Anti-Microbial Properties Of Two Varieties Of *Musa acuminata* Fruit: An *In-vitro* Study

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Abstract -

Background: *Musa acuminata* is found to contain flavonoids, tannins, phlobatannins, alkaloids, glycosides, and terpenoids in their peels. Numerous biological and pharmacological effects (antibacterial, antihypertensive, antidiabetic, and anti-inflammatory activities) of these phytochemicals have been reported. Therefore, the presence of these bioactive substances in banana peels implies that the peels have valuable medicinal potential that has not yet been investigated since the majority of a plant's medicinal qualities are attributed to its bioactive compounds.

Materials and methods: Banana peel antimicrobial efficacy was assessed via agar well diffusion on Mueller Hinton agar plates. Bacterial and fungal suspensions were spread on plates, and wells received varied banana peel extract concentrations (25 µg, 50 µg, 100 µg). Incubation at 37°C for 24- 48 hours allowed measurement of inhibition zones, determining antimicrobial activity.

Results: According to the findings, rasthali banana peel had stronger overall antimicrobial activity against *Lactobacillus acidophilus* than red banana banana peel did against *Enterococcus faecalis*. Both types of peels combined have the same antimicrobial properties as the red banana variant. But, both of them showed a very good anti fungal property against *Candida albicans.*

Conclusion: From this study, Banana peels could be employed as an antimicrobial component in tooth paste and other dental care products. As the concentration of the properties increased, there was a rising trend in them. Extracts from the peels of red banana and rasthali, either separately or together, may prove to be a viable, efficient, and economical replacement or supplement to the antimicrobial drugs that are currently on the market.

Keywords (MeSH): Antimicrobials, Antimicrobial activity, Banana, *Musa accuminata*, *Musas*, banana peel

Introduction -

Many medicinal plants are being investigated for possible antimicrobial activity due to the growing resistance of pathogenic microbial infectious agents to antibiotics and the failure of chemotherapy treatments. Their long history of developing resistance to microbiological agents has resulted in different approaches to drug development. Plant extracts are becoming more and more important because of their enormous potential as sources of inhibitors against viruses and bacteria. Plant parts such as bulbs, gel, leaves, roots, barks, peels, etc. are utilized for this purpose [1]. Throughout human history, various plant families and their individual parts have been utilized to treat threats. [2]

Bananas and plantains are members of the *Musa* genus, which belongs to the *Zingiberales* family of plants. There are about 70 species of *Musa*, each with a wide range of applications. The common was *Musa sapientum* [3], or banana, according to science. There are many different types of banana peels, and they are a natural source of phytochemicals and antioxidants that can fight off dangerous free radicals. Unripe banana plantain pulp contains a variety of secondary metabolites, including tannins,

alkaloids, phenols, and flavonoids like quercetin and leucocyanidin. These substances give banana pulp and peels strong antimicrobial peptide activity and antioxidant qualities. Through the activation of enzymes like superoxide dismutase (SOD) and catalase, the flavonoids found in bananas are especially effective at reducing harmful hydroperoxides and conjugated dienes [4]. Banana peels also contain sterols such as stigmasterol, sitosterol, and campesterol, as well as non-phenolic antioxidants like ascorbic acid, beta-carotene, and cyanidin.

There are many composition of banana skin like enzymes such as polyphenoloxidase, pectin as gelling agent and that the banana peel extract is used alone or combined with a cream or ointment, medicinal benefits of the extract include relief of pain, swelling and itching [5]. Additionally, Flavonoids, tannins, phlobatannins, alkaloids, glycosides and terpenoids were found to be present in the peels of genus Musa. These phytochemicals have been reported to exert multiple biological and pharmacological effects (antibacterial, antihypertensive, antidiabetic and anti-inflammatory activities). The presence of these bioactive substances in banana peels therefore suggests that the peels possess valuable medicinal potential yet to be explored. As the bioactive compounds contained in plants are majorly responsible for their medicinal properties [6].

