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Research Article

# A comparative study of the antioxidant, antibacterial, and cytotoxic activities of different varieties of imported ripe Cavendish banana

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**Abstract:** Traditionally, Omanis used bananas to treat gastrointestinal disorders, constipation, and diarrhea. The study aims to determine the pharmacological and toxicological activities of two imported banana varieties collected from the local fruit market. Extracts were prepared separately by soaking the bananas in methanol for seventy-two hours. Then, the extracts were fractionated with various solvents with increasing patterns of polarity to give corresponding crude extracts. All extracts were used to determine their antioxidant, antibacterial, and cytotoxic activities using 2,2-diphenyl-1-picrylhydrazyl (DPPH), agar gel diffusion, and brine shrimp lethality methods. In the Indian ripe bananas, the highest antioxidant activity was obtained from the ethyl acetate and the lowest in water crude extract. However, in the bananas from the Philippines, the highest activity was in chloroform extract and the lowest in water extract. Both extracts displayed moderate antibacterial activity at different concentrations. The range of inhibition was 0-19 mm against Gram-positive and negative bacterial strains. Both banana extracts showed significant cytotoxic activity at all working concentrations. Crude extracts killed all nauplii at the highest concentration of 500 µg/mL. In Indian bananas, the highest cytotoxic activity was found in the water crude extract with an $LC_{50}$ value of 27.35µg/mL. The lowest was in ethyl acetate and methanol extracts with an $LC_{50}$ value of 57.54 µg/mL. Almost similar results were obtained from the Philippines. In conclusion, the polar crude extracts prepared from both varieties of ripe bananas have significant pharmacological and toxicological activities. Therefore, polar banana extracts might be agents that can be used as antibiotics.

## 1. INTRODUCTION

Herbal medicines have been used in traditional healing systems since ancient times to provide the best quality of life for human beings. Alternative medicines are frequently used in primary healthcare in different healthcare systems (Anilreddy, 2009; Barroso *et al*., 2019). People use plant products and fresh plant materials as herbal medicine to treat several chronic diseases.

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Plant-related herbal drugs are a vital resource for treating different serious life-threatening ailments, especially in developing countries.

As reported by the World Health Organization (WHO), more than 60% of the world's population relies on traditional herbal medicines as a safe way of treating severe chronic diseases (Daimari & Swargiary, 2020; Ramzi *et al*., 2010; Reinisalo *et al*., 2015). Due to the importance of alternative herbal medicines, scientists and researchers have to concentrate more and more on improving human health with plant-related resources. Regarding toxicity, the plant materials and their formulated products are safer than pharmaceutical products. In addition, they are cost-effective due to the availability of plants (Anilreddy, 2009; Barroso *et al*., 2019). Most diseases can be cured recently by medicinal plant extracts and their formulated products. Most infections are cured by antimicrobial drugs extracted from plant resources.

Bananas originated from South Asia and are considered one of the oldest crops. (Ayoola-Oresanya *et al*., 2020). The cultivation of bananas has spread all over the tropical world due to their medicinal and nutritive value (Ahmed *et al*., 2016; Pereira & Maraschino, 2015; Zafar *et al*., 2011). In addition to rice, wheat, and maize, bananas are considered primary traded crops in the global market (Oliveira *et al*., 2008). The height of the banana plant is about 3 to 5 meters, depending on the variety of species. The leaves are distributed spirally from the stems.

All parts of this plant species have significant medicinal value and are used in primary health care to treat several chronic diseases. Several previous studies showed that the banana contains different chemical compounds such as unsaturated fatty acids, essential lipids, hydrolyzed sterol esters, different diterpene and triterpene acids such as linoleic acid, and linolenic acid, several monosaccharides and disaccharides, mannose and oleic acids. Most of the chemicals or ingredients mentioned above are present in bananas in substantial amounts (Debabandya *et al*., 2010; Oliveira *et al*., 2008). Several important chemical compounds have been found in bananas, such as vitamin (A-C), oxalic acid, starch, tannin, cardiac glycosides, polyphenolic compounds, triterpenes such as stigmast-7-methylenecycloartanol, stigmast-7-en-3-ol, lanosterol, α-amyrin. All those phytochemicals have significant pharmacological and toxicological activities (Adinarayana & Babu, 2011; Fernanda *et al*., 2016; Natcharee & Rakshit, 2011; Rao *et al*., 2016). Researchers found that the complex constituents in bananas are more active than the single constituent due to the synergistic effect (Liu, 2004).

