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Effect of Turmeric (Curcuma) on Bacteria Isolated from Burn Wound Infection in Some Patients in Al-Jomhouri Hospital, Sana'a, Yemen

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Abstract
This study was conducted to determine the effect of Turmeric (Curcuma) on bacteria isolated from burn wound infection in some patients in Al-Jomhouri Hospital, Sana'a, Yemen. A total of 100 burn wound swab samples were taken from hospitalized patients who presented invasive burn wound infection from both sex and average age of 10-55 years from 1/4/2018 to 20/6/2018. All swabs were subjected to conventional cultural and biochemical methods for microbial enumeration. *Staphylococcus aureus* was most common isolate with 55.3% incidence, followed by *Pseudomonas aeruginosa* (33.3%), *E.coil* (3.3%), Enterobacter spp. (3.3%), *Salmonella typhi* (3.3%) and Klebsiella spp. with (3.3%). The turmeric extract was found to have an antimicrobial effect on *Staphylococcus aureus* and did not affect the rest of the bacterial isolates.
Keywords: Microbes, turmeric extract, burn wound, Al-Jomhouri Hospital.

INTRODUCTION

Burn wound infections are one of the most important and potentially serious complications that occur in the acute period following injury. These wounds are subsequently colonized by microorganisms, including Gram-positive bacteria, Gram-negative bacteria and Yeasts, which derived from the host's normal flora (gastrointestinal flora, upper respiratory flora) and from the hospital environment (Mohammed., 2007). Burn injury is the local response of a tissue, with or without systemic response, to an energy transfer form a physical (mechanical, thermal, electrical, radiation) or chemical source (Koller, 2014). Infection is an important cause of morbidity and mortality in hospitalized burn patients, in patients with burn over more than 40% of the total body surface area, 75% of all deaths following thermal injuries are related to infections. The rate of nosocomial infections is higher in burn patients due to various factors like nature of burn injury itself, immunocompromised status of the patient, age of the patient, extent of injury, and depth of burn in combination with microbial factors such as type and number of organisms, enzyme and toxin production, colonization of the burn wound site, systemic dissemination of the colonizing organisms (Barzani *et al.,* 2014).

The common burn wound pathogens are *Pseudomonas aeruginosa*, Klebsiella spp, and *Staphylococcus aureus*, which produce a number of virulence factors that are important in the pathogenesis of invasive infection (Mohammed, 2007). The denatured protein of the burn eschar provides nutrition for the organisms. Avascularity of the burned tissue places the organisms beyond the reach of host defense mechanisms and systemically administered antibiotics (Order *et al.,* 1965). Gram-positive bacteria that survive the thermal insult, such as *S. aureus* located deep within sweat glands and hair follicles, heavily colonize the burn wound surface within first 48 hours (Monafo and Freedman, 1987).

Medicinal plants are important source for the verification of pharmacological effects and can be natural composite sources that act as new anti-infectious agents (Ali *et al.,* 2017; Amin *et al.,* 2017; Hussain *et al.,* 2016; Ushimaru *et al.,* 2007). Curcumin, a yellow crystalline polyphenol with low molecular weight, is extracted from rhizome of turmeric. Turmeric belongs to the perennial herb named *Curcuma longa* L. which is prevalent in tropical and subtropical regions, mostly in India, South East Asia and China. India is the first producer, consumer and exporter of *Curcuma longa* in the world (Chang *et al.,* 2014). Curcumin has wide range of applications as a dietary food ingredient, dying agent, therapeutic agent and medicament in different diseases.

Curcumin has various pharmacological effects including antioxidant activities (Tajik *et al.,* 2007). It has been proved that curcumin is a potential agent for prevention and treatment of different cancers including: gastrointestinal, breast, lung, melanoma, head and neck, neurological and sarcoma cancers (Duvoix *et al*., 2005). Various studies have documented the antibacterial activity of curcumin that indicate inhibition properties of a wide range of bacteria. The objective of this work was the isolation and identification of bacteria from burn wounds and to determine the effect of curcuma on bacteria isolates.

MATERIALS AND METHODS

Curcuminoid was extracted by Soxhlet apparatus following previously described procedure (Sahne *et al.,* 2016). Six different strains of bacteria were used for testing antibacterial activity that include *Staphylococcus aureus*, *Pseudomonas aeruginosa, E.coli*, *Enterobacter spp, Salmonella typhi* and *Klebsiella spp*. The study was approved by the institutional research committee and anonymity of patients was protected. The specimens were taken from patients undergoing surgical operation or burn in surgical wards. All swabs obtained were cultured directly on Mueller Hinton agar for isolation of aerobic bacteria. Cultured plates were examined after overnight incubation at 37 °C, if no growth obtained on plates they were re-incubated for another 24 hrs. Purification of pathogenic bacteria was done using agar slants. Identification of pathogenic bacteria was based on gram stained smear, morphology and biochemical characters (Bergey, 1984; Iqbal *et al.,* 2012; Iqbal *et al.,* 2015; Iqbal *et al.,* 2016; Yunus *et al.,* 2016; Yunus *et al.,* 2017a; Yunus *et al.,* 2017b).

