



## Antibacterial properties of turmeric (*Curcuma longa* L.) against gram-positive and negative bacteria

Mohammed I Alghonaim\*

Department of Biology, College of Science, Imam Mohammad Ibn Saud Islamic University (IMSIU), Riyadh, Saudi Arabia

### Abstract

The aim of this study was to examine the antibacterial activity of turmeric, turmeric plus olive oil and turmeric plus Vaseline against Gram-positive and negative Bacteria. Turmeric, olive oil and Vaseline were purchased from the local market in Riyadh Saudi Arabia. The antibacterial activity of turmeric, turmeric plus olive oil and turmeric plus Vaseline were determined by the agar diffusion method. The tube dilution method was done to determine the minimum inhibitory concentration of the turmeric. The results of the antibacterial activity of turmeric, turmeric plus olive oil and turmeric plus Vaseline against *Staphylococcus aureus*. Both inhibited the growth of *Staphylococcus aureus*. Turmeric plus olive oil showed the highest [30mm] whereas turmeric was [10mm] antibacterial activity. When inhibited the growth of *E.coli*. turmeric plus olive oil showed the highest [18mm] whereas turmeric was [6mm] antibacterial activity. The minimum inhibitory concentration [MIC] of turmeric against microorganisms. The MIC of turmeric ranged from [0.8-1.6 mg/ml]. The lower MIC is an indication of the high effectiveness of turmeric. The blend could generate a new concept for overcoming antibiotic resistance.

**Keywords:** antibacterial properties, turmeric, gram-positive, gram-negative

### Introduction

Curcumin, the main bioactive component of turmeric (*Curcuma longa* L.), has been shown to be a powerful antioxidant, anti-inflammatory, antibacterial, antifungal, and antiviral agent. Curcumin, on the other hand, was effective against certain species and strains, including *Streptococcus pyogenes* (median MIC = 31.25 g/mL), methicillin-sensitive *S. aureus* (250 g/mL), *Acinetobacter lwoffii* (250 g/mL), and individual strains of *Enterococcus faecalis* and *Pseudomonas aeruginosa* [1]. Curcumin has antibacterial properties against standard bacterial strains at high concentrations, according to a study. Animal studies have shown that high doses of curcumin have potent antibacterial activity. More *in vivo* research is needed to shed light on the antibacterial effects of curcumin at high concentrations [2, 3]. Curcumin has been discovered to be effective against *Staphylococcus aureus* (*S. aureus*). Curcumin exerts even stronger antibacterial effects when combined with other antibacterial agents, as demonstrated by *in vitro* experiments. As a result, curcumin, a natural product derived from plants, is thought to have profound medicinal benefits and could be developed into a naturally derived antibiotic in the future.

However, there are a number of significant challenges in the development of curcumin as a medicine. *S. aureus* infections, particularly those caused by multidrug-resistant strains, have emerged as a global health issue that requires immediate attention [4]. Curcumin (CCM), a natural polyphenolic flavonoid isolated from the rhizome of the plant *Curcuma longa* Linné., has been found to have numerous biologically beneficial properties [5]. The main component of turmeric, curcumin, is effective against MRSA but only at cytotoxic concentrations or in combination with antibiotics. The main problem with curcumin-based therapies is the hydrophobic compound's poor solubility and cytotoxicity at high doses [6]. A *Caenorhabditis elegans* infection model was used to

investigate the effect of curcumin on the pathogenesis process *in vivo*.

Even at higher curcumin concentrations, no antibacterial activity was observed. Curcumin at all concentrations caused overgrowth (35-69%) and increased the pathogenicity of the bacterial strain via virulence factor overexpression [7].

Turmeric has long been used as a spice in foods as well as for therapeutic purposes such as anti-inflammatory, antihyperlipidemic, and antimicrobial properties. Turmeric and curcumin are not carcinogenic or genotoxic [8]. Curcumin plays an important role in the prevention and treatment of a variety of illnesses, including cancer, autoimmune diseases, neurological disorders, cardiovascular disease, and diabetes. Many studies have shown that curcumin has antibacterial properties against both Gram-negative and Gram-positive bacteria. Curcumin's antibacterial action involves the disruption of the bacterial membrane, the inhibition of bacterial virulence factor production and biofilm formation, and the induction of oxidative stress [9].

