Original Article

Invitro Antibacterial Activity Patterns of Branded and Locally Made Honey in the Treatment of Suspected Bacterial Keratitis in Ilorin

***Oladejo OJ[1], Oladejo JM[2], Oladejo PA[3], Kolawole O[4], Adegbehingbe S[5], Olanipekun O[6], Ubah J[7]**

[1] Ophthalmology department, LAUTECH Teaching Hospital6, Ogbomoso.
[2] Medical Microbiology & Parasitology department, University of Ilorin Teaching Hospital,
[3] Faculty of Basic Medical Sciences, Obafemi Awolowo University, Ile-Ife,
[4] Ophthalmology department, Bowen University Teaching Hospital, Ogbomoso,
[5] Ophthalmology department, University of Medical Sciences, Ondo.
[6] Ophthalmology department, Kwara State University Teaching Hospital, Ilorin,
[7] Ophthalmology Department, College of Health Sciences, Osun State University, Osogbo.

Article History
Submitted: 08/11/2024; Accepted: 15/11/2024: Published: 22/12/2024

***Correspondence:** Olawale Job Oladejo
Email: olawalejob4@mail.com

ABSTRACT

Honey has been established as an effective antibacterial and antioxidant for millennia. However, with the alarming rise in the emergence and re-emergence of antibiotic-resistant bacteria as a growing problem and a threat to public health. There is therefore urgent need to search for alternative remedies especially among plants to combat antibacterial resistance in bacteria. The purpose of this study was to determine the invitro antibacterial activity patterns of branded and local honey samples on suspected bacterial keratitis pathogens. Twenty-four honey samples (10 branded and 14 local) were collected from different supermarkets and local markets in Ilorin. The sterility test was performed on all the honey samples by culturing them on Blood agar and incubated at 37^0C in the Medical Microbiology Laboratory. The honey samples were tested for antibacterial activity against 61 clinical isolates collected from patients with suspected bacterial keratitis in Eye clinics in selected hospitals in Ilorin and tested using various culture media and disc diffusion technique in the Laboratory. The honey samples were diluted in sterile deionized water to achieve concentrations of 80, 50, 25, 12.5 and 6.25% (w/v). Different classes of commonly used antibiotics were tested against the isolates by the Kirby Bauer disc diffusion method. The inhibition zone of each antibiotic tested against each isolate was measured using graduated meter rule to determine the diameter of the inhibition zones. Sixty-one clinical isolates were identified by conventional microbiological methods. Both the branded and local honey samples exhibited antibacterial properties against tested Gram-positive and Gram-negative bacteria but the branded honey showed greater anti-bactericidal effect than local honey. Comparative susceptibility pattern of conventional antibiotics, branded and local honey samples were significant against *Klebsiella pneumoniae*, *Citrobacter freundi*, *Escherichia coli*, *Pseudomonas aeruginosa*, *Serratia marcescens*, *Mirococcus spp*, *Staphylococcus aureus* and uncommon pathogens (<0.05). All of the bacterial species studied were susceptible to branded and local honey but the bactericidal activity of branded was greater than the local honey. Branded honey is a good alternative to conventional antibiotics as it has been proven against clinical isolates.

Keywords: Antibacterial, Branded, Comparison, Honey, Inhibition, Local, Susceptible.

INTRODUCTION

Honey is a natural sweet substance consisting of hundreds of compounds.[1] Several reviews and other studies have been published on honey varieties with promising antibacterial and medicinal properties.[2] Honey has been established as an effective antimicrobial and antioxidant for millennia.[3] It is used mainly for the treatment of surface wounds, burns, and inflammation, it has since been developed into medical treatments in the

Article Access
Website: www.wjmbs.org
10.5281/zenodo.14251672

How to cite this article
**Oladejo O J, Oladejo JM, Oladejo PA, Kolawole O, Adegbehingbe S, Olanipekun O, Ubah J. Invitro Antibacterial Activity Patterns of Branded and Locally Made Honey in the Treatment of Suspected Bacterial Keratitis in Ilorin. West J Med & Biomed Sci. 2024;5(3):221-229. DOI:10.5281/zenodo.14251672.*

form of medical grade honey.[4,5] Despite this, the initial interest into honey as an antimicrobial therapy was drastically diminished upon the discovery and implementation of antibiotics.

