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Exploring the Antibacterial Potential of Traditional Medicinal Flowers- A Phytochemical and Microbiological Approach

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Abstract

Many pathogenic microorganisms contribute to major human illnesses, such as infectious diseases, which are one of the most important concerns for humans. Due to treatment with antibiotics having drug resistance problems, in recent years, the use of new herbal and alternative medicines with fewer side effects is being considered for these types of infections. The objective of this study was to investigate the antibacterial activity of Rose (*Rosa damascena*), Marigold (*Calendula officinalis*), Tuberose (*Polianthes tuberosa*), Orchid (*Dendrobium orchid*), Blue pea (*Clitoria ternatea*) and Chrysanthemum (*Chrysanthemum indica*) extracts against test organisms- *Staphylococcus aureus, Bacillus* sp., *Pseudomonas* sp., *Klebsiella* sp., *Vibrio* sp. Six flower samples were collected in pre-sterilized zip-lock bags and transported to the Centre of Excellence Laboratory, Primeasia University at the earliest convenience. Antibacterial effects of aqueous, ethanol and acetone extracts of six flower samples were experimented on above mentioned reference strains post-extraction. Antimicrobial effects were investigated using well diffusion, as well as MIC and MBC. Phytochemical analyses of flower petals were conducted. The results showed that the ethanol extract of flowers inhibited the growth of organisms in comparison to ethanol, acetone and aqueous extract. Flower petals also showed the presence of various phytochemicals. This study justified that the flower petals, which are used only for ornamental purposes, also have antibacterial activity and used for the treatment of various diseases.

Keywords: Antimicrobial activity; Flower extracts; Phytochemicals; Medicinal plants; Natural antibiotics; Antibiotic resistance

Introduction

Bacterial infections remain a major contributor to global morbidity and mortality. Although numerous antimicrobial agents have been developed and are in clinical use, the accelerated emergence and dissemination of antibiotic-resistant bacterial strains represent a critical challenge to public health systems worldwide. Current epidemiological models estimate that, by the year 2050, antimicrobial resistance (AMR) could be responsible for up to 10 million deaths annually, underscoring the urgent need for novel therapeutic strategies and effective antimicrobial stewardship (Amini et al., 2022). Over the past two centuries, advancements in chemistry and molecular biology have elucidated the critical functions of primary plant metabolites in essential physiological and biochemical processes, including mitosis, cellular growth, respiration, metabolic energy storage, and reproductive development (Bourgaud et al., 2001). Secondary metabolites are integral to plant adaptation and ecological fitness, mediating interactions with the surrounding environment. Compounds such as pigments and volatile aromatic molecules contribute to the visual and olfactory traits of reproductive organs and fruits, thereby facilitating pollinator attraction and promoting zoochorous seed dispersal. Among these metabolites, essential oils are of particular significance due to their wide range of applications in human health and industry. Composed

predominantly of monoterpenes and sesquiterpenes, essential oils are complex blends of hydrocarbon and oxygenated isoprenoid derivatives synthesized via the mevalonate and methylerythritol phosphate (MEP) pathways. Their biosynthesis and secretion occur in specialized epidermal structures known as glandular trichomes, which are commonly localized in floral and foliar tissues (Sharifi-Rad et al., 2017). Natural products, including those derived from medicinal plants, are well-established reservoirs of bioactive compounds exhibiting diverse pharmacological and biological activities (Danton et al., 2019).

The antimicrobial potential of flower-derived compounds is highly dependent on a range of factors with post-harvest processing parameters playing a pivotal role. Variations in extraction and preparation methodologies can significantly modulate the phytochemical composition and consequently, the biological efficacy of the final extract due to degradation, transformation or changing of bioactive constituents (Horablaga et al., 2023; Sharma et al., 2017; Tunç et al., 2019). Traditional medicinal practices have utilized various plant organs- including leaves, roots, bark, and latex-in the formulation of treatments for a broad spectrum of diseases. Documented therapeutic applications include the management of gastrointestinal disorders (e.g., Diarrhea, Dysentery), dermatological conditions, respiratory tract infections, scorpion envenomation, rheumatic inflammation, hepatic dysfunction (e.g., jaundice), vector-borne infections such as malaria, and metabolic diseases including diabetes (Amini et al., 2022). Many flowers contain essential oils, flavonoids, and phenolic compounds with strong antimicrobial effects such as, *Matricaria chamomilla* (chamomile) is known for its antibacterial and antifungal properties; *Echinacea* is widely used for its immune-enhancing and antimicrobial effects; and *Calendula officinalis* (calendula) is recognized for its antibacterial and anti-inflammatory actions.