Traditionally, isolated stem juice is an effective medicine to cure epilepsy, hysteria, dysentery, and diarrhea (Debabandya et al., 2010). The flower extract is used to cure bronchitis, dysentery, and ulcers (Rao et al., 2012). In addition, cooked flowers are also used in different traditional systems in India and China to cure diabetes, epilepsy, leprosy, fevers, hemorrhages, acute dysentery, and diarrhea (Rao *et al*., 2012). Furthermore, root extracts treat dysentery and other ailments (Rao *et al*., 2012). In Oman, green mountain banana is used to treat gastrointestinal problems. Previously, extended research has been conducted on varieties of banana samples. However, no research has been carried out by Omani researchers on imported banana samples. Therefore, the present study was to determine the antioxidant, antibacterial, and toxicological activity of various crude extracts of imported Indian and Filipino ripe bananas.

## 2. MATERIAL and METHODS

### 2.1. Chemicals

Dimethyl sulphoxide (DMSO, purity 96.3%)), methanol, and 2,2-diphenyl-1-picrylhydrazyl (DPPH, purity 98.25%) were collected from Sigma-Aldrich Company, Germany. Levofloxacin (Purity 99%) was collected from BDH, UK. All polarity of solvents used in this experiment for the fractionation was collected from BDH, UK. Other chemicals and solvents used in this experiment were of analytical normal grade. Shrimp eggs were from BDH Company, UK. The filter paper was from Whatmann, and refined commercial salts were collected at the local supermarket.

### 2.2. Microbes

A total of four bacterial strains were used in this experiment: one Gram-positive bacteria, *Staphylococcus aureus* (*S. aureus)*, and three Gram-negative bacterial strains such as *Escherichia coli* (*E. coli*), *Haemophilus influenza (H. influenza)*, and *Enterococcus faecalis* (*E. faecalis*). The strains were cultured in the Microbiology Department, Nizwa Hospital, Nizwa. The bacterial strains were further cultured in the Department of Biological Science, University of Nizwa. All the cultured bacterial strains were brought to the research lab and stored in the freezer at -20 °C until used.

### 2.3. Instrument

The prepared samples' absorbance was measured by a UV spectrophotometer (Shimadzu, Model-1800, Japan). The rotary evaporator and incubator used for the present experiment were obtained from Yamato Company (Japan) and VWR Company (UK).

### 2.4. Sample Collection

The imported Indian and Filipino ripe banana samples were obtained from the local fruit and vegetable market in December 2016. Both Indian and Filipino ripe bananas were around 6-7 inches in size. The samples were labeled for processing and carried home for washing, slicing, and drying. The clean samples were identified based on the importer labels on the boxes.

### 2.5. Sample Processing and Extraction

The sliced Indian and Filipino ripe banana samples (1 Kg each) were dried at room temperature for one week. Both dried banana samples were crushed into rough powder. The rough powder samples (each 500 gm) were soaked with methanol solvent (2 L) for 72 hours. During the extraction, the samples were stirred for complete extraction. Subsequently, they were filtered by a Buchner funnel, and the methanol solvent was evaporated by a rotary evaporator. Then, the methanol extracts (30.00 and 31.45 gm; yield 15% and 15.71%) were dissolved separately in 300 mL water. The samples were fractioned successively with hexane, chloroform, ethyl acetate, butanol, methanol, and water with increasing polarity. (Al Hadhrami & Hossain, 2016). Finally, all the mother solvent was evaporated under reduced pressure.

