In vitro antibacterial activity of Omani and African honey

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ABSTRACT

The study aims to investigate the antibacterial activity of honey obtained from different parts of Oman and compare it with that of honey obtained from elsewhere in Africa. A total of 24 honey samples (16 from different parts of Oman and eight from elsewhere in Africa) were investigated for their antibacterial activity against *Staphylococcus aureus* (NCTC 6571), *Escherichia coli* (NCTC 10418) and *Pseudomonas aeruginosa* (NCTC 10662) using standard antimicrobial assays. Marked variations in the antibacterial activity of the different honey samples were observed. Fourteen of the 16 Omani samples and five of the eight African samples showed antibacterial activity ranked as either fair, good or excellent to at least one of the three bacterial strains tested. Both Omani and African honeys possess *in vitro* antibacterial activity against the three bacterial strains tested, with 25% of the samples showing excellent antibacterial activity.

KEY WORDS: Bacterial infections. Honey. Staphylococcus aureus.

Introduction

Honey is used medicinally in many cultures and this is especially true of Muslims who believe strongly in its therapeutic effects. Honey and lemon-honey are traditional remedies in the Middle East and China and for many centuries have been used in the treatment and prevention of the common cold and various upper respiratory tract infections.[1,2]

Honey has also been shown to be of value in treating infected surgical wounds and ulcers,[3-7] decubitus ulcers[4,8] and burns,[9] and is a good medium for preserving skin grafts.[10,11] More recently, the therapeutic effects of honey have been rediscovered and its antibacterial properties demonstrated,[1,12-23] including its effect on organisms that are highly resistant to antibiotics.[1,24]

To our knowledge, up to now the antimicrobial activity of Omani honey has not been investigated. Here, we study the effect of honey samples obtained from different regions of Oman and elsewhere in Africa against three common microbes.

Materials and methods

Honey samples

Twenty-four honey samples (16 from different parts of Oman [H1-16] and eight from Uganda, Tanzania, Nigeria and South Africa [H17-24]) were collected in sterile universal containers and kept for no more than a month at room temperature (20-22°C) before testing.

Test for antibacterial activity

Each honey sample was double diluted with sterile distilled water up to 1 in 16 of its original concentration and *Staphylococcus aureus* (NCTC 6571), *Escherichia coli* (NCTC 10418) and *Pseudomonas aeruginosa* (NCTC 10662) were used to determine the antibacterial activity of each sample.

A sizeable colony of each standard organism was emulsified in 4 mL of distilled water, yielding approximately 1.0×10^6 cells, and used to swab diagnostic sensitivity test agar plates (DST; Oxoid, England). Wells of 6 mm diameter were made and 50 μL of each honey dilution was placed into each well with a pipette. Each dilution was tested in triplicate.

The plates were left at room temperature prior to incubation to allow the honey to diffuse into the agar. After incubation for 18 h at 37°C, the diameters of inhibition zones were measured (mm) and the average recorded.

Results

Table 1 shows the zones of inhibitions produced by all 24 honey samples. Samples H4 (from Oman) and H23 (from Uganda) showed the highest level of activity against *S. aureus*. Additionally, both showed the best activity against *P. aeruginosa* and *E. coli*. Thirteen (81%) samples of Omani honey and seven (88%) of African honey showed anti-staphylococcal activity. However, only 10 (63%) Omani honey samples and five (62%) African honey samples showed any activity against *E. coli*. Activity against *P. aeruginosa* was less common (38%) in the Omani honey samples but more common (75%) in the African honey samples.

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Table 2 shows zones of inhibition as diameters in mm (grading) as >30 mm (excellent), 21-29 mm (good), 10-20 mm (fair) and <10 mm (poor). Using this ranking, six (25%) samples out of all the honey tested showed excellent activity against *S. aureus* but none were excellent against *E. coli* or *P. aeruginosa*. However, Omani honey showed good to excellent activity in seven (39%), two (11%) and two (11%) samples against *S. aureus*, *E. coli* and *P. aeruginosa*, respectively. In the African honey a good rating was seen in 63%, 0% and 12.5% of samples, respectively.

Table 3 compares honey from a region in Oman (Dhofar) with those from the remainder of Oman, and honey from one country in Africa (Uganda) with those from the rest of Africa against *S. aureus* only. All the Ugandan samples showed good to excellent activity, and four (57%) samples from the Dhofar region of Oman showed good activity.