Curcumin inhibits cyst formation in surviving trophozoites, which may be due to its effect on *Acanthamoeba* ATG-related gene mRNA expression [10]. The most common pathogen of wound infections is *Staphylococcus aureus*. So far, methicillin-resistant *S. aureus* (MRSA) has emerged as the leading cause of wound infections, particularly nosocomial infections. Routine antimicrobial therapies rarely eradicate MRSA infections [11]. The aims of this study were to evaluate the antibacterial Properties of Turmeric (*Curcuma longa* L.) Against Gram-positive and negative Bacteria

### Materials and methods

#### Materials

Turmeric (*Curcuma longa* L.), olive oil and Vaseline were purchased from the local market in Riyadh Saudi Arabia.

**Antibacterial activity of Turmeric (*Curcuma longa* L.) assay**

The antibacterial activity of Turmeric (*Curcuma longa* L.), turmeric plus olive oil and turmeric plus Vaseline were determined by the agar diffusion method. For this, fresh [overnight] isolated colonies of *Staphylococcus aureus* and *E. coli* were suspended in sterile saline to get turbidity of 0.5 McFarland standards. 0.1 ml. of this suspension was spread aseptically on sterile Muller Hinton agar medium [Hi media]. Then the wells [6 mm diameter] were bored by a sterile cork borer. 0.2 ml. of each turmeric, turmeric plus olive oil and turmeric plus Vaseline were added to the wells. It was allowed to diffuse, and 10 % DMSO in one of the wells was used as a negative control. After the diffusion of turmeric, the plates were incubated at 37°C for 24 hours. Zones of inhibition were then measured in mm. For each turmeric, turmeric plus olive oil and turmeric plus Vaseline three replicates were maintained.

**Determination of minimum inhibitory concentration [MIC]**

The tube dilution method was done to determine the minimum inhibitory concentration of the turmeric. A series of two-fold dilutions of turmeric (*Curcuma longa* L.) ranging from 10 mg/ml *Staphylococcus aureus* and *E. coli* to 0.3 mg/ml was made in Muller Hinton broth. 0.1 ml of a

suspension of *Staphylococcus aureus* and *E. coli* matched to 0.5 McFarland standard was seeded into each dilution. Two controls were maintained for each test batch. This included tubes containing turmeric and growth medium without inoculum and organism control i.e. tubes containing the growth medium and inoculum. The tubes were incubated at 37°C for 24 hours and checked for turbidity. Minimum inhibitory concentration was determined as the highest dilution of the turmeric that showed no visible growth.

