, 30mm and 34mm against *S.typhi*, *Pseudomonas* and *S.aureus* respectively and the zone of inhibition against *S.aureus* was found cogent as compared to positive control (14mm) and expressive against *S.typhi* and *Pseudomonas* (Fcal-685, Df-10, SED-0.516, SEM±-0.365, CD at 5%-1.054), ethanol extract showed zone of inhibition of 25mm and 30mm against *B.subtilis* and *E.coli*. The value 25mm was found satisfactory as compared to petroleum ether and aqueous extract. Petroleum ether showed zone of inhibition 10mm against *E.coli*. However, against rest bacterial species it gives no zone of inhibition. No zone of inhibition was obtained by aqueous extract against all bacterial species. Various extracts showed different zone of inhibition against different bacteria. Findings obtained from present work showed that ethyl acetate extract gives maximum zone of inhibition against *E.coli* and least against *Pseudomonas* and *S.aureus*. The ethanol extract gives maximum zone of inhibition against *S.typhi* and *S.aureus* and least against *B.subtilis* (Sushma Jhariya and Arun Kakkar 2016).The antibacterial sensitivity of various solvent extracts of *L.camara* shows significant reduction in bacterial growth in terms of zone of inhibition around the disc. The present study showed that acetone extract was the most potent solvent with maximum zone of inhibition against *E.coli* (13, 12mm), *Salmonella typhimurium* (19, 18mm) and *Staphylococcus aureus* (18, 17mm) than other solvents. The result showed that all parts of the studied plant exhibited effective response against Gram negative poultry pathogen *E.coli*. Significant antibacterial activity was observed in ethyl acetate extract of stem part and methanol extract of stem part (15mm), which was followed by acetone extract of stem part and diethyl ether of flower part (13mm), which was followed by acetone extract of root part (12mm). Negative inhibitory zone was observed in acetone extract of leaf part and ethyl acetate extract of leaf part. The antibacterial sensitivity of various solvent extracts of *Lantana* camara (root, stem, leaf, flower and fruit) against *Salmonella sp*. were tested. The result showed that all the selected parts of experimental plant showed activity against Gram negative poultry pathogen *Salmonella sp.*The highest antibacterial activity was observed in chloroform extract of stem part (20mm) followed by methanol extract of root part (19mm) and acetone extract of root part (18mm). The antibacterial activity of various solvent extracts of *Lantana camara* (root, stem, leaf, flower and fruit) against *S.aureus* was also tested. The result showed that all the parts of the plant exhibited activity against Gram positive poultry pathogen *S.aureus*. The maximum antibacterial efficacy waa observed in the chloroform extract stem part and ethyl acetate extract of root part (20mm) followed by chloroform extract of leaf part, methanol extract of flower part and acetone extract of stem part (18mm), moderate activity was observed in methanol extract of fruit part and acetone extract of fruit part (17mm). the antimicrobial effect of root and stem parts of *Lantana camara* were highly comparable with standard antibiotics (gentamicin and tetracycline) against test strains (Jepa Chandra Mohan and SubalakshmiT. 2017). The antibacterial activity of the two different leaf extracts, that is, chloroform and methanol of *Lantana camara* were tested. Chloroform extract showed good antibacterial showed good antibacterial activity as compared with that of standard drug ciprofloxacin. Phytochemical studies revealed the presence of alkaloids in chloroform and methanol extracts. The analgesic activity study revealed that chloroform and methanolic leaf extracts showed good activity compared with that of standard drug aspirin. It may be presumed that the presence of alkaloids may be contributing the analgesic activity of chloroform and methanolic extracts of *Lantana camara* olant (L. Kalyani, A. Lakshmana Rao and U. S. Mishra. 2011).The structures of the isolated triterpenoids from the plant *L.camara* were determined on the basis of their IR, MS, ^{1}H-NMR, 2D-NMR (COSY) and ^{13}C-NMR spectral data, the CH_2CL_2:MeOH extract of *L.camara* was tested for antibacterial activity on a developed TLC plate and it showed an inhibited growth of some Gram positive (*Bacillus cereus, Micrococcus luteus, Staphylococcus aureus, Streptococcus faecalis*) and Gram negative (*Escherichia coli, Pseudomonas aeruginosa, Proteus mirabilis*) bacteria and after partitioning the extract between hexane and MeOH:H_2O (6:4), only the aqueous fraction showed antibacterial activity and column chromatography of the aqueous fraction of the CH_2CL_2:MeOH extract of *L.camara* on Silica gel followed by reversed phase HPLC showed four antibacterial compounds in which lantic acid possessed the strongest antibacterial activity, a bioautographic assay of lantic acid with chloramphenicol as a positive control showed that it possessed about one tenth the activity of chloramphenicol when tested against *E.coli* and *B.cereus* in which 0.08 and 0.1µg were the least amount bacterial growth inhibition, respectively, compared to 0.05 and 0.005µg of chloramphenicol respectively, these result indicate that lantic acid has broad spectrum antibacterial activity and it may hold promise as a non-selective antimicrobial agent and it seems that the carboxylic group at C-17 is essential for the antibacterial activity, especially since it is in the γ-position of a π-cloud of the C-12/C-13 double bond and this explains the strong activity of lantic acid compared to lantinilic, camrinic and camaric acid, whose C-17 contains an ester group rather than a carboxylic group (Mohamoud Saleh et al. 2008), the antibacterial activities of the MLE (Methanolic Leaf Extract), ALE (Aqueous Leaf Extract) and MBE (Methanolic Berry Extract) of *L.camara* at concentration of 25mg/ml revealed that MLE comparable to the control (streptomycin) as they both showed inhibitory activities against thirteen (92.86%) out of the fourteen bacterial isolates with IZD (Inhibition Zone Diameter) from 10mm-20mm and 11mm-24mm respectively, the tested bacterial strains are, Gram positive (*Cornynebacterium pyogenes* LIO, *Bacillus cereus* NCIB6349, *Bacillus stearothermophilus* NCIB8222, *Micrococcus luteus* LIO, *Bacillus anthracis* LIO, *Clostridium sporogenes* NCIB532, *Bacillus polymyxa* LIO, Methicillin Resistant *Staphylococcus aureus* LIO, *Bacillus subtilis* NCIB3610) and Gram negative (*Escherichia coli* NCIB86, *Klebsiella pneumoniae* NCIB418, *Proteus vulgaris* LIO, *Pseudomonas fluorescence* NCIB3756, *Pseudomonas aeruginosa* NCIB950), the ALE was active against only three (21.43%)

