

Research Title

Antibacterial potentialities of the aqueous extracts of Garlic bulb (*Allium sativum*) and Lalob (*Balanites aegyptiaca*) fruit on *Escherichia coli* and *Staphylococcus aureus* local strains

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Abstract

Garlic and *Balanites* were used locally hundreds of years as an available ingredient, in traditional medical remedy. The aim of this study was to evaluate the antibacterial potentialities of the aqueous extracts of garlic bulb and *Balanites* fruit on the local strains of *E. coli*, and *Staphylococcus aureus* bacteria. The standard methods of plant extracts, growth media preparation, and the susceptibility tests of the aqueous extracts against the selected bacteria were carefully followed. Pure strains of *E. coli*, and *Staphylococcus aureus* were brought from the Central Medical Laboratory. The test was run at Microbiology Lab., University of Gezira, Sudan. The inhibition zones (in mm) produced within bacterial colonies as a result of the aqueous extracts were used to evaluate these plant products. Positive control was used (tetracycline 500) to compare the potentiality of both plant products. The inhibition zones produced by *B. aegyptiaca* fruit reached 8.3 mm at the higher concentration (241.71 mg/ml) on *E. coli* strain and 9.7 mm on *S. aureus* strain, whereas that of the garlic bulb reached 8.8 mm at the higher concentration (127.78 mg/ml) on *E. coli* strain and 13.3 mm on *S. aureus* strain. The positive control (tetracycline 500) produced 15.3 mm inhibition zone on *E. coli* strain and 13.3 mm on *S. aureus* strain. The TLC test on the pure aqueous extract of *B. aegyptiaca* fruit separated 4 bands at different RF values. The TLC first band (at RF 0.11) produced by *B. aegyptiaca* fruit aqueous extract resulted in inhibition zones of 8.5 mm on *E. coli* and 8.0 mm on *S. aureus*, whereas the second band (at RF 0.34) of garlic bulb aqueous extract resulted in 6.2 mm on *E. coli* and 8.7 mm on *S. aureus*. It was noticed that, *S. aureus* was more susceptible than *E. coli* strain against garlic bulb aqueous extract. These kinds of researches should be continued, and the innovative and effective alternative antibacterial agents should be screened in order to combat antimicrobial resistance.

Keywords: Antibacterial, aqueous extract, garlic, *Balanites*, *E. coli* and *Staphylococcus aureus*.

الإمكانات المضادة للبكتيريا للمستخلصات المائية لأبصال الثوم (*Allium sativum*) وثمار اللالوب (*Balanites aegyptiaca*) ضد سلالات محلية من الإشريكية القولونية والمكورات العنقودية الذهبية

المستخلص

استُخدم الثوم واللalob محليًا منذ مئات السنين بوصفهما مكوّنين متاحين في العلاجات الطبية التقليدية. هدفت هذه الدراسة إلى تقييم الإمكانات المضادة للبكتيريا للمستخلصات المائية لأبصال الثوم وثمار اللالوب ضد سلالات محلية من الإشريكية القولونية (*E. coli*) والمكورات العنقودية الذهبية (*Staphylococcus aureus*). اتُبعت الطرق القياسية لتحضير المستخلصات النباتية وأوساط النمو واختبارات حساسية البكتيريا المختارة للمستخلصات المائية. وُجِلت سلالات نقية من البكتيريتين من المختبر الطبي المركزي، وأُجريت الاختبارات في مختبر الأحياء الدقيقة بجامعة الجزيرة، السودان. واستُخدمت أقطار مناطق التثبيت (بالمليمتر) المتكوّنة في المستعمرات البكتيرية لتقييم المستخلصات، مع استخدام شاهد موجب (تتراسيكلين 500) للمقارنة. بلغت منطقة التثبيت الناتجة عن مستخلص ثمار اللالوب 8.3 ملم عند أعلى تركيز (241.71 ملغم/مل) ضد الإشريكية القولونية، و 9.7 ملم ضد المكورات العنقودية الذهبية؛ في حين بلغت للمستخلص المائي لأبصال الثوم 8.8 ملم عند أعلى تركيز (127.78 ملغم/مل) ضد الإشريكية القولونية، و 13.3 ملم ضد المكورات العنقودية الذهبية. وأحدث الشاهد الموجب (تتراسيكلين 500) منطقة تثبيط قطرها 15.3 ملم ضد الإشريكية القولونية و 13.3 ملم ضد المكورات العنقودية الذهبية. وفصل اختبار الاستشراب بالطبقة الرقيقة للمستخلص المائي النقي لثمار اللالوب أربع حزم عند قيم مختلفة لمعامل الانتقال (RF). وأنتجت الحزمة الأولى (عند RF 0.11) منطقة تثبيط قطرها 8.5 ملم ضد الإشريكية القولونية و 8.0 ملم ضد المكورات العنقودية الذهبية، بينما أنتجت الحزمة الثانية (عند RF 0.34) من مستخلص أبصال الثوم منطقة تثبيط قطرها 6.2 ملم ضد الإشريكية القولونية و 8.7 ملم ضد المكورات العنقودية الذهبية. ولوحظ أن المكورات العنقودية الذهبية كانت أكثر حساسية من الإشريكية القولونية للمستخلص المائي لأبصال الثوم. وتوصي الدراسة بمواصلة هذا النوع من البحوث وتحري بدائل مبتكرة وفعالة من العوامل المضادة للبكتيريا لمواجهة مقاومة مضادات الميكروبات.