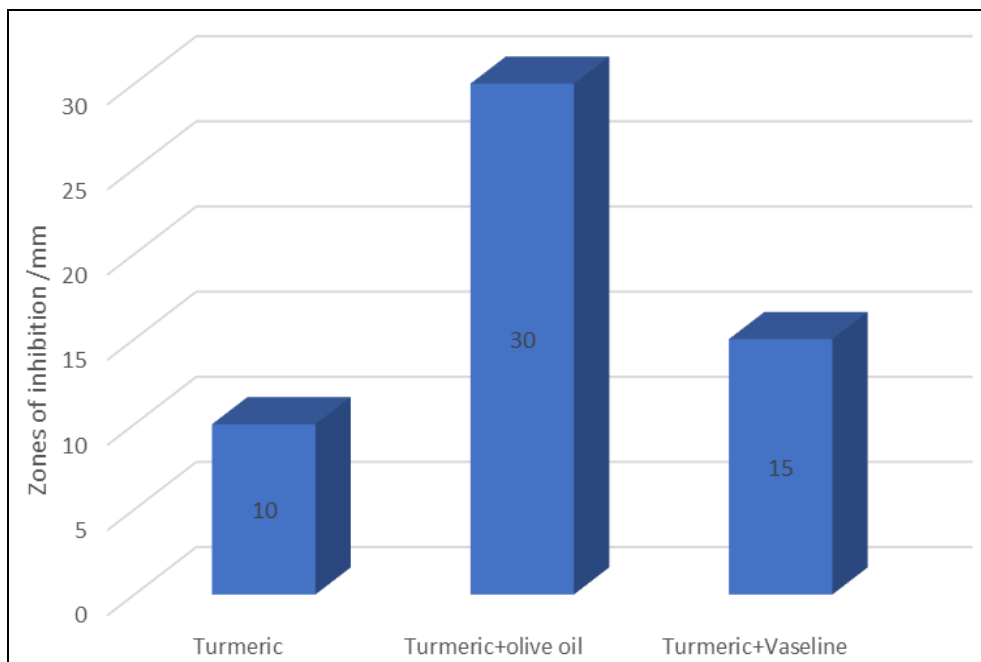
**Statistical analysis**

Data from the experiment for assay of the anti-bacterial activity of turmeric were statistically analyzed using analysis Excel Program 2019, and presented as average, standard error. Means were obtained using t-tests and making graphs.

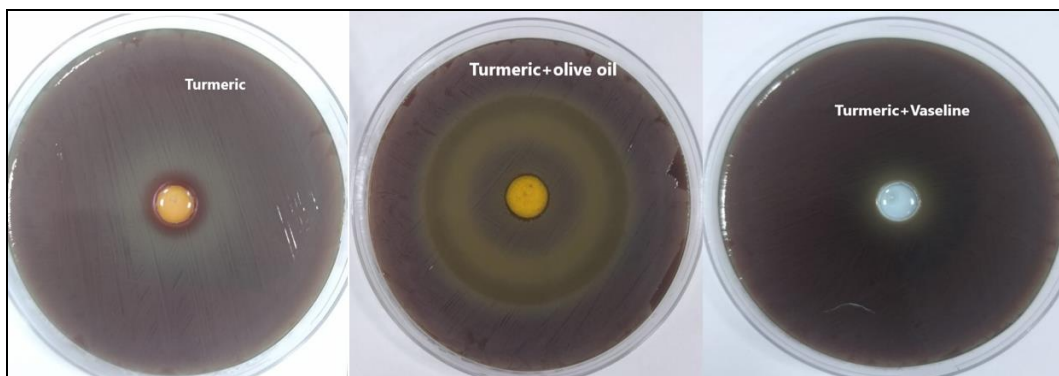
**Result**

**Antibacterial Activity**

Figure 1&2 shows the results of the antibacterial activity of turmeric, turmeric plus olive oil and turmeric plus Vaseline against *Staphylococcus aureus*. Both inhibited the growth of *Staphylococcus aureus*. Turmeric plus olive oil showed the highest [30mm] whereas turmeric was [10mm] antibacterial activity.



**Fig 1:** The antibacterial activity turmeric, turmeric plus olive oil and turmeric plus Vaseline against *Staphylococcus aureus*



**Fig 2:** The antibacterial activity of turmeric, turmeric plus olive oil and turmeric plus Vaseline against *Staphylococcus aureus*

Figure 3&4 shows the results of the antibacterial activity of turmeric, turmeric plus olive oil and turmeric plus Vaseline against *E.coli*. Both inhibited the growth of *E.coli*. turmeric

plus olive oil showed the highest [18mm] whereas turmeric was [6mm] antibacterial activity.