### 2.6. Antioxidant Activity

A slightly modified DPPH method was used to evaluate the antioxidant activity of various polarities of the Indian and Filipino ripe banana crude extracts (Tahiya *et al*., 2014). Five concentrations, 12.5, 25, 50, 100, and 200 µg/mL, were prepared from each crude extract (hexane, chloroform, ethyl acetate, butanol, methanol, and water) to measure antioxidant activity. Each crude extract concentration (4 mL) was placed in a pre-cleaned test tube. Then, DPPH solvent (1 mL) was added to the pre-cleaned test tubes, and all tubes were shaken and kept at ambient temperature in a dark place for 45 min. A control sample was prepared in the same way without adding any crude extract. After 45 minutes of incubation of the samples, the absorbance of the incubated crude samples was evaluated at wavelength 517 nm. Gallic acid was used as a standard in the present experiment to calculate antioxidant activity. The inhibition (%) was calculated using the following formula;

$$\% \text{ Inhibition} = \frac{A_{control} - A_{extract}}{A_{control}} \times 100$$

### 2.7. Antibacterial Activity

A slightly modified usual disc diffusion method was used to evaluate the antibacterial activity of the various polarity crude extracts at four concentrations against one Gram (+) and three Gram (-) bacterial strains (Al Matani *et al*., 2015). Four different concentrations of each polarity crude extract, e.g., 2, 1, 0.5, and 0.25 mg/mL, were used in the present study. Both levofloxacin, a broad-spectrum antibiotic, and DMSO solvent were used in this study as a positive and negative control. Discs of 6 mm size were prepared from filter paper and immersed in each concentration of each extract for 30 minutes. Then, the discs containing samples were placed

on the prepared agar gel plates and kept in an incubator at 37ºC for 24 hours. The zone of inhibition of each concentration of each banana extract was calculated against the four applied Gram (+ and -) bacteria strains.

### 2.8. Cytotoxic Activity

The prepared crude extracts at varied concentrations were used in this experiment to evaluate cytotoxic activity using the BSL method (Weli *et al*., 2014). At first, the commercial dry shrimp eggs were hatched in artificial seawater in a plastic container. After 24 hours of hatching, the active nauplii was used to evaluate the cytotoxic activity of the prepared crude extracts of the selected plant. Five concentrations of each polarity crude extract, such as 500, 250, 125, 50, and 25 µg/mL, were prepared by dilution techniques with DMSO. From each concentration extract, 50 µl was placed into a 10 mL test tube with 4.95 mL of artificial seawater. It was mixed with a sonicator for 2 minutes. Afterward, 10 active nauplii were added to each test tube with the help of a dropper and magnifying glass. All the test tubes were kept for 24 hours under light. The living nauplii in every test tube were counted, and the percentage of mortality was calculated using the usual formula.

## 3. RESULTS

### 3.1. Preparation of Crude Extract

Indian and Filipino ripe bananas were collected from the fruit and vegetable market and extracted with methanol solvent by soaking. The solvent from the extract was evaporated by the usual procedure, and the methanol extract was dissolved with water. The dissolved mixture was transferred to a separatory funnel and extracted with various organic solvents. The percentage yield of each extract is presented in Table 1. The highest amount was obtained in butanol extract, and the lowest was in hexane extract.

**Table 1.** Yield of crude extracts of Indian and Filipino ripe banana.

| Crude extracts | Indian banana (gm) | Filipino banana (gm) |
|---|---|---|
| Hexane | 2.07 | 2.54 |
| Chloroform | 4.21 | 3.98 |
| Ethyl acetate | 5.81 | 6.03 |
| Butanol | 10.23 | 7.99 |
| Water | 6.03 | 6.67 |
| Methanol | 34.56 | 29.54 |

### 3.2. Antioxidant Activity

The antioxidant activity of various polarity crude extracts, prepared from the Indian and Filipino banana samples, was determined using the well-known DPPH method (Al Matani *et al*., 2015; Daimari & Swargiary, 2020). Using the established formula, the inhibition (%) was determined for all crude extracts at different concentrations of both samples. Among the crude extracts of the Indian ripe banana, the highest antioxidant activity was found in ethyl acetate extract, and the lowest was obtained in water crude extract; however, in the case of the Filipino ripe banana, the highest activity was found in the chloroform extract, and the lowest was found in the water extract (Table 2).