Additionally, vitamins A, C, gallocatechin, dopamine, E, B6, sitosterol, malic acid, succinic acid, palmatic acid, magnesium, phosphorus, potassium, fiber, and iron are present in banana peels. The antimicrobial activity of banana peels is attributed to their fatty acid content. Because of the numerous studies conducted on the different parts of the banana plant that demonstrated an inhibitory effect against food-borne pathogens, the banana plant should be taken into consideration as a possible natural source of both antioxidant agent [7] and antimicrobial agent. This study is set out to evaluate the fresh banana peels' aqueous extracts' antimicrobial potential against various microbial isolates.

Materials and methods -

The present study does not require ethical clearance by the Institutional Human Ethical Committee as it is an invitro study. The in-vitro investigations were conducted in the Gold Lab, Saveetha Dental College and Hospitals, Chennai, India. The red banana and rasthali fruits were procured from a local fruit and vegetable market in Chennai, India.

Preparation of extract:

Before the peel was prepared for aqueous and alcoholic extracts, the unripe banana fruit of Musa acuminata (Red banana and Rasthali) was separated, cleaned, and dried. After being maintained for 48 hours at 40 degrees centigrade in a hot air oven, the peels were ground into powder. Five grams of dried peel powder from unripe red bananas and rasthali were dissolved in 25 ml of distilled water to create the aqueous extract. A similar process was used to create the alcoholic extract. Alcoholic extract was produced by heating ethanol, an organic solvent, to a temperature of 100 degrees Celsius for 30 minutes. The two extracts were then combined to produce aqueous alcoholic extract. Cotton plugs were inserted on top of the conical flasks holding the extract to stop evaporation. In an orbital shaker, the extract was shaken for 24 hours at 250 rpm. They were filtered twice once with muslin cloths and once with filter paper after being shaken all night. The resultant extracts were stored at 4°C. The preparation of the extract is depicted in **Figure 1**.

Anti-microbial activity:

The agar well diffusion technique was used to assess the antimicrobial activity of the banana peel extract. Mueller Hinton agar plates were prepared and autoclaved for 15–20 minutes at 121°C to sterilize them. The medium was poured onto sterile Petri plates after they had been sterilized, and it was then left to cool to room temperature. Using sterile cotton swabs, the bacterial suspension (*Streptococcus mutans, Lactobacillus sp., Staphyloccus aureus, and Candida albicans*) was evenly distributed onto the agar plates. In the agar plates, wells measuring 9 mm in diameter were made using a sterile polystyrene tip. Next, varying concentrations of CuO NPs (25 µg, 50 µg, and 100 µg) were added to the wells. As a standard, an antibiotic (such as Fungi-Flucanazole or Bacteria- Amoxyrite) was employed. For twenty-four hours, the plates were incubated at 37°C and 48 hours for fungal cultures. By measuring the diameter of the inhibition zone surrounding the wells, the antimicrobial activity was assessed. A ruler was used to measure the zone of inhibition's diameter in millimeters (mm), and the zone of inhibition's value was computed.

Results -

The experimental results for red banana reveal distinct responses among different organisms to varying concentrations. *Streptococcus mutans* exhibited a concentration-dependent increase in growth, with 25ug/ml showing 9 colonies, 50ug/ml with 11, and 100ug/ml with 13, while the standard concentration reached 18 colonies. *Lactobacillus* demonstrated a more pronounced response, with colony counts of 9, 16, and 17 at 25ug/ml, 50ug/ml, and 100ug/ml, respectively, escalating significantly compared to the standard concentration of 40 colonies. *Enterococcus faecalis* maintained a relatively constant colony count of 9 at all concentrations, contrasting with *Candida albicans*, which displayed an increase from 13 colonies at 25ug/ml to 16 at 100ug/ml, with the standard concentration at 9 colonies as shown in **table 1** and **figure 2&3**. These findings underscore the varying sensitivities of different organisms to the tested concentrations, providing valuable insights into their respective growth patterns.the highest antimicrobial activity of the substance is observed against *Lactobacillus*. At the standard concentration of 40 colonies, *Lactobacillus* exhibited significantly fewer colonies compared to the other organisms, indicating a stronger antimicrobial effect against this microorganism. Also, the red banana shows the highest antimicrobial activity against *Candida albicans*. At the standard concentration, *Candida albicans* exhibited the lowest colony count of 9, indicating a more potent antimicrobial effect against this organism.