الكلمات المفتاحية: مضاد للبكتيريا، المستخلص المائي، الثوم، اللالوب، الإشريكية القولونية، المكورات العنقودية الذهبية

INTRODUCTION

The *Balanites aegyptiaca* tree reaches 10 m (33 ft) in height with a generally dark green compound leaves grow out of the base of the spines and are made up of two leaflets which are variable in size and shape. The fluted trunk has grayish-brown, ragged bark with yellow-green patches where it is shed. The ellipsoid fruit is normally less than 4 cm (1.6 in) long and is green when not ripe; it ripens to a brown or pale brown fruit with a crispy skin. The seed contains 30-48% fixed (non-volatile) oil, like the leaves, fruit pulp, bark and roots, and contains the saponin diosgenin and yamogenin. Saponins likewise occur in the roots, bark wood and fruit (BGCI, 2019; Ibnouf, 2020).

B. aegyptiaca is effective to cure several diseases include malaria, intestinal worm infection, jaundice, diarrhoea, and dysentery. It possesses various active compounds like lipids, carbohydrates, proteins, organic acids, alkaloids, saponins and flavonoids that mainly responsible for its pharmaceutical activities. In conclusion, the diverse pharmacological activities of this plant make it a valuable resource for developing new herbal remedies and pharmaceutical products (Thakkar *et al.*, 2025).

Garlic (*Allium sativum*) is a species of bulbous flowering plants in the genus *Allium*. It is native to central and south Asia, and it also grows wild in parts of Mediterranean Europe. There are two subspecies and hundreds of varieties of garlic. It has been used for thousands of years as a culinary ingredient, and traditional medical remedy (Block, 2010).

Fresh or crushed garlic yields the sulfur-containing compounds allicin, ajoene, diallyl polysulfides, vinylthiins, and *S*-allylcysteine, as well as enzymes, saponins, and flavonoids (Macpherson *et al.*, 2005).

Escherichia coli, is a Gram-negative, facultative anaerobic, rod-shaped, coliform bacterium of the genus *Escherichia* that is commonly found in the lower intestine of warm-blooded organisms (Tenaillon *et al.*, 2010). Most *E. coli* strains are harmless, but some serotypes can cause serious food poisoning in their hosts, and are occasionally responsible for food contamination incidents that prompt product recalls (CDC, 2012). The most common way to get an *E. coli* infection is by eating contaminated food or drinking contaminated water, and it can easily travel from person to person, especially when infected adults and children don't wash their hands properly (MayoClinic.org, 2020). Symptoms of *E. coli* infection includes: nausea or vomiting, severe abdominal cramps, watery or very bloody diarrhea, fatigue and fever (Medlineplus, 2021).

Staphylococcus aureus is bacillota, anaerobic, gram-positive, and spherical-shape bacteria. It is usually found in the upper respiratory tract and on the skin, and can become an opportunistic pathogen. It causes skin infections and is widely associated with antibiotic resistance (Turista and Puspitasari 2019; Murray *et al.* 2022).