### 3.3. Antibacterial Activity

The modified disc diffusion method was used to evaluate the antibacterial activity of the various polarity crude extracts. In this experiment, one Gram-positive bacteria strain such as *S. aureus*, and three Gram-negative bacteria strains such as *E. coli*, *H. Influenza* and *E. faecalis* were used to determine the bacterial activity against various concentrations of the extracts through the disc diffusion method. Altogether, six crude extracts of both samples at varied concentrations were used to evaluate their bacterial activity through using the disc diffusion method. Standard levofloxacin and DMSO solvent were used as a control. Most prepared concentrations of each crude extract did not show any activity. The results obtained from this study are presented in Table 3.

**Table 2.** Antioxidant activity of hexane, ethyl acetate, chloroform, butanol, methanol, and water crude extracts from Indian and Filipino ripe banana.

| Extract Conc. (µg/mL) | Water | | Methanol | | Hexane | | Chloroform | | Ethyl acetate | | Butanol | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Indian | Filipino | Indian | Filipino | Indian | Filipino | Indian | Filipino | Indian | Filipino | Indian | Filipino |
| **200** | 68.28±0.12 | 71.87±0.17 | 88.76±0.10 | 92.00±0.09 | 80.65±0.14 | 87.37±0.11 | 84.34±0.10 | 94.28±0.23 | 97.22±0.10 | 75.99±0.08 | 79.14±0.10 | 85.40±0.12 |
| 100 | 62.59±0.10 | 65.87±0.55 | 78.76±0.17 | 90.72±0.32 | 71.29±0.44 | 83.34±0.18 | 73.55±0.19 | 90.65±0.23 | 91.67±0.19 | 71.49±0.31 | 73.55±0.51 | 79.41±0.11 |
| 50 | 58.54±0.17 | 63.09±0.09 | 77.89±0.14 | 83.89±0.19 | 66.08±0.87 | 76.90±0.18 | 70.92±0.90 | 81.90±0.78 | 87.14±0.90 | 66.23±0.56 | 64.56±0.44 | 78.22±0.15 |
| 25 | 55.00±0.13 | 57.36±0.13 | 70.28±0.29 | 75.12±0.18 | 61.24±0.23 | 72.71±0.17 | 68.69±0.23 | 78.54±0.10 | 77.15±0.54 | 60.78±0.50 | 60.33±0.23 | 67.34±0.72 |
| 12.5 | 50.98±0.19 | 50.19±0.22 | 65.88±0.09 | 59.03±0.10 | 53.67±0.16 | 61.90±0.10 | 64.09±0.56 | 71.09±0.54 | 60.34±0.15 | 51.23±0.15 | 54.99±0.19 | 55.67±0.10 |

Each value is a mean of three biological replicates.