The experimental outcomes for rasthali banana showcase distinctive responses across various organisms to different concentrations of the tested substance. *Streptococcus mutans* exhibited a concentration-dependent trend, with colony counts of 10, 11, and 13 at 25ug/ml, 50ug/ml, and 100ug/ml, respectively, while the standard concentration yielded 9 colonies. *Lactobacillus* displayed a notable increase in growth, with 10, 12, and 13 colonies at 25ug/ml, 50ug/ml, and 100ug/ml, in contrast to a higher standard concentration of 38 colonies. *Enterococcus faecalis* demonstrated a similar pattern with 9, 12, and 14 colonies at the respective concentrations, while the standard concentration reached 40 colonies. *Candida albicans* exhibited growth with 10, 12, and 13 colonies at the varying concentrations, with a standard concentration of 10 colonies as shown in **table 2** and **Figure 4&5**. Considering the antimicrobial activity, the rasthali peel extract appears most effective against *Lactobacillus*, as evidenced by the significantly lower colony counts in comparison to the other organisms at the standard concentration of 38 colonies.

The results of 1:1 ratio of red banana and rasthali reveal distinct responses among various organisms to different concentrations of the tested substance. *Streptococcus mutans* exhibited a concentration-dependent trend, with colony counts of 9, 12, and 14 at 25ug/ml, 50ug/ml, and 100ug/ml, respectively.

Lactobacillus displayed moderate growth inhibition, with 9, 10, and 11 colonies at the corresponding concentrations, while a higher standard concentration resulted in 36 colonies. *Enterococcus faecalis* demonstrated sensitivity to the substance, displaying 9, 13, and 14 colonies at 25ug/ml, 50ug/ml, and 100ug/ml, with the standard concentration yielding 44 colonies. *Candida albicans*, on the other hand, exhibited increased growth at higher concentrations, with 11, 13, and 15 colonies, while the standard concentration resulted in 9 colonies. These findings offer insights into the varying antimicrobial effects on different organisms under the specified conditions. In this dataset, the highest antimicrobial activity is observed against *Candida albicans*. At the standard concentration, *Candida albicans* displayed the lowest colony count of 9, indicating a substantial inhibition of growth and suggesting a potent antimicrobial effect against this particular organism compared to the other tested concentrations as shown in **table 3** and **Figure 6&7.** However, there was no statistically significant difference ($p>0.05$) between the tested extracts and standard in all the concentrations.

Discussion -

With the goal of using herbal plants as potential alternatives to synthetic drugs, to which many infectious microorganisms have developed resistance, several studies have been conducted to assess the phytochemical compositions and antimicrobial activities of various parts of diverse plants [8]. Effect of plant constituents can combat human and plant pathogenic bacteria, fungi, and viruses without toxic side effects and environmental hazards [9].

Several studies have confirmed the inhibitory effect of aqueous banana extracts on Gram-positive bacteria, as demonstrated in our investigation. Ighodaro [10] proved that *M. paradisiaca*, a type of *Musa acuminata*, had an antibacterial effect in its aqueous extract. More so than antifungals, *Escherichia coli* (against *Proteus mirabilis* and *Staphylococcus aureus*) [12]. Due to its high nutritional content, this fruit is highly consumed. Its shell has been researched for the treatment of gastrointestinal disorders (diarrhoea, gastritis, and gastric ulcers) [13] and is frequently used to treat wounds, particularly those resulting from breastfeeding-related nipple fissures that are primarily caused by *Staphylococcus aureus* [14]. Banana peel gel was also shown by Lino et al. (2013) to suppress the growth of pyogenic and *enterobacteria* [15]. According to Aldean et al., "aqueous extraction of banana skin exhibited a variable degree of antibacterial activity against the streptococcus species and other Gram positive and negative bacterial isolates causing gingivitis." [16].

Sumathy et al discovered that yellow banana fruit peel has antifungal and antibacterial qualities, making it effective against a variety of Gram positive and negative bacteria. Furthermore, it can have a significant impact on therapeutic interventions [17]. Therefore, further research on the application of plant extracts as medicinal agents, particularly that which deals with the management of antibiotic-resistant microorganisms, can be conducted in the future.