Antibacterial activity was tested by agar well diffusion method (Mukherjee *et al*., 1995). Different concentrations of the turmeric curcuminoids were prepared in ethanol and methanol respectively by using serial dilution method. The test organisms were seeded into respective medium by gently mixing 0.1 ml of the 24 h fresh cultures with 35

ml sterile melted agar in sterile Petri plates. Four 7mm diameter wells were made using sterile borer. The wells were filled with 0.1ml of the sample extract. The antibacterial assay plates were incubated at 37ºC for 24 h. The diameter of the zones of inhibition around each of the well was taken as measure of the antibacterial activity. Each experiment was carried out in triplicate and mean diameter of the inhibition zone was recorded.

The extracts which showed antibacterial activity in agar well assay were subjected to MIC assay (Jones *et al*., 1985). In order to determine MIC, serial dilutions of the extracts were prepared with concentration ranged from 4 to 28 mg/ml. The MIC values were interpreted as the highest dilution (lowest concentration) of the sample, which showed clear zone. All tests were performed in triplicate.

RESULTS

A total of 100 bacteria isolates were obtained from burn wound infection patients. The most predominant bacterial isolate was *Staphylococus aureus* 55 (55.33%) followed by *Pseudomonas aeruginosa* 3(33.33%), *Escherichia coli* 3 (3.33%), *Enterobacter spp*. 3(3.33%), *Salmonalla typhi* 3 (3.33%), and *Klebsiella spp*. 3 (3.33%) (Table 1). Ethanol turmeric extract showed inhibitory effects for *S. aureus* only (Figure 1). The MIC value of turmeric extract with *S. aureus* was 0.75 µg/mL.

Table 1. Pathogens isolated from burn wound infection.

Pathogens	No. of isolates	%age
Staphylococcus aureus	55	55.3
Pseudomonas aeruginosa	33	33.3
E.coli	3	3.3
Enterobacter spp.	3	3.3
Salmonalla typhi	3	3.3
Klebsiella spp.	3	3.3

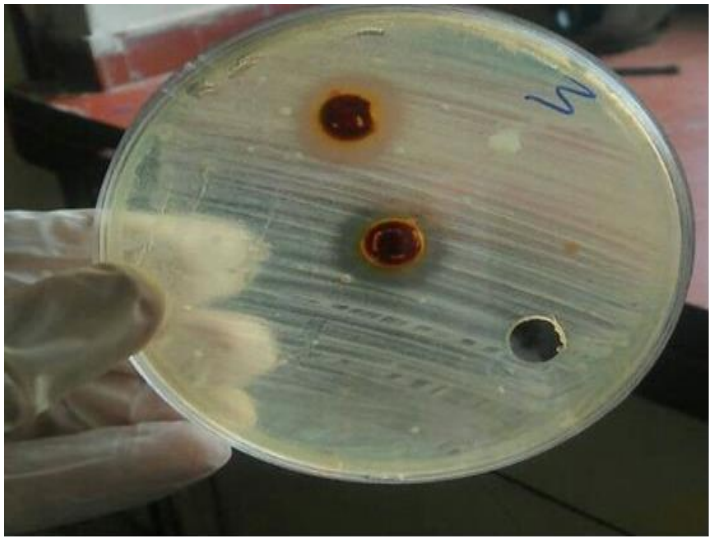

Fig. 1. Inhibition zone of *S. aureus* with ethanol turmeric extract.

Circle-shaped arrow indicates binding whereas blocked arrow represents inhibition. (a) Curcumin may bind into proteins, thereby inhibiting the assembly of proteins. protoflaments. This, in turn, suppresses the formation of Z-ring leading to inhibition of cytokinesis and bacterial proliferation. (b) In the case of MRSA, curcumin could inhibit the mecA gene transcription, causing reduced expression of PBP2alfa proteins. As a result, MRSA can be sensitized towards the antibacterial action of Beta-lactam antibiotics such as Penicillin and Methicillin. (c) the binding between curcumin and peptidoglycan on *S. aureus* cell wall could trigger damage on the cell wall membrane, leading to cell lysis of *S. aureus*.