while the MBE was active against six (42.86%) bacterial isolates with IZD ranging from 10mm-11mm and 11mm-17mm respectively and the antibacterial results suggested that methanol could be a preferable agent for extraction of active ingredients of plant parts such as leaves, berry, stem and roots. *P.vulgaris* exhibited the lowest IZD (10mm) while the MRSA exhibited the highest IZD (20mm) to the MLE, the most resistant bacterial isolate to MBE was *Klebsiella pneumoniae* (11mm) while the most sensitive was *Micrococcus luteus* (17mm), *B.cereus* and *P.fluorescence* were sensitive to all the plant extracts while *P.aeruginosa* was resistant to all the plant extracts, statistical analysis is revealed that methanolic leaf extract of *L.camara* compared favourably with streptomycin in inhibiting the growth of *B.anthracis* (P=0.09), MRSA (P=0.53), *B.subtilis* (P=0.11) and *P.fluorescence* (P=0.09). This study showed that *L.camara Linn* contains phytochemical compounds with antibacterial activities against the sensitive studied bacteria and moreover, the methanolic leaf extract of *L.camara* is active against MRSA, pathogenic bacteria that is versatile in developing resistance to different classes of antibiotics as well as capable of causing severe nosocomial and community-acquired infections (A. A. Ajiboye et al. 2013).MICs of the ethanolic (leaf and root) extracts of *L.camara* and synergic effect combined with antibiotics were tested. The antibacterial properties of the extracts were observed for the inhibitory activity against *E.coli* Ec 27 and *S.aureus* Sa 358 multiresistant strains. The data showed that both bacterial strains presented greater sensitivity to leaves extract with MIC (256µg ml^{-1} against *E.coli*) and (512µg ml^{-1} against *S.aureus*), while MICs of the antibiotics (Neomycin, Amikacin, Kanamycin, Gentamicin, LE, RE) were in range of 40-625µg ml^{-1}. The MICs for all antibiotics used here decreased in presence of extracts. The most expressive effect was obtained for the activity of gentamicin but root extract or amikacin on *E.coli* with MIC reduction (312 to 5µg ml^{-1}). The root extract showed weak antibacterial activity, but presented synergetic effect for all antibiotics in association. In general, the extracts interference (synergism) on antibiotic action was correlated to the antibiotic type and bacterial strain, the controlled DMSO showed a MIC≥1024µg ml^{-1} and no modyfying antibiotic activity (Oliveira de Sousa et al. 2015).The methanolic leaf extract of *L.camara* showed an MIC value of 20µg/ml for H37Rv and 15µg/ml of medium for TMC-331 and the wild strain 28-25271, compared to rifampicin which showed MIC values of 1.0µg/ml of medium for H37Rv and the wild strain, but was ineffective against the rifampicin resistant TMC-331 strain of MTB (*Mycobacterium tuberculosis*). Rifampicin showed complete inhibition of growth for H37Rv and the wild strain at 1.5µg/ml of medium but was unable to inhibit TMC-331 even at a concentration of 3.0µg/ml of medium, this showed a clear contrast with the methanol extract of *L.camara* which was active against all the strains of MTB used and the methanol leaf extract of *L.camara* has the best activity among the three extracts investigated against three strains of *Mycobacterium tuberculosis*, H37Rv, TMC-331 and wild strain (28-25271) (Claude Kirimuhuzya et al. 2009).