The study explored the antimicrobial potential of aqueous extracts from fresh banana peels, specifically red banana and rasthali, against various microbial isolates. The results revealed distinct responses among different organisms to varying concentrations of the extracts. Notably, *Streptococcus mutans*, *Lactobacillus*, *Enterococcus faecalis*, and *Candida albicans* exhibited concentration-dependent trends, indicating varying sensitivities to the tested

substances. In the case of red banana, *Lactobacillus* showed the highest sensitivity, displaying significantly fewer colonies at the standard concentration compared to other organisms. Similarly, red banana demonstrated the highest antimicrobial activity against *Candida albicans*, as evidenced by the lower colony count at the standard concentration. These findings underscore the potential of red banana peel extracts in inhibiting the growth of specific microbial strains, particularly *Lactobacillus* and *Candida albicans.* On the other hand, rasthali banana extract displayed distinct responses across organisms, with Lactobacillus being the most affected at the standard concentration. The 1:1 ratio of red banana and rasthali extracts showed varied antimicrobial effects on different organisms, with

Candida albicans exhibiting the highest sensitivity, displaying the lowest colony count at the standard concentration.

Despite these observations, it's crucial to note that there was no statistically significant difference between the tested extracts and the standard in all concentrations. This suggests that while the extracts demonstrated antimicrobial activity, the effectiveness did not surpass the standard concentration. This finding prompts further investigation and optimization of extraction methods or consideration of additional factors that might enhance the antimicrobial properties of banana peel extracts. Moreover, the presence of various bioactive compounds in banana peels, such as flavonoids, tannins, alkaloids, and vitamins, highlights the potential medicinal benefits of these extracts. The study contributes valuable insights into the diverse antimicrobial activities of red banana and rasthali peel extracts, laying the foundation for future research to explore their applications in pharmaceuticals or natural remedies.

Conclusion -

In conclusion, the global rise in antibiotic resistance has spurred increased interest in exploring alternative therapeutic options derived from natural sources. The study focused on the antimicrobial potential of aqueous extracts from fresh banana peels, specifically red banana and rasthali, against various microbial isolates. The investigation revealed promising results, showcasing distinct responses among different organisms to varying concentrations of the extracts. Numerous studies, as cited, have highlighted the antimicrobial properties of banana peels, attributing their effectiveness to phytochemical compositions such as flavonoids, tannins, and alkaloids. These constituents have demonstrated inhibitory effects on a range of microorganisms, including Gram-positive and Gram-negative bacteria, fungi, and viruses. The potential of banana peels, particularly red banana, in inhibiting the growth of specific microbial strains like Lactobacillus and Candida albicans is noteworthy.

Despite the observed antimicrobial activity in the experimental results, it is essential to acknowledge that there was no statistically significant difference between the tested extracts and the standard in all concentrations. This suggests that further refinement and optimization of extraction methods may be necessary to enhance the efficacy of banana peel extracts. Additionally, the exploration of other factors that could augment the antimicrobial properties of these extracts is a potential avenue for future research.

The presence of diverse bioactive compounds in banana peels, along with their documented nutritional content, underscores the medicinal potential of these extracts. The findings contribute

valuable insights into the broader application of red banana and rasthali peel extracts in pharmaceuticals or as natural remedies. As the world faces increasing challenges in combating antibiotic-resistant microorganisms, continued research in this direction holds promise for the development of alternative, sustainable, and effective therapeutic interventions. Overall, the study lays a foundation for future investigations and applications of banana peel extracts in addressing the pressing global issue of antimicrobial resistance.