The current work aimed to evaluate the antibacterial potentialities of the aqueous extracts of garlic bulb and *Balanites* fruit on the local strains of *E. coli*, and *Staphylococcus aureus* bacteria.

MATERIALS AND METHODS

Materials

The Garlic (*A. sativum* L.) bulb, and *Balanites* (*B. aegyptiaca* (L.) Delile) fruit, were brought from the local market of Wad Medani City, Gezira State, Sudan.

The pure strains of *E. coli* (O25:H4) and *S. aureus* (SO-1977) were brought from the Microbiology Department, Central Medical Laboratory, University of Gezira.

Preparation of ethanol extracts

The selected plant materials were first cleaned manually, cut to small pieces, then dried at room temperature (27 ± 2 °C) away from the direct sunlight (to avoid light reaction). These plant parts were crushed to a fine powder after they were dried completely (to increase its surface area). Honey was not dried and was used as it is. The prepared plant materials were used to prepare the ethanol extract, in addition to run the phytochemical tests.

Three g of each plant dried powder were dissolved separately in 20 ml ethanol in a 50-ml conical flask for 24 hours. Each extract was filtered in a clean Petri-dish, and the clear solution were let to evaporate under room temperature. The difference in weight of the empty and the dried extract-containing Petri-dish of each product were used to quantify the amount of the stock extracted materials, and hence their series of the dilutions prepared from each extract.

Thin layer chromatography test

The procedure described by Vogel *et al.* (2003) was carefully followed for garlic bulb, *Balanites* fruit, clove pods, honey, and *Punica* peel (ethanol extract). The procedure started by dissolving of about 1.0 g of the fine powder of each product in 5 ml ethanol. The filtered extract of each was applied as a spot (using a micro-syringe) at one cm up the lower edge of the TLC plate (origin point) which coated with silica gel (0.5 mm thickness). The plate was stand into a tank containing the solvent mixture (hexane: ethanol; 20:80 ml) till the solvent mixture developed up to about 19 cm of the TLC plate. After drying at room temperature, the TLC plate was sprayed with iodine and visualized under UV lamp to detect the separated active spots (narrow zone of chemical constituents) which were characterized by their *R_f* value (the distance between that spot and the origin point over the distance the mixture can reach. Each of the detected spot was scratched on 3 ml of water in small test tube to prepare the hydro-ethanol extract, which later tested individually for their anti-bacterial activity.

Media Preparation

For S. aureus strain:

Weight of 28 g of nutrient agar powder (0.5% of peptone, 0.3% yeast extract, 1.5% agar, and 0.5% NaCl) was suspended in 1.0 L distilled water. This mixture was heated, stirred to fully dissolve all components, and autoclaved at 121 °C for 15 minutes. Then allowed to cool but not solidify. When the mixture cooled to 45-50 °C, 5% (v/v) sterile defibrinated blood (that has been warmed to room temperature) was added and mixed well. Air bubbles were avoided and pH was adjusted to 7.2 – 7.6. The whole mixture was then dispensed into sterile plates before solidified (Turista and Puspitasari 2019).

For E. coli strain:

Ten g tryptone, 5 g yeast extract, 5 g NaCl, and 15 g agar were added and the volume was adjusted to 1000 ml with distilled water. The mixture was autoclaved in conical flask at 121°C for 30 minutes, let to cool to about 60°C and then poured into sterile plastic petri dishes. The plates were allowed to cool and solidify at room temperature and pH of 7.0 (Son and Taylor 2021).

Each media was then poured in sterile Petri dishes (size of 100 mm × 15 mm), left to solidify and incubated at 37°C under aerobic conditions. Each bacteria strain was cultured in its proper media before the antibacterial agents were added, in Biosafety Level 2 (BSL-2) cabinet, provided with fan, ultra violet lamp and flame. The prepared plates were stored at 4°C when not used.