Flavonoids contribute significantly to the antimicrobial efficacy of flowers. Their mechanisms of action include disrupting microbial cell membranes, inhibiting essential enzymes, interfering with nucleic acid synthesis, scavenging reactive oxygen species (ROS), triggering apoptosis, and disrupting quorum sensing pathways that regulate microbial virulence and biofilm formation. Due to these diverse bioactivities, flower extracts hold great promise for applications in pharmaceuticals, cosmetics, skincare, and food preservation (Górniak et al., 2019; Sharma et al., 2017; Zhou et al., 2023). Their natural antimicrobial and anti-inflammatory properties offer a sustainable alternative to synthetic agents. Continued research and innovation are essential to fully harness these resources for practical applications. Initial screening of plant extracts is a critical step in identifying antibacterial potential and guiding further investigation into bioactive components (Sharma et al., 2017; Tunç et al., 2019). In this context, the present study aimed to evaluate the antibacterial activity of ethanolic and acetonic extracts from six different flowers against selected microbial test strains.

Methodology

Sample collection and processing

In this study, six flower samples were rose (*Rosa damascena*), marigold (*Calendula officinalis*), tuberose (*Polianthes tuberosa*), orchid (*Dendrobium orchid*), blue pea (*Clitoria ternatea*) and Chrysanthemum (*Chrysanthemum indica*) were used, and all samples were collected three times during February 2025 to May 2025 from local market of Agargaon, Dhaka. The samples were then transported to the Microbiology Laboratory of Primeasia University, Bangladesh. Then the sample petals were separated and were washed under running tap water and sterilized with 15% NaCl for 15min with gentle agitation then rinsed with sterile distilled water to remove dust particles and microbes. After cleaning, the petals were dried in a tray on hot air oven at 50-60°C for 2-3 days. Dried flower petals were ground finely in a sterilized laboratory grinder and collected on sterilized zipper bag (Banik et al., 2018; Munir et al., 2025).

Moisture content

A hot air oven set to 105°C was used to dry 100g of fresh plant until its weight remained constant. The following formula was used to determine the moisture content (given as a percentage) of the plants that were gathered:

$$\text{Moisture content} = [(Mi - Mf / Mi) \times 100]$$

where "Mi" represents the sample's original weight and "Mf" represents its final weight following drying. For every sample, three replications were carried out. Three replicates were used to get the mean value, which was then reported as a percentage (Fliou et al., 2023).

Phytochemical Screening

The phytocompounds as alkaloids, Flavonoids, Saponins, Steroids, Tannins, Terpenoids, Glycosides, Phenols etc. were analyzed according to acetone and ethanol extracts of six selective flower samples by following a previous study (Buddhika et al., 2021; Fliou et al., 2023; Patil et al., 2015).

Extract preparation

Each dried selected flower petals samples of 10g were soaked using 90% ethanol, acetone and water respectively, in sterilized Duran glass bottle and shaken at 120 rpm in a shaker incubator (WIS-10, wisecube, Germany) at 37°C for 48h. Each fraction was separated by sterilized cheesecloth, then filtered through sterilized Whatman filter paper (No.01) and allowed to evaporate at 50-60°C in hot air oven (ED53, Binder, Germany) to reduce the volume of those filtrates. After the evaporated extract was weighed, and dissolved in ethanol, acetone and water respectively, to a concentration of 100 mg/ml, and then stored at separately and kept at 4°C for successive studies (Mutiara et al., 2025).

$$\textbf{Extract yield } (\%) = \frac{\textbf{Weigh of crude extract}}{\textbf{Samples dry weigh}} \textbf{x } \textbf{100}$$

Test microorganisms

Five microorganisms were used for this work and all strains were isolated from different works in the Microbiology Department, Primeasia University, Dhaka, Bangladesh. Microbes were *Staphylococcus aureus, Bacillus* sp., *Pseudomonas* sp., *Klebsiella* sp., *Vibrio* sp.