However, with the alarming rise in the emergence and re-emergence of antibiotic-resistant bacteria as a growing problem and a threat to public health, both in developed and developing nations of the world,[6] uncontrolled use of antibiotics had resulted in emergence of multi-antibiotic-resistant bacteria strains with increasing prevailing infections causing high number of morbidity and occasionally high mortality, mostly in developing countries.[7]

Therefore, there is indeed urgent need to search for alternative remedies especially among plants and animals to combat antimicrobial resistance in bacteria. Honey seems to be a potential natural plant product that can serve for this purpose. Honey is produced by bees, which feed on plants nectar and convert it by enzymatic action to sweet honey which is stored in the honey comb.[8] Honey has been widely reported to possess antibacterial activities.[9] Throughout history, honey has been used in a variety of cultures, with differing applications. The ancient Egyptians used honey as a topical ointment, a wound dressing and for embalming their dead.[9]

The first observations of the antimicrobial activity of honey were made in 1892, and since then honey has been observed to have a broad spectrum of activity inhibiting both Gram-positive and Gram-negative organisms. Antimicrobial activity can be attributed to a variety of factors, in addition to the presence of hydrogen peroxide, osmolarity, and acidity.[10] Water-diluted honeys had higher antimicrobial activity against bacterial strains than broad-spectrum antibacterial antibiotics (tetracycline and chloramphenicol), but they were less effective against fungal strains than antimicrobial antibiotics.[11] The efficacy of honey against these organisms is dependent on the honey used, due to variations in botanical origin, bee health, geographical location and the processing of honey.[3,12]

Antibacterial activity of branded and locally made honey in eye infection is less studied. The purpose of this study was to determine the antibacterial efficacy of branded honey from supermarkets and local honey samples from other markets in Ilorin against corneal pathogens.

MATERIALS AND METHODS

The study setting

The study was conducted at the Eye clinic, Department of Ophthalmology, University of Ilorin Teaching Hospital (UITH), Specialist Eye Hospital and Civil Service Eye Clinic in Ilorin which serve as referral hospitals in Kwara State, North Central, Nigeria. Ethical permission for the study was obtained from Ministry of Health, Ilorin, Kwara State with approval code: MOH/KS/EC/777/88/24.

Characteristics of the participants

This is a cross-sectional study of patients who presented with suspected bacterial keratitis at the Eye Clinics of selected hospitals in Ilorin between July, 2016 and July, 2019. Eyes with clinically suspected fungal, viral or parasitic ulcers were excluded. A complete history was taken with regards to pain, photophobia, watering, and redness. History of predisposing factors like trauma, contact lens wear, dry eye, surgery was obtained. Ocular examination included visual acuity (VA) of both eyes, and slit lamp examination of the cornea for size, site, and depth of the ulcer, presence or absence of perforation. Fluorescein staining of the corneal ulcer for epithelial defects and the presence or absence of hypopyon was determined.

Cornea sample collection

After taking informed consent and explaining the procedure to the patients. Clinical samples totaling 79 corneal scrapings were collected by the Ophthalmologist from infected cornea using 21G needle under Slit lamp examination after instillation of non-preservative topical anaesthesia. Immediately after collection, the samples were introduced into brain heart infusion broth (BHB), yeast extract broth (YEB), and Tris (EDTA) buffer which was stored at temperature of -80^{0}C. Also smears of the samples were made on the slide for Gram staining and the remaining sample was streaked directly on Blood agar, Chocolate and MacConkey agar. The culture samples thereafter transported to the Medical Microbiology and Parasitology Laboratory in University of Ilorin

Teaching Hospital where culture isolation and identification of microorganisms were done.

Gram stained for cellular morphology was done to characterize each isolate. Further characterization was done by subjecting colonies to biochemical tests and Analytical profile index (API) to identify the bacteria to species. The resulting reactions were read according to the reading table attached with the API kit and the identification was obtained by referring to the identification software on apiweb (http//apiweb.biomerieux.com).