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Figure 1:

Preparation of banana peel extract

Organisms	25ug/ml	50ug/ml	100ug/ml	Standard	P value
S.mutans	9	11	13	18	0.32
Lactobacillus	9	16	17	40	0.32
E.faecalis	9	9	9	34	0.32
C.albicans	13	15	16	9	0.32

Table 1: values for zone of inhibition of red banana

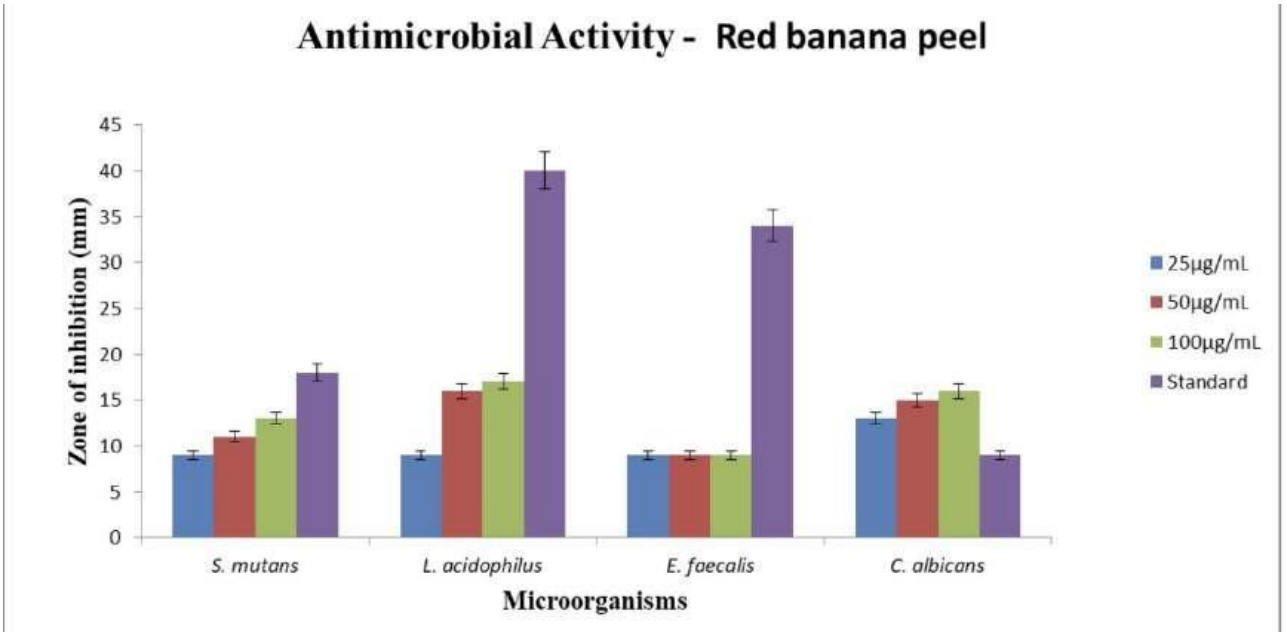

Figure 2: Anti-microbial activity graph of red banana

Figure 3: Anti-microbial culture plates of red banana

Organisms	25 ug / ml	50ug/ m l	100ug/ ml	Standar d	P value
S.mutans	10	11	13	9	0.32
Lactobacillus	10	12	13	38	0.32
E.faecalis	9	12	14	40	0.32
C.albicans	10	12	13	10	0.32