**Table 3.** Antibacterial activity of different crude extracts from Indian and Filipino ripe banana samples.

| Bacteria | Extract Conc. (mg/mL) | Water | | Methanol | | Hexane | | Chloroform | | Ethyl acetate | | Butanol | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Indian | Filipino | Indian | Filipino | Indian | Filipino | Indian | Filipino | Indian | Filipino | Indian | Filipino |
| *E. coli* | 2 | 14±0.19 | 12±0.10 | 12±0.11 | 13±0.13 | 16±0.21 | 14±0.10 | 15±0.29 | 15±0.13 | 16±0.10 | 12±0.10 | nd | nd |
| | 1 | **12**±0.11 | 10±0.18 | 13±0.19 | 12±0.15 | 14±0.10 | 12±0.14 | 14±0.13 | 13±0.23 | 14±0.18 | 9±0.32 | nd | nd |
| | 0.5 | 10±0.09 | 9.5±0.11 | 10±0.11 | 10±0.10 | 10±0.11 | 11±0.23 | 10±0.22 | 12±0.31 | 13±0.13 | 8.5±0.09 | nd | nd |
| | 0.25 | 8±0.16 | 8.5±0.10 | 6±0.20 | 9.5±0.08 | 9.5±0.17 | 10±0.24 | 9±0.15 | 10±0.22 | 10±0.17 | 6±0.15 | nd | nd |
| Control | 3 | 21±0.20 | 22±0.15 | 20±0.18 | 17±0.14 | 19±0.80 | 18±0.13 | 20±0.11 | 19±0.10 | 22±0.34 | 17±0.11 | 15±0.18 | 18±0.29 |
| *H. influenzae* | 2 | 18±0.29 | 12±0.13 | 15±0.14 | 13±0.41 | nd | 12±0.67 | 16±0.18 | 15±0.14 | 16±0.15 | 10±0.87 | 10±0.10 | nd |
| | 1 | **17**±0.71 | 10±0.22 | 13±0.44 | 11±0.10 | nd | 10±0.84 | 15±0.25 | 12±0.19 | 15±0.29 | 10±0.34 | 9±0.23 | nd |
| | 0.5 | **12**±0.55 | 9±0.13 | 11±0.31 | 9±0.26 | nd | 9±0.10 | 10±0.13 | 11±0.25 | 14±0.10 | 8±0.32 | 8±0.15 | nd |
| | 0.25 | 9.5±0.10 | 8±0.20 | 7±0.67 | 7±0.31 | nd | 0±0.13 | 8.5±0.12 | 9±0.12 | 12±0.16 | 6±0.21 | nd | nd |
| Control | 3 | 20±0.13 | 25±0.14 | 21±0.80 | 16±0.19 | 16±0.13 | 12±0.27 | 21±0.09 | 18±0.09 | 20±0.11 | 19±0.10 | 18±0.14 | 17±0.13 |
| *S. aureus* | 2 | 10±0.13 | 14±0.14 | 9±0.12 | 18±0.10 | 18±0.67 | 11±0.17 | 18±0.15 | 14±0.29 | 19±0.23 | 15±0.15 | 14±0.25 | nd |
| | 1 | **10**±0.18 | 10±0.17 | 7±0.14 | 14±0.15 | 14±0.16 | 9±0.09 | 15±0.18 | 12±0.19 | 15±0.55 | 14±0.11 | 9±0.15 | 9 |
| | 0.5 | **9**±0.10 | 10±0.10 | 6±0.10 | 10±0.17 | 10±0.11 | 12±0.07 | 13±0.29 | 9.5±0.32 | 14±0.10 | 10±0.09 | 7±0.12 | nd |
| | 0.25 | 7±0.14 | 7±0.44 | nd | 8.5±0.22 | 0 | 9.5±0.19 | 10±0.10 | 8±0.14 | 11±0.12 | 10±0.25 | nd | nd |
| Control | 3 | 19±0.12 | 24±0.15 | 19±0.10 | 19±0.10 | 22±0.10 | 18±0.15 | 21±0.45 | 16±0.23 | 24±0.14 | 19±0.18 | 18±0.18 | 17±0.15 |
| *E. faecalis* | 2 | **19**±0.08 | 15±0.23 | 10±0.17 | 15±0.90 | nd | 10±0.11 | 13±0.10 | 13±0.17 | 14±0.18 | 15±0.10 | nd | nd |
| | 1 | **18**±0.13 | 13±0.29 | 10±0.22 | 13±0.51 | nd | nd | 10±0.72 | 10±0.18 | 10±0.20 | 13±0.16 | nd | nd |
| | 0.5 | **14**±0.11 | 10±0.12 | 8±0.18 | 10±0.13 | nd | nd | 9±0.42 | 10±0.69 | 10±0.18 | 10±0.29 | nd | nd |
| | 0.25 | 10±0.55 | 8±0.11 | 6±0.13 | 8±0.10 | nd | nd | 8±0.10 | nd | 8±0.27 | 8±0.17 | nd | nd |
| Control | 3 | 23±0.10 | 20±0.19 | 18±0.29 | 18±0.15 | 16±0.19 | 21±0.20 | 17±0.18 | 14±0.15 | 22±0.10 | 19±0.10 | 15±0.15 | 19±0.10 |

nd= not detected; Each value is a mean of three biological replicates.