Preparation of honey samples and antibiotics

The ten branded honey samples randomly purchased from supermarkets in Ilorin were coded as B1, B2, B3, B4, B5, B6, B7, B8, B9, B10 and fourteen local honey samples randomly purchased from local markets in Ilorin were coded OM, MAK, SEJ, RRI, RR4, KL2, RR2, JO, KL1, R1, PAK, RR3 CSO2 and CSO1. All the samples were transferred to the Medical Microbiology and Parasitology Laboratory, University of Ilorin Teaching Hospital, stored in universal sterile bottles in the dark and kept at 4^0-5^0C until analyzed. Each honey sample was diluted in sterile deionized water to achieve concentrations of 80, 50, 25, 12.5 and 6.25% (w/v). The samples were used immediately after dilution. Sterility test was performed on all the honey by culturing them on Blood agar and incubated at 37^0C for 24-48 hours. The control antibiotics used for the study were Ceftazidime (30µg), Ceftriaxone (30µg), Cefuroxime (30µg), Ciprofloxacin (5µg), Augmentin (30µg), Erythromycin (15µg), Gentamicin (10µg) against the isolated organisms from corneal scraping samples by the Kirby Bauer disc agar diffusion method on Muller Hinton agar according to CLSI guidelines.[13] The inhibition zone of each antibiotic tested against each isolate was measured using graduated meter rule to determine the diameter of the inhibition zones and interpreted as sensitive and resistant according to CLSI guidelines.[13] An artificial honey control was also prepared to test the osmolarity of the honey sugars against the organisms. The control contained 40g of fructose, 30g of glucose, 8g of maltose, and 2g of sucrose dissolved in 100ml of distilled water and diluted to obtain concentrations of 80, 50, 25, 12.5, and 6.25% (w/v).

Antimicrobial activity

The antimicrobial activity of all the honey samples against each of the bacterial organism was examined using the agar well diffusion method described by Stagos et al.[15] Overnight broth culture of 0.5MacFarland turbidy was prepared and spread on Muller Hinton agar, and allowed to air dry. Then, 6 mm diameter well of 4 mm depth was bored into the agar at 4 cm distance apart using sterile cork borer. A 100µl of honey samples was placed in each well while 100µl sterile water served as negative control and 100µl ciprofloxacin of 10µl/ml as positive control. The plates were incubated at 37^0C for 18 to 24 hours. The inhibition zones were measured using graduated meter ruler and mean diameters of the inhibition zones were determined. The inhibition zones less than 12 mm were considered as having no antimicrobial activity according to CLSI 2017 (9).

Minimum inhibitory concentration (MIC)

Standard micro-tube dilution bio-assay was used to determine the MIC of the honey samples against the isolates obtained from the corneal scraping. To each of the well, 100µl of sterile 1% peptone water was placed in well 2 to well 10 in each row. To well 1 and well 2, 100µl of honey sample was placed and serial doubling dilution was made separately from well 2 to well 10 while 100µl was discarded from well 10. Equal volume of 100µl overnight broth culture of 0.5 MacFarland turbidity of identified organism was added to all the dilution ranges from well 1 to well 10. Overnight broth culture of Control organism was placed in well 11 with honey while well 12 contains only 100µl of the honey and 100µl of sterile 1% peptone only to serve as blank. The plate was incubated at 37^0C in ambient air for 24 hours. Absorbance of the each well turbidity before and after incubation was measured on microtiter plate reader Jenway spectrophotometer at 590nm wavelength. The MIC is defined as the lowest concentration of the honey that shows no growth (that is similar absorbance as that of blank). The respective MIC shown by the honey against the isolates was interpreted according to CLSI 2017.[11]

Minimum bactericidal concentration (MBC)

The MBC is defined as the lowest dilution of the honey that kills the bacteria isolates. Subculturing was made from two-fold broth dilutions that inhibit growth of bacteria. The broth dilutes were streaked unto Nutrient agar and incubated at 37^0C for 24 hours. Lack of growth indicates that the honey is having bactericidal potential.