Antimicrobial agents, media and chemical

The antibiotic was used Chloramphenicol (C-30µg) which purchased from local laboratory market (Dhaka, Bangladesh). Nutrient Broth (NB) and Nutrient Agar (NA), Normal saline water, Mueller Hinton Broth (MHB), Mueller Hinton Agar (MHA) were used in our study.

Antimicrobial susceptibility assessment

In this study, the agar diffusion method was used for evaluation of the antibacterial activity of aqueous, ethanol and acetone extract of different flowers. In this method, freeze stored nutrient broth cultures of bacterial strains were grown on nutrient agar plates and incubated overnight at 37˚C. One plate of each microorganism was taken and the colony was transferred into normal saline (0.89%) under aseptic conditions. The density of each microbial suspension was adjusted to be equal to 0.5 McFarland units (approximately 10^6 CFU/ml for bacteria) to use it as the inoculum for the agar well diffusion assay. Selective bacterial strains were spread inoculated with a sterile cotton swab on the surface of sterile MHA plates to achieve confluent growth. Following inoculation, agar well of 8 mm in diameter, 4 mm in depth and about 2cm apart were punched in the MHA plate with a sterile cork borer. Fifty microliters (50 µl) of the inoculum of each test organisms were poured into the labeled wells and kept aside for 3h before incubation at 37˚C for 24h. The diameter of the inhibition zone (mm) was measured, and the activity index was also calculated. Triplicates were maintained and the experiment was repeated thrice, for each replicates the readings were taken in three different fixed directions, and the average values were recorded. By using the disc diffusion method, the antibacterial activity of commercial drug was determined. Aseptically placed the antibiotic disc over the MHA plate after inoculation. following incubation, the results were recorded by evaluating the diameter of the zone of inhibition (ZOI) in mm. The extracts were active, moderately active and highly active depending on their ability of clear zone parameter, respectively. Each experiment was performed in triplicate and the mean values of the diameter of inhibition zone ± standard deviations were also calculated (Chowdhury et al., 2019).

Determination of MIC and MBC

Minimum inhibitory concentration (MIC) represents the lowest concentration of antimicrobial compound that can inhibit the visible growth of a microorganism after incubation overnight. The MIC values of extracts were determined based on a micro-broth dilution method by using 96 well microtiter plate. The aqueous, ethanol and acetone extract at a concentration of 102.4µl/ml was prepared in MHB and mixed well. Following mixing, 50µl of this extract concentration was transferred to another well containing 50µl MHB and this dilution continued to give extract concentrations of 102.4, 51.2, 25.6, 12.8, 6.4, 3.2, 1.6, 0.8, 0.4 and 0.2µl/ml. Finally, 50µl of microbial suspension was added to each well and the contents were thoroughly mixed. One well of fresh extract and one well with tested bacteria was used as negative and positive control, respectively. Each plate was wrapped with a plastic cover lid to ensure that bacteria did not become dehydrated.

The plates were prepared in triplicate and placed in an incubator at 37˚C for 24h. The Minimum Bactericidal Concentration (MBC) is the lowest concentration of antimicrobial agent that will kill any organism. In this study, the lowest concentration value of extracts that represented the absence of microbial growth on NA plates was recorded as the MBC (Avijit et al., 2020).

Statistical analysis

Experimental assays for each spice were conducted in triplicate to ensure reproducibility. The data were subjected to statistical evaluation using one-way analysis of variance (ANOVA), with mean values and standard deviations reported. Statistical significance was established at a confidence level of $P < 0.05$.

Results

Determination of percentage moisture content and extraction yield

In this study, the moisture content of fresh flowers was recorded highest in Merigold 14.80% and lowest in blue pea 4.40%, respectively. The percentage of extraction (yield%) ethanolic and Acetone solvents extract (yield%) of Rose, Tuberose, Marigold, Blue pea, Orchid and Chrysanthemum flowers was determined. Ethanol extract recorded the highest percentage extracted blue pea yield (0.90%) and Acetone extract blue pea yield (0.80%) and lowest ethanol percentage extract orchid yield (0.48%) and acetone percentage extract orchid (0.42%). The result indicated that the extraction efficiency favors the highly polar solvents.