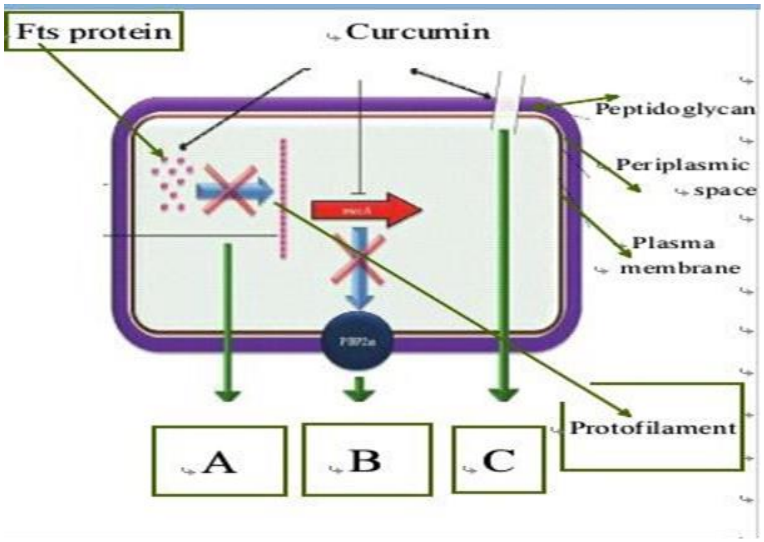

Fig. 2. The potential mechanisms underlying the antibacterial effect of curcumin against *S. aureus.*

DISCUSSION

Turmeric is well known indigenous herbal medicine having many biological activities (Ammon and Wahl, 1991). Curcumin suppress growth of several bacteria (Bhavani and Sreenivasa, 1979). The most predominant bacterial isolate in our study was *Staphylococus aureus* 55 (55.33%). Similarly a previous study reported *S. aureus* as the predominant organism which formed 28.4% of all isolates at the end of the first week after admission (de Macedo and Santos JB, 2005). All the *S. aureus* strains showed significant inhibitory activities. The results are similar to other studies (Atoyebi *et al.,* 1992). An important finding of our study is an apparent change in the microbiology of burns wounds away from the traditionally important gram-negative rods to gram positive cocci. The source of *S. aureus* in burn patients may be exogenous. This finding is corroborated by high environment contamination of surfaces and air with *S. aureus* including MRSA. Since a high level of contamination of air and bath trolleys was seen, it is obvious that control measures should be directed against contamination of environment with *S. aureus*. The reasons for prevalence may be due to factors associated with the acquisition of nosocomial pathogens in patients with recurrent or long-term hospitalization, complicating illnesses, prior administration of antimicrobial agents, or the immunosuppressive effects of burn trauma. No environmental sources were found for *P. aeruginosa*. We suspect the gut of the patient to be a source as *P. aeruginosa* can colonize guts of 30% of the hospitalized patients (Pandit *et al.,* 1993). Patient housing in single bed in a room with a separate sink facility to wash hands and change in staffing pattern has been shown to prevent

infection and reduce mortality (Shirani *et al.,* 1986). The major constituent of turmeric (*Curcuma longa* L.) commonly used for cooking in Asian cuisine is known to possess a broad range of pharmacological properties at relatively nontoxic doses (Teow *et al.,* 2015). It contains a mixture of powerful antioxidant phytonutrients known as curcuminoids and inhibits cancer at initiation, promotion and progression stages of tumor development. It is a strong anti-oxidant, which supports colon health, exerts neuroprotective activity and helps to maintain a healthy cardiovascular system (Luthra *et al.,* 2001). Our results showed MIC value of turmeric extract with *S. aureus* was 0.75 µg/mL, which agrees with a previous study by Lawhavint et al. (2010). It has been reported that Gram positive bacteria are more sensitive to plant extracts (Cosentino *et al*., 1999; Karaman *et al*., 2003). Alzoreky and Nakahara (2003) studied that among gram positive bacteria, *B. cereus* was the most sensitive organism to *C. longa* extract.

CONCLUSION

It was concluded that bacteria burns are more dangerous and may lead to death most often. To ensure early and appropriate therapy in burn patients, a frequent evaluation of the wound is necessary. Curcumin has shown potent antibacterial activity and other pharmacological actions in the past 50 years. Curcumin has been marketed globally as a health supplement mainly for its antioxidant and anti-infammatory properties. In addition, it also has high potential to be developed in to an antibiotic against *S. aureus* and other bacterial strains in the future. More investigation is required in order to better understand the broad action of curcumin prior to develop this compound or its derivatives into a potential antibiotic.

CONFLICT OF INTEREST

The authors declare that no competing interests exist.

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