Antibacterial Activity Test

It was run using Disc diffusion method. Five diluted concentrations (w/v) of each product were prepared from the stock concentration, in addition to tetracycline (the synthetic antibiotics) as +ve control. Using sterile cotton wood swab, *S. aureus* and *E. coli* strains were cultured at the surface of the prepared media. After 10 minutes, the excessive solution whenever noticed was aspirated completely out of each Petri-dish. Small disk papers (5 mm diameter) soaked in only one concentration of the prepared concentrations were placed onto the media seeded with the tested bacteria strain and one disc embedded in distilled water was placed as negative control, while penicillin-soaked disc papers were used as positive control. These procedures were performed under strict aseptic condition. Three replicates were done. Each Petri-dish was incubated at 37°C for 48 h. The diameter (mm) of each inhibition zone was measured by transparent ruler.

Statistical Analysis

The main classes of the phytochemicals were expressed as (+) for detected, and (-) for those not detected, while the GC-MS identified compounds were expressed as compound names, conc. %, molecular formula, and retention time. The antimicrobial activity was expressed as inhibition zone (in mm) and the Least Significant Difference (LSD) was used to evaluate the obtained results. The higher the inhibition zone (in mm), denotes the more susceptible case.

RESULTS

The inhibition zones exerted by the pure aqueous extract of *B. aegyptiaca* fruit (Table 1) were increased with the concentration. At the negative control no inhibition zone was formed, and it started at about 3.7 mm at the concentration of 0.39 mg/ml up to 8.3 mm at the higher concentration (241.71 mg/ml) on *E. coli* strain and 9.7 mm on *S. aureus* strain. The positive control (tetracycline 500) produced 15.3 mm inhibition zone on *E. coli* strain and 13.3 mm on *S. aureus* strain.

The TLC test on the pure aqueous extract of *B. aegyptiaca* fruit separated 4 bands at different RF values. The first band (at RF 0.11) was more potent against both strains; the resulted inhibition zones were 8.5 mm on *E. coli* and 8.0 mm on *S. aureus*, whereas the last band (at RF 0.83) was least potent against both strains (4.7 mm on *E. coli* and 2.7 mm on *S. aureus*). It was noticed that, *S. aureus* was relatively more susceptible than *E. coli* strain against *B. aegyptiaca* fruit aqueous extract.

Table (1) Inhibition zone (mean±SE mm) of *E. coli* and *S. aureus* caused by *B. aegyptiaca* fruit aqueous extract

Conc (mg/ml)	<i>E. coli</i>	<i>S. aureus</i>
Control (0.0)	0±0 ^f	0±0 ^g
0.39	3.7±0.67 ^e	4.3±0.3 ^f
1.93	5.3±0.3 ^d	6.3±0.3 ^e
9.67	7.2±0.17 ^{bc}	8.2±0.17 ^d
48.34	7.7±0.67 ^b	8.8±0.17 ^c
241.71	8.3±0.3 ^b	9.7±0.3 ^b
Tetra. (500)	15.3±0.3 ^a	13.3±0.3 ^a
Spot No. (RF)		
1 (0.11)	8.5±0.17 ^a	8.0±0.0 ^a
2 (0.31)	5.7±0.67 ^b	6.8±0.17 ^b
3 (0.51)	5.3±0.3 ^b	7.7±0.67 ^b
4 (0.83)	4.7±0.67 ^b	2.7±0.67 ^c

Different letters in the same column means different significant level

The inhibition zones exerted by the pure aqueous extract of Garlic bulb (Table 2) were increased with the concentration as same as the aqueous extract of *B. aegyptiaca* fruit. The inhibition zone started at about 4.7 mm at the concentration of 0.20 mg/ml up to 8.8 mm at the higher concentration (127.78 mg/ml) on *E. coli* strain and 13.3 mm on *S. aureus* strain.

The TLC test on the pure aqueous extract of Garlic bulb separated 5 bands at different RF values. The second band (at RF 0.34) was more potent against both strains; the resulted inhibition zones were 6.2 mm on *E. coli* and 8.7 mm on *S. aureus*, whereas the first band (at RF 0.11) was least potent against both strains (4.0 mm on *E. coli* and 6.3 mm on *S. aureus*). It was noticed that, *S. aureus* was more susceptible than *E. coli* strain against garlic bulb aqueous extract.