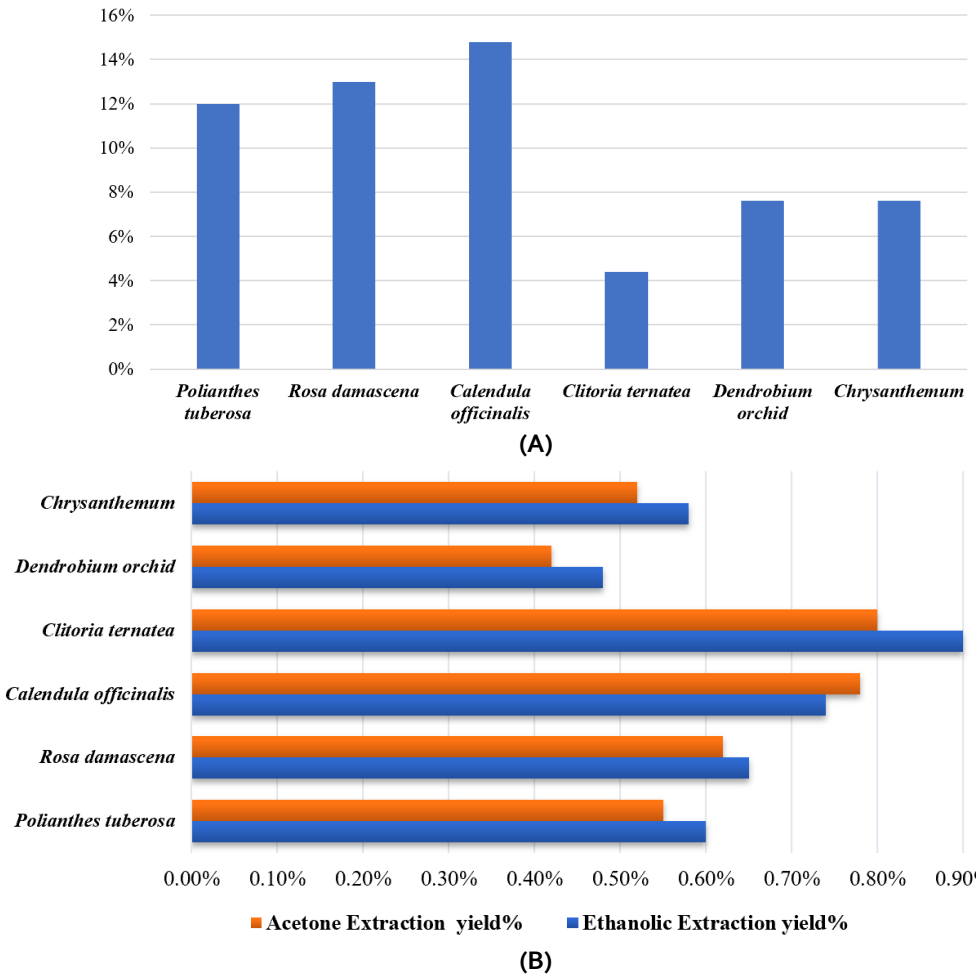


Fig. 1. Determination of (A) Moisture content and (B) yield percentage of different samples

Comparative evaluation of phytochemical properties of flower sample's petals

In this study showed the presence and absence of steroids, diterpenes, phlobatannins, tannin, cardial glycosides, flavonoid, coumarin, phenols, leucoanthocyanim, phytosterol, saponin and alkaloids were screened for six selective flower petals of ethanol and acetone extracts showed the presence and absence of certain phytochemical classes (Table 1 & 2). Blue pea showed more active in steroids, flavonoid and coumarin in ethanol extract against acetone extract. Marigold and Orchid showed fewer phytochemical activities comparative other four flowers in acetone and ethanol extraction. Tannin, leucoanthocyanin and alkaloids activities present in all flower extract in acetone

and ethanol extraction. Only phenols active present in blue pea flower in respective extraction items.