3. Conclusion

It could be concluded from the above review that the weed plant *Lantana camara L.* which is widely spread across the whole globe has the potential to be used as an antibiotic drug against many bacterial pathogens and especially against muti-drug resistant bacteria which poses a great threat in today's health of the people. This part of the plant which possess a capability is the leaf part of this plant which could be observed from the review and then the flower and the root part. The ethanol and methanol leaf extract has been seen quite the most effective as compared to other solvents. *Lantana camara L.* has great effect on Gram positive bacteria as compared to Gram negative bacteria. This weed plant which is the causes many diseases in humans could actually be used in favour of the humans if used wisely and hence in the favour of the environment also as this weed is not only harmful for humans but other living organisms and our environment also.

Although there is still a lot of work yet to be done related to this weed plant against the Multi Drug Resistant Bacteria.

4. Declarations

Ethics approval and consent to participate: Not Applicable

Consent for publication: Not Applicable

Availability of data and materials: Not Applicable

Competing Interests: There is no competing interests declared

Funding: Not Applicable

Author's contributions
JC collected and analysed all the data related to the effect of *Lantana camara* on the growth of MDR bacteria for this review paper and PS analysed the general features of *Lantana camara.* All authors read and approved the final manuscript.

5. Acknowledgements

The authors wish to thank the Management and Staff of DNA Labs, Dehradun, Uttarakhand, India for helping in this study.

References

[1] A.A. Ajiboye, O.O.Oyedara, D.A.Agboola and O.T.Familola. Evaluation of Antibacterial Effects and Phytochemical Analysis of *Lantana camara L.* Leaf and Berry Extracts. European Journal of Medicinal Plants. 2013.
[2] Ahmed R, Uddin BM, Khan AS, Mukul AS, Hossain KM (2007). Allelopathic effects of Lantana camara on germination and growth behavior of some agricultural crops in Bangladesh. J.Forestry Res. 18 (4):301-304.