Statistical analysis

The patients' data were collected using a proforma. Thereafter, the data was entered and analyzed using the Statistical Package for Social Scientists (SPSS) version, Chicago 20.0' USA software. Percentages, mean and standard deviation were used to describe numerical variables. Independent categorical variables were compared using the Chi squared test. Confidence interval was set at 95% and for all statistical test $p>0.05$ was considered significant. Presentation was done with the use of frequency tables, charts and figures.

RESULTS

Out of the 79 samples, 61 clinical isolates were obtained through corneal scrapings from patients with suspected bacterial keratitis in the selected hospitals by the Conventional Microbiological Methods, Analytical Profile Index (API) and PCR genotyping at the Microbiology Laboratory of University of Ilorin Teaching hospital. *Staphylococcus aureus* had the highest occurrence of 14 (22.8%), followed by *Pseudomonas aeruginosa* 5 (8.2%), while collection of uncommon pathogens accounted for 17 (27.9%) as indicated in table 1. The most potent active honeys were B4, B6, SEJ and CSO2 as stated in table 2. Branded honey B4 (3, 100%), B6 (6, 100%), B7 (6, 100%) and local honey samples SEJ (4, 100%), CSO2 (4, 100%) had maximum susceptible rates while B1 (3, 50%), B2 (3, 50%), and B3 (2, 50%) had lower susceptible rates and OM, RR1, RR4, KL2, KL1 had zero susceptible rates. Significant higher bactericidal activity was shown by branded honey B6 (6, 100%) and local honey MAK (15, 93.6%) as indicated in table 3. Both Gram- negative and Gram-positive corneal isolates were susceptible to conventional antibiotics as revealed in table 4. Comparative susceptibility pattern of conventional antibiotics, branded and local samples were significant against Klebsiella pneumoniae, Citrobacter freundi, Escherichia coli, Pseudomonas aeruginosa, Serratia marcescens, Staphylococcus aureus and uncommon pathogens (<0.05) as shown in table 5.

Table 1. Bacterial isolates obtained from infectious keratitis using API[14] and conventional methods

Isolates	Number(n)	Percentage (%)
Acinetobacter baumani	2	3.3
Citrobacter freundi	2	3.3
Enterobacter cloacae	2	3.3
Enterococcus faecalis	1	1.6
Escherichia coli	2	3.3
Klebsiella oxytoca	1	1.6
Klebsiella pneumoniae	4	6.6
Micrococcus species	2	3.3
Proteus mirabilis	1	1.6
Pseudomonas aeruginosa	5	8.2
Pseudomonas flu orescens	2	3.3
Serratia marcesens	4	6.6
Staphylococcus epidermidis	2	3.3
Staphylococcus aureus	14	22.8
Unknown pathogens*	17	27.9

**Aeromonas salmonicida, Chromobacterium violaceum, Kokuria varians, Pantoea spp., Providencia stuarti, Pseudomonas luteola, Pseudomonas oryzihabitas, Rahanella aquatilis, Staphylococus auricularis and staphylococcus xylosus*

Table 2: Inhibition rate of Branded honey and Local honey on bacteria pathogens from bacterial keratitis

Branded honey	Susceptible rate, n/%	Resistant rate, n/%	Local honey	Susceptible rate, n/%	Resistant rate, n/%
BI	3 (50.0)	3 (50.0)	OM	0 (0.0)	6 (100.0)
B2	3 (50.0)	3 (50.0)	MAK	14 (87.5)	2 (12.5)
B3	2 (50.0)	2 (50.0)	SEJ	4 (100.0)	0 (0.0)
B4	3(100.0)	0 (0.0)	RR1	0 (0.0)	2 (100.0)
B5	4 (66. 7)	2 (33.3)	RR4	0 (0.0)	2 (100.0)
B6	6 (100.0)	0 (0.0)	KL2	0 (0.0)	2(100.0)
B7	6(100.0)	0 (0.0)	RR2	1 (25.0)	3 (75.0)
B8	7 (77.8)	2 (22.2)	JO	2 (66.7)	1 (33.3)
B9	4 (66.7)	2 (33.3)	KL1	0 (0.0)	2 (100.0)
B10	8 (88.9)	1 (11.1)	R1	1 (25.0)	3 (75.0)
			PAK	1 (25.0)	3 (75.0)
			RR3	3(60.0)	2 (40.0)
			CSO2	4 (100.0)	0 (0.0)
			CSO1	2 (40.0)	3 (60.0)