Antibacterial activity of flower petals extraction

In the current study, the antibacterial activity of each of the six flower extracts in aqueous, ethanol and acetone solvent were examined. The mean diameters of the inhibition zone in millimeter of all tested flower extracts against five (2 Gram-positive, 3 Gram-negative) microbes were associated. Each tested spices of ethanol and acetone solvent for the antibacterial activity showed significant variation ($p < 0.05$). Following preparation of flower extracts, 100µl of extracts were tested for their antibacterial activity using agar well diffusion method by the diameter of zone of inhibition. All the flowers of ethanol and acetone extraction degrees of ZOI against tested organisms. Unfortunately, in the selective flower acetone extract samples had no results against *Bacillus* spp. and merely tuberose showed lowest (9.23mm) ZOI against *Bacillus* spp. In ethanol extraction solvent. On the other hand, Aqueous extraction did not show any antibacterial activities in our study. So other were no interpretation according to aqueous study after no zone of inhibition against selective organisms.

Table 1. Ethanol extracted phytochemicals results of the test samples

Ethanol-extracted phytochemical	Rose	Marigold	Tuberose	Orchid	Chrysanthemum	Blue pea
Steroids	+	-	+	-	+	++
Diterpenes: copper acetate test	+	-	-	-	+	+
Phlobatannins	-	-	-	-	-	+
Tannin by $FeCl_3$ test	+	+	+	+	+	+
Cardial glycoside	-	-	+	+	-	+
Flavonoid: Alkaline reagent test	+	-	-	+	-	++
Coumarin	+	-	-	+	-	+
Phenols: $FeCl_3$ test	-	-	-	-	-	++
Leucoanthocyanin	+	+	+	-	+	+
Phytosterol: Salkowski's test	-	+	+	-	+	+
Saponin: Foam test	+	-	-	-	+	+
Alkaloids: Wagner's reagent	+	+	+	+	+	+

Table 2. Acetone extracted phytochemicals results of the test samples

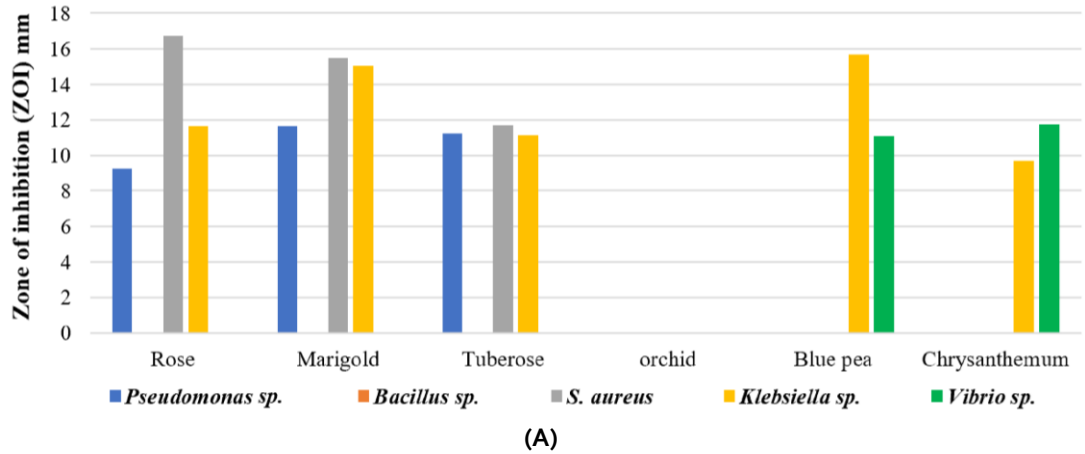
Acetone-extracted phytochemical	Rose	Marigold	Tuberose	Orchid	Chrysanthemum	Blue pea
Steroids	+	-	+	-	+	++
Diterpenes: copper acetate test	+	-	-	-	+	+
Phlobatannins	-	-	-	-	-	+
Tannin by $FeCl_3$ test	+	+	+	+	+	+
Cardial glycoside	-	-	+	+	-	+
Flavonoid: Alkaline reagent test	+	-	-	+	-	++
Coumarin	+	-	-	+	-	+
Phenols: $FeCl_3$ test	-	-	-	-	-	++
Leucoanthocyanin	+	+	+	-	+	+
Phytosterol: Salkowski's test	-	+	+	-	+	+
Saponin: Foam test	+	-	-	-	+	+
Alkaloids: Wagner's reagent	+	+	+	+	+	+

Table 3. MIC of ethanol and acetone extracts of flowers petals against five selected bacterial pathogens