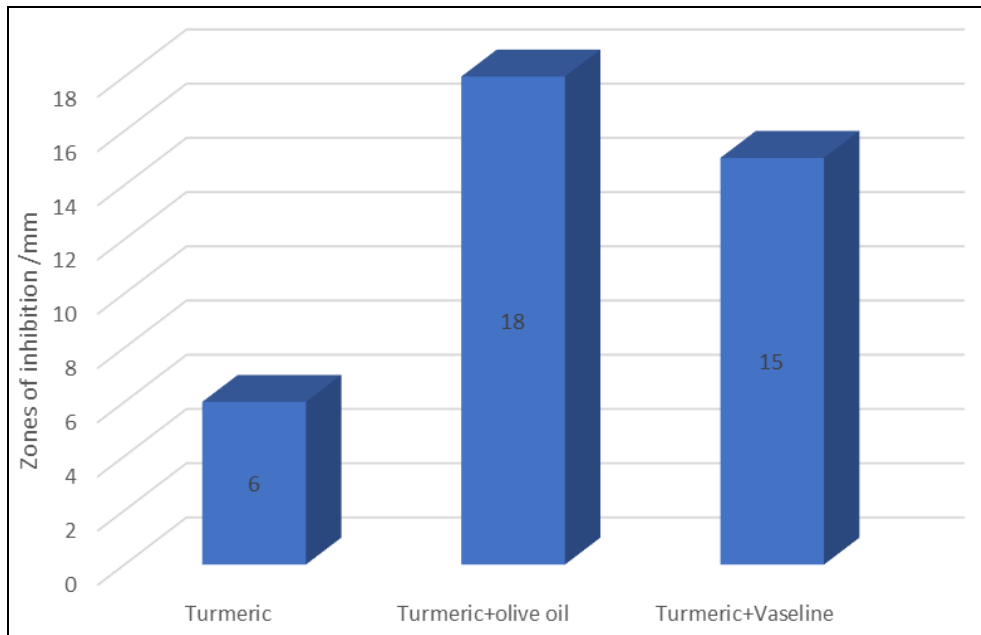


Fig 3: The antibacterial activity of turmeric, turmeric plus olive oil and turmeric plus Vaseline against *E.coli*.

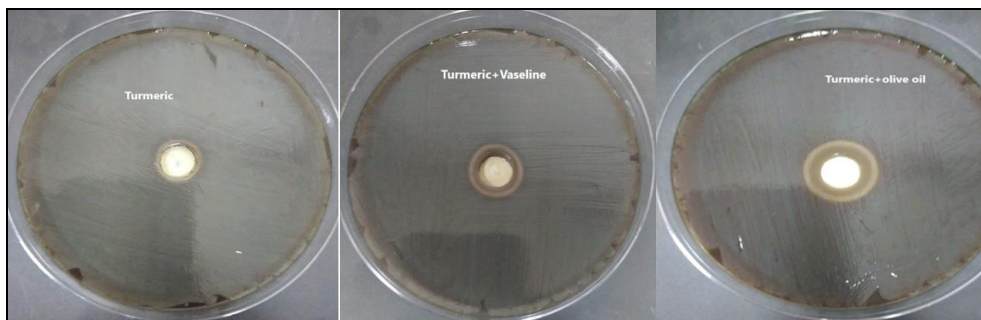


Fig 4: The antibacterial activity of turmeric, turmeric plus olive oil and turmeric plus Vaseline against *E.coli*

Figure. 5 shows the minimum inhibitory concentration [MIC] of turmeric against microorganisms. The MIC of

turmeric ranged from [0.8-1.6 mg/ml]. The lower MIC is an indication of the high effectiveness of turmeric.