[3] Alekshun and Levy, Lee et al., Ojha et al., Weigel et al. Molecular Mechanisms of antibacterial Multidrug Resistance. Cell. 2008.
[4] Ashish Saraf, Sadaf Quereshi, Kavita Sharma, Noor Afshan Khan, Anti Microbial Activity of *Lantana camara L.* Journal Experimental Sciences. 2011.
[5] B.Sharma and P.Kumar. Bioefficacy of *Lantana camara L.* Against some Human Pathogens. Indian Journal of Pharmaceutical Sciences. 2009.
[6] Badakhshan Mahdi Pour, Sasidharan Srinivasan, Rameshwar Naidu Jegathambigai, Ramanathan Suresh. A Comparative Study:Antimicrobial Activity of Methanol Extracts of *Lantana camara* various parts. Pharmacognosy Research. 2009.
[7] Barreto FS, Sousa EO, Campos AR, Costa JGM, Rodrigues FFG. Antibacterial Activity of *Lantana camara* and *Lantana montevidensis* Brig Extracts from Cariri-Ceará, Brazil. In pharm Association, A Young Pharmacist's Group of India, JYP. 2010.
[8] Batianoff GN, Butler DW (2003). Impact assessment and analysis of sixty-six priority invasive weeds in southeast Queensland. Pl. Prot. Quart 18: 11-17.
[9] Claude Kirimuhuzya, Paul Waako, Moses Joloba, Olwa Odyek. The Antibacterial Activity of *Lantana camara* a plant Traditionally Used to Treat Symptoms of tuberculosis in South-Western Uganda. African Healyh Sciences. 2009.
[10] Clement Yaw Effah, Anthony Annan-Prah, Nicholas T.K.D., Dayie and Akorli Senyo Yao. Nutrition, Phytochemical Properties and Antibacterial Potential of *Lantana camara* against Methicillin Resistant *Staphylococcus aureus* (MRSA). Journal of Animal and Veterinary Advances. 2018.
[11] Day MD, Broughton S, Hannan-Jones MA (2003) Current distribution and status of Lantana camara and its biological control agents in Australia, with recommendations for further biocontrol introductions into other countries. BioControl 24: 63N–76N.
[12] Day, M.D. *Lantana:* Current Management Status and Future Prospects. Australian Centre for International Agricultural Research. 2003.
[13] Debasmita Dubey, Rabindra N. Padhy. Antibacterial Activity of *Lantana camara L.* against Multidrug Resistant Pathogens from ICU Patients of a Teaching Hospital. Journal of Herbal Medicine. 2013. DOI : 10.1016/j.hermed.2012.12.002.
[14] Experimental Study on the Antibacterial Activity of Medicinal Plant *Lantana camara* on Fish Pathogen, *Providencia vermicola.*
[15] Garima Bhardwaj, Shaili Yadav, Jyoti Srivastava. Antibacterial Activity in Different Extracts of *Lantana camara* against Enteropathogens. Innovare Journal of Sciences. 2015.
[16] Gujral GS, Vasudevan P (1983) Lantana camara L., a problem weed. Journal of Scientific and Industrial Research 42: 281–286.
[17] Hiremath A.J. & B. Sundaram. 2005. The fire-Lantana cycle hypothesis in Indian forests. Conservation and Society 3: 26-42.
[18] Hosam O. Elansary, Mohames Z.M. Salem, Nader A. Ashmawy and Mohamed M. Yacout. Chemical composition, Antibacterial and Antioxidant Activities of Leaves Essential Oils from *Syzygium cumini L.*, *Cupressus sempervirens L.* and *Lantana camara L.* from Egypt. Journal of Agricultural Science. 2012.
[19] Houghton PJ. Old yet new- pharmaceuticals from Plants. J Chem Educ. 2001.
[20] Jepa Chandra Mohan and Subalakshmi T. Screening of Antibacterial Activity of *L.camara* Against Selected Poultry Pathogens. World Journal of Pharmacy and Pharmaceutical Sciences. 2017.
[21] Jigisha Anand, Shanu Choudhary, Nishant Rai. *Lantana camara* Enhances Antibacterial Potency of Antibotics and Exerts Synergistic Inhibitory Effect Against Pathogenic Bacterial Species. Oriental Phaemacy and Experimental Medicine. 2018.
[22] Jimenez-Arellanes A, Meckes M, Ramirez R, Torres J, Luna-Herrera J. Activity against Mutidrug Resistant *Mycobarterium tuberculosis* in Mexican plants used to treat Respiratory Diseases. Phytotherapy Research. 2003.
[23] Jo-Ann T. Salada, Lotis M. Balala, Erlinda A. Vasquez. Phytochemical and Antibacterial Studies of *Lantana camara* leaf Fraction and Essential Oil. International Journal of Scientific and Research Publications. 2015.
[24] Kimothi, M. M., D. Anitha, H.B. Vasistha, P. Soni & S.K. Chandola. 2010. Remote sensing to map the invasive weed, Lantana camara in forests. Tropical Ecology 51: 67-74..
[25] Kohli, R.K., D.R. Batish, H.P. Singh & K.S. Dogra. 2006. Status, invasiveness and environmental threats of three tropical American invasive weeds (Parthenium hysterophorus L., Ageratum conyzoides L., Lantana camara L.) in India. Biological Invasion 8: 1501–1510..
[26] Kohli, Ravinder K. Status, Invasiveness and Environmental Threats of three tropical American invasive weeds (*Parthenium hysterophorus L.*, *Ageratum conyzoides L.*, *Lantana camara L.*) in India. Biological Invasions. 2006.
[27] Kulkarni NN, Jagtap AB, Wadkar SS, Shete CC and Ghosh JS. Antimicrobial Properties of Ethanolic Leaf Extract of *L.camara L.* and its Effect on the Powdery Mildew of *Coccinia grandis L.* Journal of Natural and Ayurvedic Medicine. 2009.
[28] L.Kalyani, A.Lakshmana Rao and U.S.Mishra. antibacterial and Analgesic Activity of Leaves of *Lantana camara*. International Journal of Phytomedicine. 2011.
[29] Mohamoud Saleh, Alaa Kamel, Xiaoyang Li and James Swaray. Antibacterial Triterpenoids Isolated from *Lantana camara.* Pharmaceutical Biology. 2008.
[30] Oliveira de Sousa, Erlânio, Fernandez Galvão Rodrigues, Fabíola, Rolim Campas, Adriana, Martins sa Costa, José Galberto. Phytochemical Analysis and Modulation in Aminoglycosides Antibiotics Activity by *Lantana camara L.* Acta Scientiarum. Biological Sciences. 2015.
[31] Rabia Naz and Asghari Bano. Phytochemical Screening, Antioxidants and Antimicobial Potential of *Lantana camara* in Different Solvents. Asian Pacific Journal of Tropical Disease. 2013.
[32] Ramesh Subramani, Marhivanan Narayanasamy, Klaus-D. Feussner. Plant Derived Microbials to Fight Against Multidrug Resistant Human Pathogens. 2017.