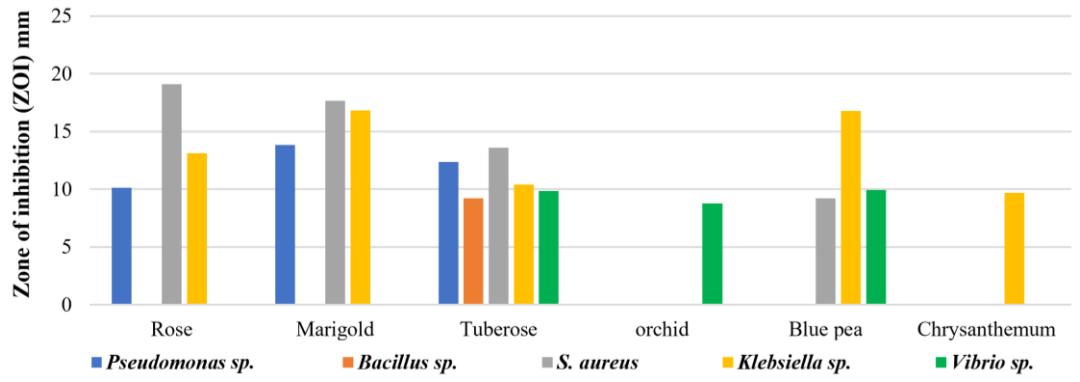
	Ethanol (MIC) mg/mL						Acetone (MIC) mg/mL					
	Rose	Marigold	Tuberose	Orchid	Blue pea	Chrysanthemum	Rose	Marigold	Tuberose	orchid	Blue pea	Chrysanthemum
Microorganisms	MIC	MIC	MIC	MIC	MIC	MIC	MIC	MIC	MIC	MIC	MIC	MIC
Pseudomonas sp.	512	256	256	0	0	0	1024	512	512	0	0	0
Bacillus sp.	0	0	1024	0	1024	0	0	0	1024	0	0	0
S. aureus	68	128	512	0	0	0	128	0	1024	0	0	0
Klebsiella sp.	512	124	512	0	64	1024	512	512	512	0	0	0
Vibrio sp.	0	0	1024	1024	1024	0	0	0	0	0	1024	1024

Ethanolic extraction of marigold and tuberose showed the highest ZOI of the most organisms from other flower extractions. Rose showed highest ZOI against *S. aureus* with a diameter of 19.1mm. Marigold showed ZOI against *Pseudomonas sp.*, *Bacillus sp.*, *S. aureus* with a diameter of 13.83mm,17.66mm, 16.82mm respectively. Tuberose showed ZOI against *Pseudomonas* sp., *Bacillus* sp., *S. aureus, Klebsiella sp.*, *Vibrio* sp. With a diameter of 12.35mm, 9.23mm,13.6mm, 10.39mm, 9.83mm respectively. Also, blue pea showed ZOI against *S. aureus, Klebsiella* sp., *Vibrio*

sp. With a diameter of 9.23mm, 16.77mm, 9.93mm respectively. Acetonic extraction of rose and blue pea showed highest ZOI against *S. aureus* and *Klebsiella* sp. With a diameter of 16.75mm, and 15.67mm. Tuberose showed ZOI against *Pseudomonas* sp., *S. aureus*, *Klebsiella* sp. With a diameter of 11.23mm, 11.7mm, and 11.13mm respectively. Marigold showed ZOI against *Pseudomonas* sp., *S. aureus* and *Klebsiella* sp. With a diameter of 11.65mm,15.5mm and 11.07mm respectively. Also rose showed ZOI against *Klebsiella* sp. With a diameter of 11.6mm. In the acetone extract, orchid extract not working as no ZOI in against in any select microorganisms (Fig. 2).



(A)



(B)

Fig. 2. Antimicrobial Activity of Flower – (A) Acetone extraction, (B) Ethanol extraction

Ethanolic extraction of marigold exhibited 13.83mm ZOI against *Pseudomonas* sp. Which is highly comparable to the commercial antibiotic Chloramphenicol 30µg because the antibiotic showed 9.53mm ZOI against *Pseudomonas* sp. (Fig. 3).