Table 2: values for zone of inhibition of rasthali banana

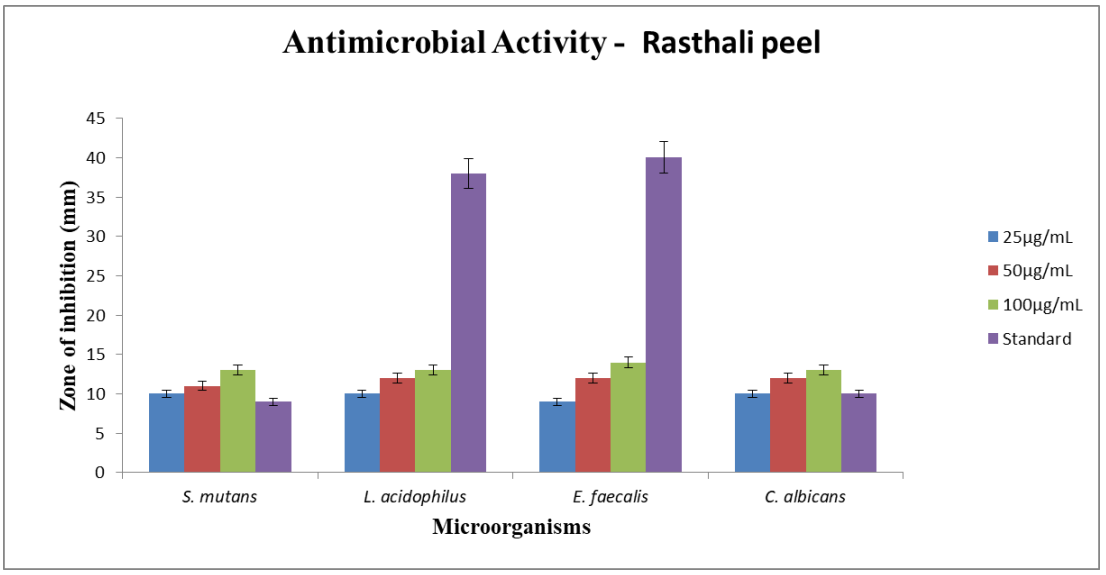

Figure 4: Anti-microbial activity graph of rasthali banana

Figure 5: Anti-microbial culture plates of rasthali banana

Organisms	25 ug/ml	50 ug/ml	100ug/ml	Standard	P value
S.mutans	9	12	14	9	0.32
Lactobacillus	9	10	11	36	0.32
E.faecalis	9	13	14	44	0.32
C.albicans	11	13	15	9	0.32