Discussion

Honey has been reported to have anti-*S. aureus* and anti-*E. coli* activity,[16,25] but no activity against *Pseudomonas* species.[26] In the present study, the activities against *S. aureus* and *E. coli* were confirmed; however, some Omani and African honey samples also showed activity against *P. aeruginosa*. Although, honey has been reported to have antifungal activity against *Candida albicans*,[2,27] our samples failed to show any inhibitory effect.

Table 1. Antibacterial activities of the Omani and African honey samples

	Code	Zones of inhibition in mm for dilutions(0-1:16)							
		S. aureus					*E . coli*		*P. aeruginosa*
	0	1:2	1:4	1:8	1:16	0	1:2	0	1:2
Omani honey									
Dhofar Royal farm, Salalah	H4	45	40	35	20	10	20		20
Golub	H10	25	18				19	16	0
Wadi Darbat	H1	25	16				10		10
Nashib	H11	20	11				20		10
Garziz	H9	18					0		0
Arzat Farm	H8	16					0		0
Salalah City	H2	0					0		0
Muscat City 1	H3	30	18				15		10
City 2	H7	0					12		0
Batinah region	H5	35	20				12		20
Barka	H12	21	12				14		0
Dhahrah region	H6	0					0		0
Other areas of Oman									
Wadi Al Sheek	H13	19					14		0
Wadi Naar	H14	15					19		10
Wadi Geneen	H15	14					0		0
Gabal Dummar	H16	18					0		0
African honey									
Uganda Eucalypitus	H23	38	25	15	10		13		20
Mogaliga	H22	32	18				10		10
Propalis	H21	25	17				10		10
Mixed	H24	30	19						10
South Africa	H18	20	12				0		15
Nigeria 1	H19	13					10		10
2	H20	0					0		0
Tanzania	H17	10					0		0

Table 2. A comparison of anti bacterial activity of honey from Oman and Africa against different bacterial strains

Quality	Zone (mm)	*S. aureus*		*E. coli*		*P. aeruginosa*	
		Oman	Africa	Oman	Africa	Oman	Africa
Excellent	>30	3	3	0	0	0	0
Good	21-29	4	2	2	0	2	1
Fair	10-20	6	0	8	5	4	5
Poor	0-9	3	3	6	3	10	2
Total		16	8	16	8	24	8

Table 3. A regional comparison of antibacterial activity against *S. aureus* for honey from Oman and Africa

Quality	Zone(mm)	Dhofar	Oman	Uganda	Africa	Total
Excellent	>30	1	2	3	0	6
Good	21-29	3	1	1	1	6
Fair	10-20	2	4	0	0	6
Poor	0-9	1	2	0	3	6
Total		7	9	4	4	24

Honey at a concentration of 40% was reported to possess strong bactericidal activity to various Gram-negative and Gram-positive bacteria,[28] in particular against Salmonella, Shigella, enteropathogenic *E. coli* and *Vibrio cholera*.

Analysis showed that an Omani honey sample (H4) had the greatest activity out of all the samples tested against *S. aureus*. This antibacterial activity was demonstrable to a dilution of 1 in 16, whereas many samples lost their activity on dilution. It is interesting to note that when a sample showed excellent or good activity against *S. aureus*, it was likely to have fair to good activity against *E. coli* and *P. aeruginosa* (Gram-negative organisms). This would indicate broad-spectrum activity.

When we compared the antibacterial activity of Omani honey with those obtained from Africa, one Ugandan honey sample (H23) obtained from Eucalyptus forests showed almost equivalent antibacterial activity to the best sample (H4) from Oman. It seems, therefore, that the degree of activity depends on the geographical location and the plant source of the honey sample.[29] It might be expected that honey obtained from wadis (river valleys) or mountainous area would show better antibacterial activity than honey obtained from city farms. In the present study, however, this did not appear to be the case as some honey samples obtained from wadis showed no antibacterial activity.

The chemical composition of honey is attributable to the nectar of the flower from which it is produced, and comprises derivatives of seven tetracyclins, fatty acids, lipids, amylases, ascorbic acid, peroxidases and fructose,[30] which may contribute to its antimicrobial activity. High osmolarity, low pH (3.6-3.7), content of phenol 'inhibine', peroxidase, glucose and fructose in honey, and the presence of tetracycline derivatives or fatty acids may all play a role in the antibacterial action.[4,10,16,32-34] However, the relative importance of these factors will depend on the sensitivity of the bacterial species and any additional substances in the honey. Although honey is known to act against different bacteria, including those that are highly resistant to antibiotics,[1,24] its exact mode of action remains unclear.

From the present study and those of others,[14,16] it is clear that some honey samples possess considerable antibacterial activity that could be used to treat infections, particularly in areas where there is a shortage of antibiotics. □

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