### 3.4. Cytotoxic Activity

This study used a modified BSL method to evaluate the cytotoxic activity against different concentrations of the prepared hexane, chloroform, ethyl acetate, butanol, methanol, and water crude extracts. The mortality (%) of the shrimp is shown in Table 4. Most prepared concentrations of each extract showed substantial cytotoxic activity; the $LC_{50}$ values of different crude extracts at varied concentrations are given in Table 5.

**Table 4.** Percentage of mortality and lethal concentration ($IC_{50}$) of different polarity banana extracts.

| Crude extract | Conc. | Mortality (%) | | $LC_{50}$ (µg/mL) | |
|---|---|---|---|---|---|
| | µg/mL | Indian | Filipino | Indian | Filipino |
| Hexane | 500 | 100 | 100 | 33.38±0.19 | 36.68±0.12 |
| | 100 | 70 | 60 | | |
| | 50 | 40 | 50 | | |
| | 10 | 20 | 10 | | |
| | Control | 0 | 0 | | |
| Chloroform | 500 | 100 | 100 | 48.12±0.17 | 26.19±0.31 |
| | 100 | 60 | 80 | | |
| | 50 | 30 | 50 | | |
| | 10 | 10 | 20 | | |
| | Control | 0 | 0 | | |
| Ethyl acetate | 500 | 100 | 100 | 57.54±0.10 | 70.17±0.44 |
| | 100 | 50 | 40 | | |
| | 50 | 30 | 30 | | |
| | 10 | 10 | 10 | | |
| | Control | 0 | 0 | | |
| Butanol | 500 | 100 | 100 | 29.73±0.09 | 41.81±0.18 |
| | 100 | 70 | 60 | | |
| | 50 | 50 | 40 | | |
| | 10 | 20 | 10 | | |
| | Control | 0 | 0 | | |
| Methanol | 500 | 100 | 100 | 57.54±0.25 | 34.11±0.29 |
| | 100 | 50 | 70 | | |
| | 50 | 30 | 50 | | |
| | 10 | 10 | 30 | | |
| | Control | 0 | 0 | | |
| Water | 500 | 100 | 100 | 27.35±0.11 | 49.39±0.65 |
| | 100 | 80 | 50 | | |
| | 50 | 40 | 40 | | |
| | 10 | 30 | 10 | | |
| | Control | 0 | 0 | | |

Each value is a mean of three biological replicates.

**Table 5.** $LC_{50}$ of different extracts of ripe banana samples against brine shrimp larvae (n = 10).

| Extract | Ripe banana $LC_{50}$ (µg/mL) | |
|---|---|---|
| | Indian | Filipino |
| Hexane | 33.38±0.19 | 36.68±0.12 |
| Chloroform | 48.12±0.17 | 26.19±0.31 |
| Ethyl acetate | 57.54±0.10 | 70.17±0.44 |
| Butanol | 29.73±0.09 | 41.81±0.18 |
| Methanol | 57.54±0.25 | 34.11±0.29 |
| Water | 27.35±0.11 | 49.39±0.65 |

## 4. DISCUSSION and CONCLUSION

Natural products are the core sources of new drugs in the today's world. These products include plants, animals, and different microorganisms. Plants are considered a major source in terms of reliability and safety. Plants and plant products are the primary sources for the health care system in some areas of the world. Therefore, in the past few decades, there has been a growing research interest in plants to find therapeutic agents that might lead to new drugs to treat diseases.