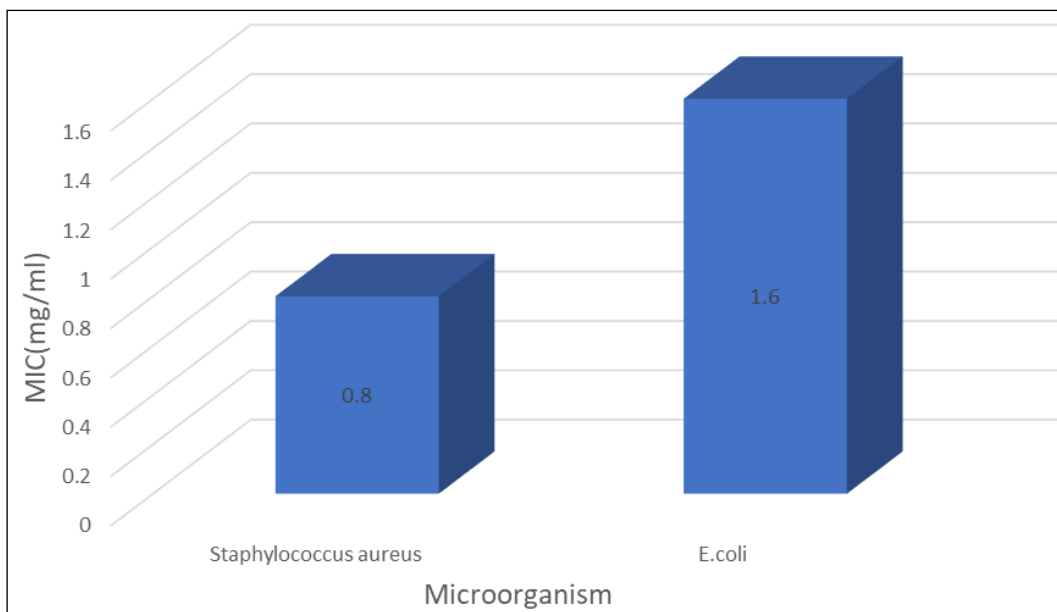


Fig 5: The minimum inhibitory concentration of turmeric against tested microorganisms

## Discussion

In the last years, organisms resistant to multiple drugs have developed a warning challenge global [12]. Organic material reduces antibacterial activity while conserving bactericidal efficacy. Curcumin's anticancer effects have received the most attention in the last decade [13]. Curcumin's antibacterial activity against *S. aureus*, *Trichophyton gypseum*, *Salmonella paratyphi*, and *Mycobacterium tuberculosis* was described in the first report describing its biological action [14]. Turmeric natural dye inhibited *E. coli* and *Vibrio cholera* with zones of inhibition ranging from 7mm to 15mm and 10mm to 15mm, respectively. Turmeric powders are used to colour natural fibres used in the production of consumer goods [15]. The previous finding supported the results obtained by the current study due to the antimicrobial activity of turmeric, therefore when mixed with olive oil and Vaseline increased the inhibition zone this result refers to some active ingredients dissolved in oil or giving a synergistic effect with olive oil. As a result, curcumin, a natural product derived from plants, is thought to have profound medicinal benefits and could be developed into a naturally derived antibiotic in the future. However, there are several significant challenges in the development of curcumin as a medicine. *S. aureus* infections, particularly those caused by multidrug-resistant strains, have emerged as a global health issue that requires immediate attention [4]. Therefore, alternative natural or combination drug therapies are required. Curcumin (CCM), a natural polyphenolic flavonoid isolated from the rhizome of the plant *Curcuma longa* Linné., has been found to have numerous biologically beneficial properties [16]. The study focused on commonly used antibiotics combined with herbal extracts against MRSA, as well as the mechanisms involved. We discovered that herbal extracts combined with antibiotics such as  $\beta$ -lactams, quinolones, aminoglycosides, tetracyclines, and glycopeptides could significantly improve antibacterial effects, reduce dosage and toxic side effects, and reverse MRSA resistance. As a result, we conclude that herbal extracts combined with antibiotics may be a promising MRSA treatment strategy [17]. The synergistic effect between plants and the extraction of antibiotics was evaluated using the disk diffusion method. The results indicated that the plant has antibacterial properties against the tested bacteria to various degrees; this could be attributed to plants' active ingredients. [18, 19] The study exhibited a significantly larger variation in the curcumin activity than previous works and suggested that numerous clinical strains of widespread pathogens have poor sensitivity to curcumin. The sensitivity of species was not associated with its affiliation to the genus, and it could differ a lot (e.g., *S. pyogenes*, *S. agalactiae* and *A. lwoffii*, *A. baumannii*). Hence, curcumin can be considered a promising antibacterial agent, but with a very selective activity<sup>1</sup>. The curcumin MIC values were 175  $\mu$ g/ml, 129  $\mu$ g/ml, 219  $\mu$ g/ml, 217  $\mu$ g/ml, 163  $\mu$ g/ml, 293  $\mu$ g/ml and 216  $\mu$ g/ml against *P. aeruginosa*, *B. subtilis*, MSSA, MRSA, *E. coli*, *E. faecalis* and *K. Pneumonia*, respectively. This study revealed the antibacterial effects of curcumin against standard bacterial strains in high concentrations. Animal experiments have demonstrated that curcumin applied at high doses has strong antibacterial activity. There is a need for further *in vivo* studies to shed light on the antibacterial effects of curcumin with high concentrations [2]. The above results were not similar to results obtained by the current