Table 3: Bactericidal activity of Branded honey and Local honey on bacteria pathogens from Infectious keratitis

Branded honey samples	Suscept ible rate, n/%	Resistant rate, n/%	Local honey samples	Susceptible, n/%	Resistant, n/%
B1	3 (50.0)	3 (50.0)	OM	2 (33.3)	4 (66.7)
B2	3 (50.0)	3 (50.0)	MAK	15 (93.6)	1 (6.3)
B3	0 (0.0)	2 (100.0)	SEJ	2 (50.0)	2 (50.0)
B4	1 (33.3)	2 (66.7)	RR1	0 (0.0)	2 (100.0)
B5	4 (66.7)	2 (33.3)	RR4	0 (0.0)	2 (100.0)
B6	6 (100.0)	0 (0.0)	KL2	0 (0.0)	3 (100.0)
B7	4 (66.7)	2 (33.3)	RR2	2 (50.0)	2 (50.0)
B8	3 (42.0)	4 (57.2)	JO	0 (0.0)	3 (100.0)
B9	3(50.0)	3 (50.0)	KL1	0 (0.0)	2 (100.0)
B10	4 (57.2)	3(42.9)	R1	0 (0.0)	4 (100.0)
			PAK	1 (33.3)	2 (66.7)
			RR3	3 (60.0)	2 (40.0)
			CSO2	2 (50.0)	2 (50.0)
			CSO1	3 (60.0)	2 (40.0)

Table 4: : Antibacterial activities of 61 isolated pathogens in suspected bacterial keratitis

Gram+ve bacteria	No of bacteria isolate	No of sensitive isolates	No of resistant isolates	Antibiotic resistance in %					
				GN	CIP	CAZ	CRO	CXM	AUG
Staph aureus	14	7(50.0%)	7(50.0%)	16	40	-	47.6	51.7	52.4
Staph auricularis	5	4(80.0%)	1(20.0%)	4.0	0.0	-	9.8	14.1	14.2
Staph xylosus	3	3(100.0%)	0.0%	4.0	4.0	-	4.8	14.1	14.2
Staph epidermidis	2	2(100.0%)	0.0%	0.0	0.0	-	0.0	4.7	0.0
Mirococcus spp	1	1(100.0%)	0.0%	0.0	0.0	-	0.0	9.5	0.0
Aeromonas salmonicida	2	2(100.0%)	0.%	8.0	4.0	5.3	4.8	4.7	0.0
Subtotal Gram -ve bacteria									
Klebsiella pneumoniae	4	3(75.0%)	1(25.0%)	8.0	4.0	14.2	15.9	9.5	14.2
Pseudomonas aeruginosa	4	3(75.0%)	1(25.0%)	8.0	8.0	-	15.9	-	-
Pseudomonas luteola	5	5(100.0%)	0.0%	4.0	0.0	-	5.3	--	-
Escherichia coli	2	1(50.0%)	1(50.0%)	0.0	8.0	9.5	10.6	9.5	9.5
Citrobacter freundi	2	2(100.0%)	0.0%	0.0	0.0	0.0	0.0	0.0	4.8
Enterobacter cloacae	1	1(100.0%)	0.0%	8.0	4.0	0.0	0.0	4.7	9.5
Serratia marcesens	1	1(100.0%)	0.0%	4.0	0.0	4.8	5.3	4.7	4.8
Other pathogens	14	12(85.7%)	2(14.3%)	0.0	0.0	0.0	0.0	0.0	0.0
Total	61								

GN Gentamycin, CIP Ciprofloxacin, CAZ Ceftazidime, CRO Ceftriazone, CXM Cefuroxime, AUG Augumentin

Table 5: Overall comparative susceptibility pattern of bacterial agent of suspected bacterial keratitis to antibiotics, Branded and local honeys