Table 3: values for zone of inhibition of 1:1 ratio of red and rasthali banana

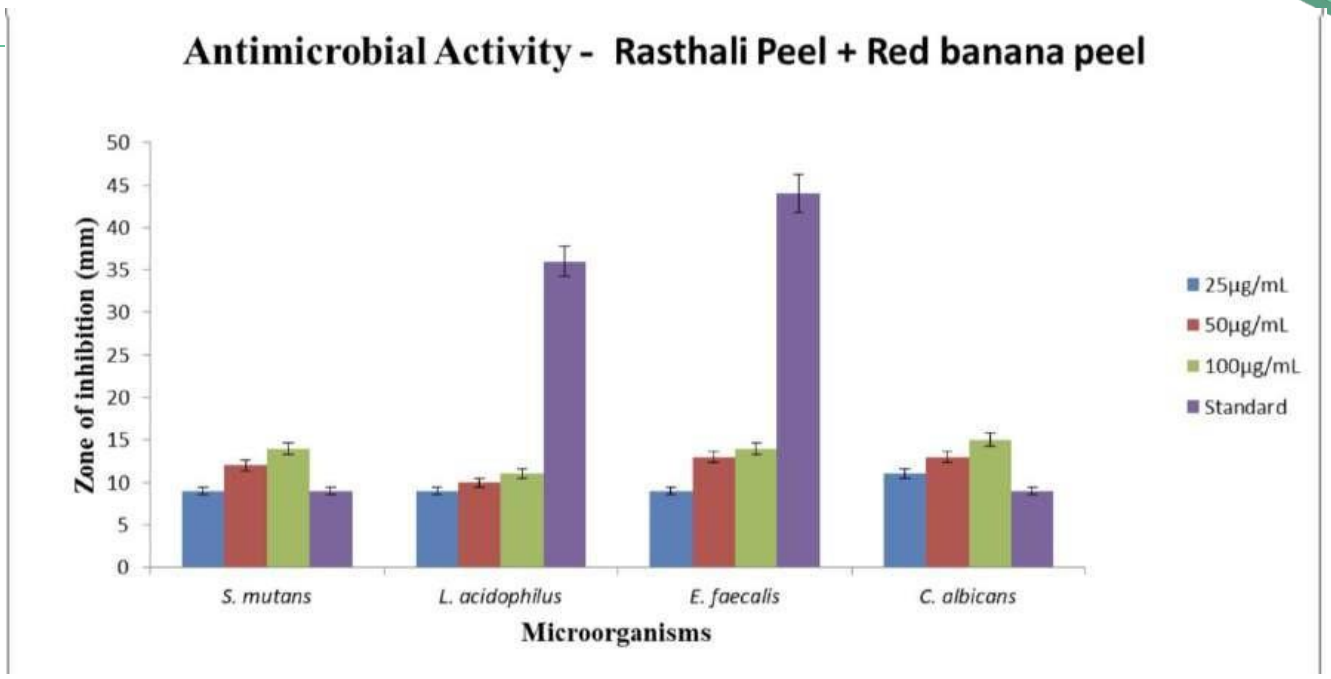

Figure 6: Anti-microbial activity graph of 1:1 ratio of red and rasthali banana

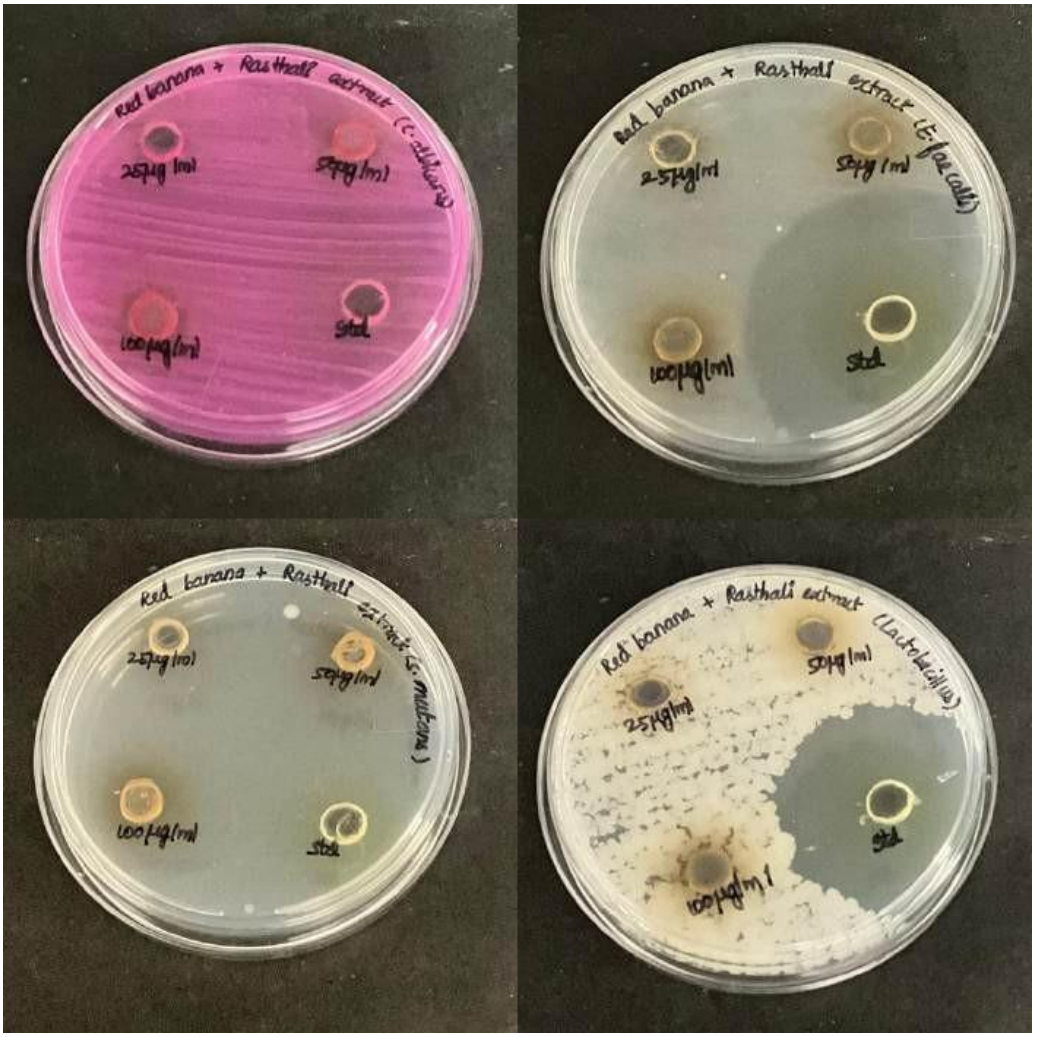

Figure 7: Anti-microbial culture plates of 1:1 ratio of red and rasthali banana