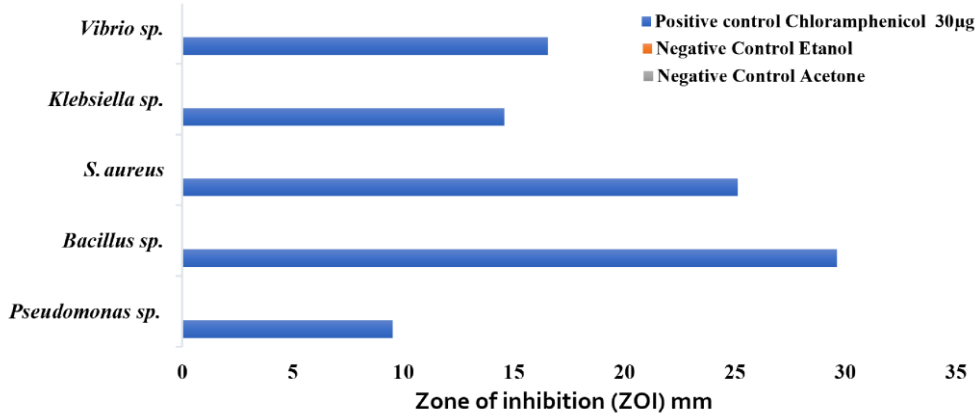


Fig. 3. Standard of the positive and negative control of the experiments

Acetonic extraction of blue pea exhibited 15.7mm ZOI against *Klebsiella* sp. Which is highly comparable to the commercial antibiotic Chloramphenicol 30µg because the antibiotic showed 14mm ZOI against *Klebsiella* sp. Marigold and tuberose exhibited 11.65mm and 11.23mm ZOI against *Pseudomonas* sp. Which is highly comparable to the commercial antibiotic Chloramphenicol 30µg because the antibiotic showed 9.53mm ZOI against *Pseudomonas* sp. Respectively (Fig. 3). In

this study, acetonic extraction of marigold showed higher ZOI against *Klebsiella* sp. and *Pseudomonas* sp. Than the findings of a previous study (Chandurkar et al., 2015).

The MIC of flower extracts against all tested microorganisms are shown in Table 3. All the flower extracts showed concentration dependent growth inhibition of the tested microbes. In the ethanol extraction, Rose and Blue pea showed the most effective flower with the MIC value at 6.4 µg/µl against *S. aureus* and *Klebsiella* sp. respectively. Against the *Vibrio* sp., Ethanol and acetone extract of flower samples present the highest range of MIC 102.4µg/µl. As similarly ethanol result, Rose and Blue pea showed the most effective MIC value in acetone extraction 12.8 µg/µl against similar microorganisms. In the acetone extraction, orchids had no activities for selective organisms, in that case orchids had no MIC activates.

Discussion

The main underlying cause of infectious diseases globally is pathogenic bacteria due to their capacity for resistance. Nowadays, the most crucial need is to find natural substances that may either kill or stop the growth of microorganisms and that, when consumed, shouldn't have any harmful effects on the human body. Numerous kinds of studies have been carried out to satisfy the need for the discovery of natural chemical compounds. Which plant extract may be helpful for medical issues is determined by the traditional use of plants as remedies. Many plant and spices extracts have been utilized as antibacterial agents in the past, including tea extract, clove extract, and rose extract, which may help treat a variety of ailments. Research is necessary to determine whether natural plants with antibacterial properties can be used to treat a wide range of infections.

The experiment findings demonstrate strong concordance with previous study, revealing the extraction methodology plays a role in determining both the yield and quality of plant-derived extracts. In our study we found the blue pea had 4.4% moisture and 0.90% ethanol and 0.80% yields that were most similar result showed in previous study against butterfly pea (0.08% yields) in aerobic fermentation (Safdar and Malik, 2020).