Isolates	Antibiotic ZID (mm) mean±SD	Branded honey	Local honey	ANOVA	p-value
Acinetobacter baumanii	20.8±3.11	22.3±2.56	15.50	1.381	0.516
Aeromonas salmonicida	19.60±0.28	20.6±2.55	14.5±1.27	7.851	0.064
Klebsiella pneumoniae	20.48±1.52	18.53±1 .93	15.58±2.33	6.394	0.019
Citrobacter freundi	23.15±1.06	17.65±1.63	14.45±1.91	15.668	0.026
Enterobacter cloacae	20.35±0.35	18.30±1.98	15.80±0.71	6.855	0.076
Escherichia coli	19.80±0.28	21.80±0.57	15.70±0.14	138.143	0.001
Micrococcus specie	21.0±00	16.0±0.28	18.75±0.50	115.769	0.001
Pseudomonas aeruginosa	20.80±2.19	19.28±2.74	15.94±1.72	6.306	0.015
Serratia marcesens	21.95±0.68	21.93±1.54	17.10±1.54	18.051	0.001
Staphyloccus aureus	19.83±1.30	17.03±2.82	17.91±1.76	6.744	0.003
Saphylococcus auricularis	20.67±0.91	28.37±10.95	18.28±2.0	2.010	0.215
Staphylococcus epidermidis	22.65±0.07	20.30±1.56	16.70±3.11	4.451	0.127
Staphylococcus xylosus	20.07±1.36	19.47±6.87	17.50±1.23	0.321	0.737
Uncommon pathogens	19.87±2.08	19.11±3.24	15.26±1.11	3.640	0.002

DISCUSSION

In the present study, the antimicrobial activities of Branded honey samples (purchased from supermarkets) and Local honey (purchased from other markets) was determined against isolated pathogens from corneal scraping samples obtained from patients with suspected bacterial keratitis. In the present study, we found that all the studied branded honeys had significant antibacterial effects against corneal bacterial pathogens, both Gram-positive bacteria and Gram-negative bacteria especially *Escherichia coli, Pseudomonas aeruginosa, Klebsiella pneumoniae and Staphylococcus epidermidis*. The findings are similar to work done by Salonen,[2] Martzen[16] and Combarros-fuertes[17] who found antibacterial activity of honey against *Escherichia coli, Pseudomonas aeruginosa, Klebsiella pneumoniae, Staphylococcus epidermidis*. The most potent active honeys comprise the branded and local honeys. Honey has been reported to have antibacterial activity[3,9] but this activity differs according to the type and source of the honey.[10] The present study showed that branded honey samples from supermarket in Ilorin has higher significant antimicrobial activity with low minimum inhibitory concentration when compared with local honey samples. Similarly, significant bactericidal activities were shown by branded honeys compare to local honeys. Our study showed that both branded and local honey had antibacterial activity but the efficacy of branded honey was higher than the local honey. The low efficacy of local honey may be due to variations in botanical origin, geographical location and the processing of honey. This is similar to the study done by Saranja and Chauhan[3,10] but is different from the work done by Wadi[18] who reported that commercial honey has the same bacterial inhibitory activity as the raw natural unprocessed honey. This may be attributed to variation in geographical location and processing of honey.

In this study, we carried out antibacterial effect on 61 clinical isolates obtained from corneal scrapings. Both Gram-positive and Gram-negative bacteria were inhibited by commonly used antibiotics, branded and the local honey. *Staphylococcus auricularis* (coagulase negative *staphylococcus*) was found to be the most sensitive to different honey samples. This finding is different from the work done by Wadi[18] who found Pseudomonas aeruginosa as the most sensitive to different honeys. This implies that the antibacterial activity and environmental variables varies by geographical area.

Comparative susceptibility pattern of conventional antibiotics, branded and local honey samples were significant against *Klebsiella pneumoniae,*

Citrobacter freundi, Escherichia coli, Pseudomonas aeruginosa, Serratia marcescens, Staphylococci aureus and uncommon pathogens. These results were in agreement with previous findings.[18] Activities of antibiotics, Branded and Local honey to other pathogens were not significant by comparative susceptibility. The overall bacterial activities of the honey samples revealed that branded and local honeys have similar antimicrobial activity against bacteria pathogens associated with infectious keratitis as that of antibiotics. These observations were in agreement with the findings of the previous studies.[11,19] Broad-spectrum antimicrobial activity of honey can be attributed to a variety of factors, in addition to the presence of hydrogen peroxide, osmolarity and acidity.[10]

Honey has also been reported to be more effective as an antibacterial agent against several *Pseudomonas* and *Staphylococcus* strains than antibiotic gentamicin.[10] To demonstrate the synergistic action of honey and antibiotics, honey can be given orally with antibiotics.[20] The inhibitory impact of various floral honey samples against resistant microbes that taint wounds and hinder wound healing [21,22,23] would pave the way for honey to be reintroduced into modern medicine ophthalmology inclusive.