study this variation may refer to different bacterial strains and different curcumin cultivars. The plant's extracts could be one of the future solutions due to antibiotic-resistant bacteria [20].

## Conclusion

In conclusion, the results of this study showed that curcumin was more effective when mixed with olive oil and Vaseline against gram-positive and negative bacteria. So it could be used as an antimicrobial agent against *Staphylococcus aureus* and *E. coli* bacteria. This blend could generate a new concept for overcoming antibiotic resistance.

## Funding

No funding for this research

## Conflict of interest

None

## References

- Adamczak A, Ożarowski M, Karpiński TM. Curcumin, a Natural Antimicrobial Agent with Strain-Specific Activity. *Pharmaceuticals (Basel)*,2020;13(7):153. doi: 10.3390/ph13070153. PMID: 32708619; PMCID: PMC7408453.
- Gunes H, Gulen D, Mutlu R, Gumus A, Tas T, Topkaya AE. Antibacterial effects of curcumin: An *in vitro* minimum inhibitory concentration study. *Toxicol Ind Health*,2016;32(2):246-50. doi: 10.1177/0748233713498458. Epub 2013 Oct 4. PMID: 24097361.
- Hosseini A, Hosseinzadeh H. Antidotal or protective effects of *Curcuma longa* (turmeric) and its active ingredient, curcumin, against natural and chemical toxicities: A review. *Biomed Pharmacother*,2018;99:411-421. doi: 10.1016/j.biopha.2018.01.072. PMID: 29367110.
- Teow SY, Liew K, Ali SA, Khoo AS, Peh SC. Antibacterial Action of Curcumin against *Staphylococcus aureus*: A Brief Review. *J Trop Med*,2016;2016:2853045. doi: 10.1155/2016/2853045. Epub 2016 Nov 13. PMID: 27956904; PMCID: PMC5124450.
- Mun SH, Joung DK, Kim YS, Kang OH, Kim SB, Seo YS, *et al.* Synergistic antibacterial effect of curcumin against methicillin-resistant *Staphylococcus aureus*. *Phytomedicine*,2013;20(8-9):714-8. doi: 10.1016/j.phymed.2013.02.006. Epub 2013 Mar 26. PMID: 23537748.
- Bugli F, Cacaci M, Palmieri V, Di Santo R, Torelli R, Ciasca G, Di Vito M, *et al.* Curcumin-loaded graphene oxide flakes as an effective antibacterial system against methicillin-resistant *Staphylococcus aureus*. *Interface Focus*,2018;8(3):20170059. doi: 10.1098/rsfs.2017.0059. Epub 2018 Apr 20. PMID: 29696091; PMCID: PMC5915661.
- Zermeño-Ruiz M, Rangel-Castañeda IA, Suárez-Rico DO, Hernández-Hernández L, Cortés-Zárate R, Hernández-Hernández JM, *et al.* Curcumin Stimulates the Overexpression of Virulence Factors in *Salmonella enterica* Serovar Typhimurium: *In Vitro* and Animal Model Studies. *Antibiotics (Basel)*,2022;11(9):1230. doi: 10.3390/antibiotics11091230. PMID: 36140009; PMCID: PMC9494991.