Table (2) Inhibition zone (mean $\pm$ SE mm) of *E. coli* and *S. aureus* caused by Garlic bulb aqueous extract

Conc (mg/ml)	<i>E. coli</i>	<i>S. aureus</i>
Control (0.0)	0 $\pm$ 0 ^e	0 $\pm$ 0 ^e
0.20	4.7 $\pm$ 0.67 ^d	7.7 $\pm$ 0.67 ^d
1.02	5.8 $\pm$ 0.82 ^d	8.3 $\pm$ 0.3 ^d
5.11	7.5 $\pm$ 0.3 ^c	9.5 $\pm$ 0.3 ^c
25.56	7.8 $\pm$ 0.3 ^c	11.0 $\pm$ 0.67 ^b
127.78	8.8 $\pm$ 0.3 ^b	13.3 $\pm$ 0.3 ^a
Penicillin (500)	15.3 $\pm$ 0.3 ^a	13.3 $\pm$ 0.3 ^a
Spot No. (RF)		
1 (0.11)	4.0 $\pm$ 0.3 ^c	6.3 $\pm$ 0.17 ^{bc}
2 (0.34)	6.2 $\pm$ 0.17 ^a	8.7 $\pm$ 0.3 ^a
3 (0.46)	6.2 $\pm$ 0.67 ^{ab}	7.0 $\pm$ 0.0 ^b
4 (0.57)	4.8 $\pm$ 0.82 ^{bc}	6.7 $\pm$ 0.67 ^b
5 (0.83)	5.3 $\pm$ 0.3 ^b	6.3 $\pm$ 0.3 ^{bc}

Different letters in the same column means different significant level

DISCUSSION

Plants as a source of medicinal compound have continued to play a vital role in the maintenance of human health since ancient times.

It was noticed that, all the concentrations of both aqueous extracts showed considerable inhibition zone (more than 0 mm) against both bacterial local strains. In a similar study, the potentialities of both plant product were tested against different bacterial strains on different areas using different methods. The seed oil of *B. aegyptiaca* was tested against *Pseudomonas aeruginosa* (G-), *E. coli* (G-), *Bacillus subtilis* (G+), *S. aureus* (G+), and *Candida albicans* to assess their antimicrobial properties. The seed oil has antimicrobial activity against most of the organisms tested (Gobara *et al.*, 2021).

The garlic extracts demonstrated varying degrees of antimicrobial activities against both *S. aureus* and *E. coli*. The results suggest that garlic extract highly active antimicrobial components (Mohammed *et al.*, 2020).

Garlic has been recommended as a medicinal plant with antibacterial qualities against *E. coli*, *S. aureus*, *Streptococcus mutans*, and *Poryphyromonas gingivalis* (Gabriel *et al.*, 2022).

Scientific researches on natural products, drugs, antimicrobial agents, dietary supplements, and biofertilizer have been accelerated recently globally. Several specialists; botanists,

microbiologists, ethnopharmacologists, biochemists, phytochemists, and organic chemists usually combining their efforts to screen for plant potent agents. Traditional healers have long used plant to relief patients and to prevent wounds infection. Plants are rich source of wide variety of secondary metabolites, such as alkaloids, glycosides, tannins, saponins, terpenoids, and flavonoids, which have an antimicrobial, antiviral, and anti-infection properties.

CONCLUSIONS

The reliance on natural products to obtain antibacterial agents is scientifically ecofriendly and cheap methods that is side-effect free. Potentiality of garlic bulbs and *Balanites* fruits were evaluated, and promising results were obtained; hence, further formulations should be targeted the more active TLC spots, although the pure extracts give comparable potentialities against both *E. coli*, and *S. aureus* bacterial strains.

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Conflicts of Interest:

The authors declare no conflicts of interest.