The limitation of honey's ophthalmic usefulness is being studied for future ophthalmic practice. To produce the active component as a pharmaceutical topical product, more research on the active compounds of efficient antibacterial action of natural bee honey is required. Hence, there is urgent need to find natural alternative treatment to counter the multi-drug-resistance organisms. To assess the potency of raw natural and commercial honey against isolated clinical isolates, further investigations should be conducted against antibiotic-resistant microorganisms.

CONCLUSION

Both branded and local honey samples exerted inhibitory effects on the various Gram-positive and Gram-negative bacteria but the bactericidal activity of branded honey is greater than local honey understudy. Branded honey was found to be more susceptible to Coagulase negative *staphylococcus* (*staphylococcus auricularis*) than any other bacteria. Honey could be an alternative treatment approach in chronic wounds and burns of different types of microorganisms not responding to conventional antibiotics without side effects.

Recommendation

There is urgent need to standardize the physico-chemical properties of honey and phytochemical compounds of honeys mostly the local honeys so that it could be adopted as alternative natural remedy for eye treatment against bacterial keratitis.

Ethical approval and consent to participate

Ethical permission was obtained from Ministry of Health, Ilorin, Kwara State with approval code: MOH/KS/EC/777/88/24.

A proforma informed consent to participate in the study was obtained from the patient.

Contribution of authors

Oladejo Olawale Job and Oladejo Janet Mosunmola were involved in study conceptualization, Oladejo Olawale Job, Oladejo Janet Mosunmola, Oladejo Promise Adedayo, Adegbehingbe Stella, Kolawole Olubayo and Ubah Josephine were involved the study methodology, Oladejo Olawale Job, Oladejo Janet Mosunmola, Adegbehinghe Stella, Olanipekun Olajumoke and Ubah Josephine were involved in soft-ware use and formal analysis of data, Oladejo Olawale Job, Oladejo Janet Mosunmola and Ubah Josephine were involved in writing and review of the manuscript, Oladejo Olawale Job and Oladejo Promise Adedayo were involved in administration. All the authors approved the manuscript submitted for publication.

Conflict of interest: None

Source of funding: Self

REFERENCES

1. Nolan V C, Harrison J, Cox J A G. Dissecting the antimicrobial composition of honey. Antibiotics. 2019; doi: org/10.3390/antibiotics8040251
2. Salonen A, Virjamo V, Tammela P, Fauch I, Julkunen-Tiitto R. Screening bioactivity and

bioactive constituents of Nordic unifloral honeys. Food Chem. 2017; 237: 214-224.