[33] Rosacia, W. Z.; et al. (2004). "Lantana and Hagonoy: Poisonous weeds prominent in rangeland and grassland areas" (PDF). Research Information Series on Ecosystems. 16 (2). Retrieved July 27, 2011.
[34] Sharma GP, Raghubanshi AS (2006). Tree population structure, regeneration and expected future composition at different levels of Lantana camara L. invasion in the Vindhyan tropical dry deciduous forest of India. Lyonia 11: 25-37.
[35] Sharma GP, Raghubanshi AS, Singh JS (2005b). Lantana invasion: an overview. Weed Biological Management 5: 157-167.
[36] Sharma GP, Singh JS, Raghubanshi AS (2005a). Plant invasions: emerging trends and future implications. Current. Science 88: 726-734.
[37] Sharma, Gyan P., Akhilesh S. Raghubanshi and Jamuna S. Signh. 2005. *Lantana* invasion: An overview. Weed Biology and Management.
[38] Singh RM, Tiwari B, Sharma DK, Singh SP (2012). Comparative study of chemical composition of Lantana Camara leaf, flower & fruit essential oil. Int. J. Pharmaceutical and chemical Sci. 1 (3): 546550.
[39] Sousa EO and Costa JGM. Genus *Lantana*:Chemical Aspects and Biological Activities. Braz J Pharmacogn. 2012.
[40] Sushma Jhariya and Arun Kakkar. Evaluation of Antibacterial Activity of Successive Extract of *Lantana camara* flower. Journal of Pharmacy Research. 2016.
[41] Udayprakash NK, Bhuvaneswari S, Arvind R, Kaviyarasan V, Kalaivanan K, Hariram SB. A comparative Study on Antibacterial Activity of Common Weeds. International Journal Of Pharma and Biosciences. 2011.
[42] Yi Z, Zhang M, Ling B, Xu D, Ye J (2005). Inhibitory effects of Lantana camara and its contained phenolic compounds in Eichhornia crassipes growth. J. App. Ecol. 17: 1637-1640.