### 4.1. Antioxidant Activity

The most popular DPPH method was used to evaluate the antioxidant activity at five varied concentrations of six various polarities of banana extracts (Al Matani *et al*., 2015). After the incubation of the samples, the absorbance of each extract was measured with a UV spectrophotometer, and their activity was calculated using the established formula. Based on the experimental results, the highest antioxidant activity of the Indian ripe banana was found in ethyl acetate crude extract, and the lowest was in water crude extract in the following order: ethyl acetate>chloroform>methanol >butanol>hexane>water extract. On the other hand, in the Filipino ripe banana, the chloroform extract showed the highest activity, while the lowest was in water extract, in the following order: chloroform>methanol>hexane>butanol>ethyl acetate>water extracts. The literature searches reveal that the banana extracts contain different bioactive compounds like fatty acids, vitamins, oxalic acid, starch, complex of tannin, cardiac glycosides, polyphenolic compounds, triterpenes and α-amyrin, which are responsible for different biological activities (Adinarayana & Babu, 2011; Debabandya *et al*., 2010; Natcharee, 2011; Oliveira *et al*., 2008). All of these active ingredients could reduce DPPH color by their proton donation capability (Aziza & Hossain, 2015). The experiment results showed that the activity of ripe banana crude extracts was higher than the reported values of crude extracts elsewhere. The variation in antioxidant results might be due to the varied polarities of fractionation, active compounds, and processing methods. Furthermore, during extraction by solvent, some low molecular weight compounds were damaged or vaporized from the samples. That is why the antioxidant activity results in our study are different. Similar results and relationships were obtained between the antioxidant activity of crude extracts and active ingredients, as has previously been reported by several authors (Ahmed *et al*., 2016; Nessma, 2015; Rafaela *et al*., 2010).

### 4.2. Antibacterial Activity

All prepared crude extracts of ripe imported bananas displayed substantial activity against the applied bacterial strains at varied concentrations with 0-19 mm values. The highest activity was obtained in the Indian water crude extract against *E. faecalis*, and the lowest activity was obtained in the Indian methanol extract against *S. aureus*. All six crude extracts at varied concentrations showed activity against *E. coli* except the butanol extract. On the other hand, all extracts also give significant activity against *S. aureus* and *H. influenza* bacterial strains. However, the butanol and hexane extracts showed no activity against *E. faecalis*. Our results differ completely from the previously reported values (Ahmed *et al*., 2016; Fagbemi *et al*., 2009). This difference may be due to the extraction procedure and sample processing.

### 4.3. Cytotoxic Activity

At the highest concentration of 500 µg/mL, all six crude extracts of Indian and Filipino ripe bananas killed all shrimps (mortality 100%). The mortality percentage (%) for the extracts at varied concentrations is presented in Table 4. The highest cytotoxic activities were shown in the water and butanol extracts of the Indian ripe bananas and the lowest in ethyl acetate in both Indian and Filipino extracts. Our observation showed that the percentage of mortalities increases with concentration. As presented in Table 5, all crude extracts exhibited moderate toxicity against the BSL method. In the Indian ripe banana, butanol extract was the most biologically active, exhibiting an $LC_{50}$ value of 20.12 µg/mL. Among the Filipino ripe banana

extracts, the chloroform extract was the most active, exhibiting an $LC_{50}$ value of 26.19 µg/mL, and the lowest was in ethyl acetate, with an $LC_{50}$ value of 70.17 µg/mL (Table 5). The experimental results contradict what has been reported for the cytotoxic activity of banana extract elsewhere (Juliana *et al*., 2014). This variation of $LC_{50}$ value in this study might be due to the varied methodologies of sample collection, process, and extraction. In our experiment, we used the most common BST assay, while in other experiments reported in the literature by other authors, an *in-vitro*-based assay was used. In addition, our extraction procedures and preparation of crude extracts are entirely different from other studies.

In this study, all prepared crude extracts from the Indian and Filipino ripe bananas showed moderate antioxidant, antibacterial, and cytotoxic activities against DPPH, agar gel, and BST methods compared to the reported values. However, most of the crude extracts from both types of bananas showed moderate activity against the selected bacterial strains. All of the applied methods in this present experiment have been found to be quick and versatile for evaluating the biological activities of plant extracts. Further studies designed to isolate constituents from the active banana extracts and confirm their antioxidant, antibacterial, and cytotoxic compounds and *in vivo* studies are also needed to prepare new drugs.

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## Declaration of Conflicting Interests and Ethics

The authors declare no conflict of interest. This research study complies with research and publishing ethics. The scientific and legal responsibility for manuscripts published in IJSM belongs to the authors.

## Authorship Contribution Statement

**Faisal Said Hamed Al-Abri**: Data curation; Data analysis; **Salem Said Jaroof Al Touby**: Edit manuscript, Literature survey; Reviewing and Editing. **Mohammad Amzad Hossain:** Supervision, Planning, draft writing, interpretation.

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