3. Cokcetin N N, Pappalardo M, Campbell L T, Brooks P, Carter D A, Blair S E, Harry E J. The antibacterial activity of Australian Leptospermum honey correlates with methylglyoal levels. Plos ONE. 2016; 11: e0167780.
4. Albaridi N A. Antibacterial Potency of Honey. Int J Microbiol. 2019; 2019: 10.
5. Saranraj P, Sivasakthi S. Comprehensive Review on Honey: Biochemical and Medicinal Properties. J Acad Ind Res. 2018; 6: 165-181.
6. Cheng W, Li J, Wu Y, Xu L, Su C, ian Y, et al. Behavoiur of antibiotics and antibiotic resistance genes in eco-agricultural system: a case study. J Hazard Mater. 2016; 304: 18-25.
7. Iroha I, Ikeagwu I, Ejikeugwu C, Nwakaeze E, Eze E, Alu-Okafor F, Ugbo E, Ikechukwu M, Nwuzo A. Prevalence and Antibiogram of Pathogenic Gram-Negative Bacteria Isolated from patients seeking medical care in a Tertiary Hospital in Abakaliki, Nigeria. Global Advanced Res J Medicine and Medical Sciences.2015; 4: 455-460.
8. McLoone P, Warnock M, Fyfe L, Honey; A realistic antimicrobial for disorders of the skin. J Microbiol Immunol Infect. 2016; 49: 161-167.
9. Alaa A M, Al-Nahari S B, Almasaudi E I, Sayed M, El-Ghany A, Barbour E, Soad K, Jaouni A, Harakeh S. Antimicrobial activities of Saudi honey against Pseudomonas aeruginosa. Saudi J Biological Sci. 2015; 22: 521-525.
10. Owayss A A, Elbanna K, Iqbal J et al. In vitro antimicrobial activities of Saudi honeys originating from Ziziphus spina-christiL and Acacia gerrardiiBenth. Trees. Food Science & Nutrition. 2020; 8(1): 390-401.
11. Center for Disease Control and Preventions, National Center for Emerging and Zoonotic Infectious Diseases (NCEZIN) Division of Health Care Quality Promotion (DHQP)
12. El-Sohaimy S A, Masry S H D, Shehata M G. Physicochemical characteristics of honey from different origins. Ann Agric Sci. 2015; 60: 279-287.
13. Clinical and Laboratory Standards Institute (CLSI) (2017) Performance Standards for Antimicrobial Disc Tests. 12th Edition, Clinical and Laboratory Standards Institute, Wayne, PA.
14. Chauhan A, Jindal T. Biochemical and molecular methods for bacterial identification. In: Microbiological methods for environment, food and pharmaceutical analysis. Springer, Chm. 2020: 425-468. Doi.org/10.1007/978-3-030-52024-3 10
15. Stagos D, Soulitsiotis N, Tsadila C, Papaeconou S, Arvanitis C, Ntontos A, Karkarnta F, Adamon-Androulakis S, Petrotos K, Spandidos D A, Kouretas D, Mossialos D. Antibacterial and antioxidant activity of different types of honey derived from Mount Olympus in Greece. Int J Mol Med. 2018; 42: 726-734.
16. Matzen R D, ZinckLeth-Espensen J, Jansson T, Nielsen D S, Lund M N, Matzen S. The antibacterial effect in vitro of honey derived from various Danish flora. Dermato Res Pract.doi: 10.1155/2018/7021713
17. Combarros-Fuertes P, Estevinho L M, Dias L G, Castro J M, Tomas-Barberan F A, Tornadijo M E, Fresno-Baro J M. Bioactive components and antioxidant and antibacterial activities of different varieties of honey: a screening prior to clinical application. J Agric Food Chain Chem. 2019; 67:688-698. doi:org/10.1021/acs.jafc.8b05436
18. Wadi M A. In Vitro Antibacterial Activity of Different Honey Samples against Clinical Isolates. Biomed Res Int. 2022; 2022: 1560050. Doi: 10.1155/2022/1560050
19. Cenet M, Bozdogan A, Sezer G, Acar L, Ulukanli Z. Antimicrobial activities, pollen diversity and physiochemical properties of natural honey from Southeastern Anatolia of Turkey. Advancements in Life Sciences. 2017; 4(2): 47-54.
20. Molan P, Rhodes T, Honey: A biologic wound dressing. Wounds. 2015; 27(6): 141-151.

21. Halstead F D, Webber M A, Oppenheim B A. Use of an engineered honey to eradicate performed biofilms of important wound pathogens: an in vitro study.J Wound Care. 2017; 442-450. Doi.org/10.12968/jowc.2017

22. Qinaala D, Lehesvaara M, Lyhs U, Tikkanem-Kaukanen C. Antibacterial activity of organic Finnish honey against pathogenic bacteria. Org Agr. 2015; 5: 153-159. Doi.org/10.1007/s13165-015-10—0103-9

23. Lee S K, Lee H. Antimicrobial activity of solvent fractions and bacterial isolates of Korean domestic honey from different floral sources. Food Sci Biotechnol. 2016; 25: 1507-1512. Doi.org/10.1007/s10068-016-0234-0