The present study represents the antibacterial activity of the six flower Patels extract by ethanol and acetone. In the study found rose, marigold and blue pea have some phytochemical activates as long as antibacterial activates that was showed mostly against *S. aureus*, *Pseudomonas* sp., *Klebsiella* sp. In those flowers contains a few parts, for example, terpenes, glycosides, flavonoids, and anthocyanins that affect the health of humans. The effects of R. damascene on pharmacology are extensive. Most of the effects on the central nervous system are anticonvulsant, pain-relieving, and sleep-inducing. The effects of this plant include antibacterial, purgative, antidiabetic, cardiovascular, respiratory, anti-HIV, relaxing, and cancer prevention. It is suggested that the great majority of the stated effects are primarily caused by the lipid-soluble (non-polar) components of this plant (Kumar and More, 2019). The saponin, alkaloids, glycosides, phytosterols, and carbohydrates have been reported as phytochemical constituents in butterfly pea flowers (Panche et al., 2016). Since flavonoids have a number of health-promoting benefits and coloring agents, they may impair the permeability of the gram-positive bacteria's cell wall, microsomes, and lysosomes (Cahyaningrum and AAA, 2023) . The antibacterial chemicals found in marigold flower extract—flavonoids, phenolics, carotenoids, and triterpenoids- are what provide the extract its capacity to stop the growth of S. aureus bacteria (Moliner et al., 2018).

In previous study found that marigold plants contain flavonoid compounds of the quercetin and phenolic groups, which act as antibacterial (Mutiara et al., 2025). In previously, study showed that rose extract showed antibacterial activities against *S. aureus* (35mm), *Pseudomonas* sp. (23mm) and *Klebsiella* sp. (20mm) but our study we found *S. aureus* (19.1mm), *Pseudomonas* sp. (10.11mm) and *Klebsiella* sp. (13.11mm) (Safdar and Malik, 2020). Some study showed, marigold flower has antimicrobial activities against *S. aureus* (18.4mm) in ethanol and other study showed in acetone extract ZOI against *S. aureus* (15mm), *Klebsiella* sp. (14mm) and *Pseudomonas* sp. (10mm). Precisely in our study we found most similar result in ethanol and acetone in according to previous result. Ethanol showed against *S. aureus* (17.66mm) and acetone found S. *aureus* (15.7 mm), *Klebsiella* sp. (11.66 mm) and *Pseudomonas* sp. (11.65mm) (Cahyaningrum and AAA, 2023; Chandurkar et al., 2015). In the case of blue pea, our result compared to previous study that we discover that blue pea activities have more in our result from previous study. In 50µl of extract, we found 9.23mm against *S. aureus* that similar organism presents 7.90mm in the same concentration (Satria et al., 2022). To compare the activity of flower extract with an antibiotic, we selected Chloramphenicol to compare the antibacterial activity. Chloramphenicol is a novel antibiotic because it mostly uses in gram positive and gram-negative bacteria. In our study we found our natural products properly work

against some positive and negative bacteria which was better than chloramphenicol such *pseudomonas* sp., *Klebsiella* sp. and closer to *S. aureus.* Undoubtedly, natural medicine could be demanding as it is harmless and has low-cost production. The traditional medicine and medicinal plant could be considered as an alternative medicine to using drugs or chemicals to treat illnesses during ancient times. Research on phytomedicine should be recognized and established due to today's health issues (Jamil and Pa'ee, 2018). Over many centuries, knowledge on the medicinal properties of plants has been acquired. The local population has a wealth of traditional knowledge about using various plants or plant components to heal common illnesses. Medicinal herbs offer primary healthcare that is both easily available and culturally appropriate. These plant-based medicines frequently have little adverse effects.

Conclusion

Using natural sources with antibacterial properties instead of artificial preservatives is becoming more and more popular. Flavonoids, through disruption of cell membranes, enzyme suppression, and nucleic acid interference, have significant antibacterial effects. Their antioxidant properties and quorum sensing make them potential natural antibiotic substitutes. Further research could lead to novel applications in agriculture and medicine. The study suggests that medicinal flowers can be used as natural antimicrobial agents, especially in the face of antibiotic resistance. The strong activity of ethanol extracts aligns with modern pharmacological methods, suggesting their suitability for drug development. The selective efficacy of acetone and aqueous extracts provides insights into solvent choice's role in extracting specific applications. However, the exact mechanisms underlying the antimicrobial activity of individual phytochemicals remain unclear. Future research should focus on isolating and characterizing compounds, evaluating synergistic effects, and testing extracts against multidrug-resistant bacterial strains. The study supports the use of medicinal flowers as a sustainable and effective alternative to synthetic drugs in combating antibiotic-resistant pathogens. There are few challenges in research in this area which are ensuring consistent extraction methods and concentrations for reliable results and navigating the regulatory landscape for the use of natural products in medicinal applications. Thus, more studies are needed to explore the full range of antimicrobial effects and mechanisms of action.

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