REFERENCES

- BGCI, Botanic Gardens Conservation International (2019).** *Balanites aegyptiaca*. IUCN Red List of Threatened Species. e.T19182478A155800536. Doi:10.2305/IUCN.UK.2019-3.
- Block, E. (2010).** Garlic and Other Alliums: The Lore and the Science. Royal Society of Chemistry. pp. 5–6. ISBN 978-0-85404-190-9.
- CDC (2012).** "*Escherichia coli*". *National Center for Emerging and Zoonotic Infectious Diseases*. Retrieved 2 October 2012.
- Gabriel, T.; Vestine, A.; Kim, K. D.; Kwon, S. J.; Sivanesan, I. and Chun, S. C. (2022).** Antibacterial Activity of Nanoparticles of Garlic (*Allium sativum*) Extract against Different Bacteria Such as *Streptococcus mutans* and *Poryphomonas gingivalis*. *Appl. Sci.*, **12**(7): 3491; <https://doi.org/10.3390/app12073491>
- Gobara, A.; Alebead, H. E.; Koko, M. K.; Ibrahim, A. S. and Wady, A. F. (2021).** Antimicrobial activity and physicochemical properties of *Balanites aegyptiaca* seed oil. *European Journal of Chemistry*, **12**(4):450-453. DOI:10.5155/eurjchem.12.4.450-453.2142
- Ibnouf, F. O. (2020).** Can Indigenous Foods Play Role as 'the Food of Survival. *European J. Agriculture and Food Sciences*, **2** (4). Doi:10.24018/ejfood.2020.2.4.26.
- Macpherson, L. J.; Geierstanger, B. H.; Viswanath, V.; Bandell, M.; Eid, S. R.; Hwang, S.; Patapoutian, A. (2005).** The Pungency of Garlic: Activation of TRPA1 and TRPV1 in Response to Allicin. *Current Biology*, **15** (10): 929–34. doi:10.1016/j.cub.2005.04.018.
- MayoClinic.org (2020).** *E. coli*. Available at: [mayoclinic.org/diseases-conditions/e-coli/symptoms-causes/syc-20372058](https://www.mayoclinic.org/diseases-conditions/e-coli/symptoms-causes/syc-20372058).
- Medlineplus (2021).** *E. coli* Infections. Available at: medlineplus.gov/ecoliinfections.html
- Mohammed, M. F.; Raman, N.; Alhoot, M. A. and Alwan, M. R. (2020).** Antibacterial

Activities of *Allium sativum* (Garlic) Extracts against *Staphylococcus aureus* and *Escherichia coli*. *European J. Molecular & Clinical Medicine*, 7(11): 526- 534. researchgate.net/publication/347966738.

- Murray, C. J. L.; Ikuta, K. S.; Sharara, F.; Swetschinski, L.; Aguilar, G. R.; Gray, A.; Han, C.; Bisignano, C.; Rao, P.; Wool, E. and Johnson, S. C. (2022).** Global burden of bacterial antimicrobial resistance in 2019: a systematic analysis. *Lancet*, **399**(10325): 629–655. DOI: [https://doi.org/10.1016/S0140-6736\(21\)02724-0](https://doi.org/10.1016/S0140-6736(21)02724-0).
- Son, M. S. and Taylor, R. K. (2021).** Growth and Maintenance of *Escherichia coli* Laboratory Strains. *Curr. Protoc.*, **1**(1): e20. doi: 10.1002/cpz1.20.
- Tenaillon, O.; Skurnik, D.; Picard, B. and Denamur, E. (2010).** The population genetics of commensal *Escherichia coli*. *Nature Reviews Microbiology*, **8** (3): 207–217.
- Thakkar, V.; Dhakad, P. K.; Mishra, R. and Gilhotra, R. M. (2025).** Phytochemical and pharmacological profiling of *Balanites aegyptiaca* linn: Exploring the therapeutic potential of a traditional medicinal plant. *Phytomedicine Plus*, **5**(2): 100804. <https://doi.org/10.1016/j.phyplu.2025.100804>.
- Turista, D. D. R. and Puspitasari, E. (2019).** The Growth of *Staphylococcus aureus* in the blood agar plate media of sheep blood and human blood groups A, B, AB, and O. *Journal Teknologi Laboratorium*, **8**(1): 1-7. DOI: 10.29238/teknolabjournal.v8i1.155.
- Vogel, H.; Gonzalez, M.; Fainic, F.; Razmilic, I.; Rodr'iguerze, J.; Mart, J. S. and Urbinag, F. (2003).** Antioxidant properties and TLC characterization of four Chilean *Haplopappus* -species known as *bailahuen*. Available at: https://repositorio.uchile.cl/bitstream/handle/2250/118615/Vogel_H.pdf.