8. Soleimani V, Sahebkar A, Hosseinzadeh H. Turmeric (*Curcuma longa*) and its major constituent (curcumin) as nontoxic and safe substances: Review. *Phytother Res*,2018;32(6):985-995. doi: 10.1002/ptr.6054. Epub 2018 Feb 26. PMID: 29480523.
9. Dai C, Lin J, Li H, Shen Z, Wang Y, Velkov T, *et al.* The Natural Product Curcumin as an Antibacterial Agent: Current Achievements and Problems. *Antioxidants (Basel)*,2022;11(3):459. doi: 10.3390/antiox11030459. PMID: 35326110; PMCID: PMC8944601.
10. Boonhok R, Sangkanu S, Phumjan S, Jongboonjua R, Sangnopparat N, Kwankaew P, *et al.* Curcumin effect on *Acanthamoeba triangularis* encystation under nutrient starvation. *PeerJ*,2022;10:e13657. doi: 10.7717/peerj.13657. PMID: 35811814; PMCID: PMC9261923.
11. Dou JL, Jiang YW, Xie JQ, Zhang XG. New Is Old, and Old Is New: Recent Advances in Antibiotic-Based, Antibiotic-Free and Ethnomedical Treatments against Methicillin-Resistant *Staphylococcus aureus* Wound Infections. *Int J Mol Sci*,2016;17(5):617. doi: 10.3390/ijms17050617. PMID: 27120596; PMCID: PMC4881443.
12. Taha OMA, Ali AHI, Alsalamah SAA, Alghonaim MIA, Almuahini AMZ, Ibrahim NA, *et al.* Molecular Detection of Some High Resistance Genes Metallo B-Lactams of *Klebsiella Pneumoniae* using Multiplex PCR. *Entomol Appl Sci Lett*,2022;9(3):18-24. <https://doi.org/10.51847/Ef36v0dx8n>
13. Ghosh D, Bagchi D, Konishi T. *Clinical Aspects of Functional Foods and Nutraceuticals*, CRC Press/Taylor and Francis Group, View at: Publisher Site, 2014.
14. Schraufstatter E, Bernt H. "Antibacterial action of curcumin and related compounds," *Nature*,1949;164(4167):456-457.
15. Ramaiah, Dr. Mariselvam, a J a, Ranjit singh, Kalirajan K. Anti-microbial Activity of Turmeric Natural Dye against Different Bacterial Strains. *Journal of Applied Pharmaceutical Science*,2012;2:210-212. 10.7324/JAPS.2012.2624.
16. Mun SH, Joung DK, Kim YS, Kang OH, Kim SB, Seo YS, *et al.* Synergistic antibacterial effect of curcumin against methicillin-resistant *Staphylococcus aureus*. *Phytomedicine*,2013;20(8-9):714-8. doi:10.1016/j.phymed.2013.02.006. Epub 2013 Mar 26. PMID: 23537748.
17. Cheng G, Hao H, Xie S, Wang X, Dai M, Huang L, *et al.* Antibiotic alternatives: the substitution of antibiotics in animal husbandry? *Front Microbiol*,2014;5:217. doi: 10.3389/fmicb.2014.00217. PMID: 24860564; PMCID: PMC4026712.
18. Abdel Moneim E Sulieman, Ahmed A Alghamdi, Vajid N Veetil, Mohanad Abdelgadir, Nasir A Ibrahim. Evaluation of antimicrobial activity of Senna (*Senna italica Mill*) plant and its synergistic effect with antibiotic drugs. *European Journal of Biotechnology and Bioscience*,2017;5(1):69-73.
19. Sulieman AE, Alghamdi AA, Veetil VN, Ibrahim NA. Antimicrobial Activity of Harmal Plant (*Peganum harmala L.*) Extract, Ha'il Region, Saudi Arabia. *Journal of Microbiology Research*,2016;6(2):40-6.
20. Sulaiman A Alsalamah. Phytochemical and antibacterial activity of some extracts of *Garcinia cola* fruits. *International Journal of Biotechnology and Microbiology*,2022;4(2):24-28.