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Orignal article

Determination of antimicrobial activity and some biochemical properties of honey and propolis in Turkish markets

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Summary. We examined the antibacterial activity, microflora, fatty acid composition and protein content of five honey and five propolis samples from Turkish markets. The in vitro antimicrobial activity of the samples was analysed using 10 bacteria (*Streptococcus* sp., *Pseudomonas aeruginosa* DSM 50071, *Escherichia coli* ATCC 25922, *Salmonella typhimurium* NRRL 4463, *Staphylococcus aureus* ATCC 6538 P, *Bacillus subtilis* ATCC 6033, *Enterobacter aerogenes* CCM 2531, *B. subtilis niger*, *Klebsiella pneumoniae* FMC 5, 102*Proteus vulgaris* FMC 11) and two yeasts (*Candida glabrata* ATTC 66032, *Saccharomyces cerevisiae* UGA). The honey samples exhibited antimicrobial activity against six bacteria and one yeast, whereas the propolis samples exhibited antimicrobial activity against all microorganisms tested. Propolis samples contained 7-16 different fatty acids, whereas three of the five honey samples contained no fatty acids, and the protein content of propolis was higher than that of honey. Thus, both propolis and honey exhibited antimicrobial activity, the former being more effective.

Key words: antimicrobial, honey, propolis

Introduction

Humans have consumed bee products for thousands of years due to their numerous health benefits. Honey is an invaluable substance made of a combination of nectar and pollen collected by bees from flowers. Honey contains carbohydrates, organic acids, proteins, amino acids, vitamins and minerals. It has been used as an effective medicinal product since ancient times for the treatment of skin burns, wound ulcers tumors, and gastrointestinal disorders as well as an antibacterial and antifungal agent (1,9).

Propolis, also referred to as bee glue, is a resinous hive product made of substances that honey bees collect from various plant sources and then mix with their own saliva and beeswax. Propolis contains various chemical compounds such as polyphenols, terpenoids, steroids, coumarin, amino acids and inorganic compounds (10-11).

Despite the fact that propolis has been known since ancient times, it has become the focus of great interest in recent years as a useful substance in medicines and cosmetics. Propolis exhibits antibacterial, antifungal, antiviral, antioxidant, antitumor and anti-inflammatory activities (12,18).

The composition of honey and propolis vary based on their plant origin (11-19); therefore, the aim of this study was to examine the natural microflora, antimicrobial effect and total protein and fatty acid contents of five types of honey and five types of propolis sold in Turkish markets.

Materials and Methods

Honey and propolis samples

Five honey samples of different brands were purchased from Turkish markets, and five propolis samples of different floral origin were purchased from herbal stores.

Antimicrobial activity

Preparation of ethanolic extracts of propolis

Thirty percent (w/v) ethanolic extracts of propolis (EEP) were prepared in the absence of bright light at room temperature with moderate shaking. After 1 week, the extracts were filtered and diluted in culture medium to perform susceptibility tests and to determine survival curve parameters.

Microorganisms

The following strains were used in the antimicrobial activity tests: *Streptococcus* sp., *Pseudomonas aeruginosa* DSM 50071, *Escherichia coli* ATCC 25922, *Salmonella typhimurium* NRRL 4463, *Staphylococcus aureus* ATCC 6538 P, *Bacillus subtilis* ATCC 6033, *Enterobacter aerogenes* CCM 2531, *B. subtilis niger*, *Klebsiella pneumoniae* FMC 5, *Saccharomyces cerevisiae* UGA 102, *Candida glabrata* ATTC 66032 and *Proteus vulgaris* FMC 11. These microorganisms were obtained from the Microbiological Laboratory of the Department of Biology, Faculty of Arts and Sciences, Firat University.

Test for antimicrobial activity

Bacteria were incubated in nutrient broth (Difco) for 24 h at 37°C, and yeast were incubated in malt extract broth (Difco) for 48 h at 25°C. The dilution plate method was used to enumerate microorganisms (105 bacteria/ml) and yeast (103–104 yeast/ml). The culture media used for bacteria and yeasts were Müller Hinton Agar (Merck) and Sabouraud Dextrose Agar (Merck 1.07315), respectively. Each medium (0.1 ml) was mixed well by gentle shaking before pouring into sterile Petri dishes. Then, 8-mm wells were cut into the nutrient agar plates for testing the antimicrobial activity (Allen et al., 1991), and 100, 50 or 10 µl of honey or EEP was added to these wells. After incubation at 37°C (for bacteria) and 25°C (for yeasts) for 18 h, the diameters of the zones of growth inhibition were measured.

Microbiological analysis

For the microbiological analysis, honey and propolis samples (10 g) were homogenized in 90 ml physiological serum using a MICRA D8 homogenizer for 5 min. Dilutions were prepared with sterile physiological serum and plated in duplicates on different specific media.

Total bacterial counts were determined on plate count agar (Merck) and incubated for 48 h at 37°C.

Fecal coliforms were determined by the most probable number method using Lactose broth (0.1, 1 and 10 ml; Merck) incubated at 37°C for 48 h.

Next, 1 ml of the dilution was plated on Salmonella-Shigella agar to determine the number of *Salmonella* strains in each dilution. The samples were incubated at 37°C for 24 h.

Furthermore, 1 ml of the dilution was plated on Baird–Parker agar (Merck) to determine the number of *Staphylococcus* strains in each dilution. The samples were incubated at 37°C for 48 h. The catalase test was used to identify *S. aureus.*

Potato Dextrose Agar (Merck) was used to enumerate mold and yeast. Each dilution (0.1 ml) was inoculated and mixed before solidification, and the inoculated plates were incubated for 5 days at 25°C.
Bacillus broth (Merck) and Manganese agar were used to enumerate *Bacillus* sp. The inoculated plates were incubated under aerobic conditions for 48 h at 37°C.

Determination of fatty acid content

The method developed by Hara and Radin (1978) was used to extract lipids from honey and propolis samples (20). The samples were dissolved in a mixture of hexane/isopropanol (3:2, v/v). Sample homogenization was achieved using a MICRA D8 homogenizer. KCl (0.88%) solution was used to remove non-lipid contaminants.

Lipid extracts were converted into methyl esters using 2% sulfuric acid (v/v) in methanol. Fatty acid methyl esters (FAMEs) were extracted using n-hexane. Gas chromatography analysis was performed using GC-17A equipped with a flame ionization detector (FID), an AOC-20s auto sampler and AOC-20i auto-injector (Shimadzu, Kyoto, Japan).

FAMEs were separated on a fused-silica capillary column with a length of 25 mm and diameter of 0.25 mm (Permabond; Macherey–Nagel, Germany). The column temperature was programmed to increase from 120°C to 220°C at a rate of 4°C/min, and the final temperature was held for 15 min. The injector and FID were set at 240°C and 280°C, respectively. Nitrogen was used as the carrier gas under a head pressure of 50 kPa (corresponding to 1.2 ml/min or a column flow rate of 43 cm/s). Individual methyl esters were

identified by comparison with external standard mixtures analyzed under the same conditions. Data were analyzed using Class GC 10 software, version 2.01.

Determination of protein content

The protein content was determined using the Bradford's method. 100 µl of honey solution (50% w/v) was added to 5 ml of Coomassie Brilliant Blue (CBB) reagent. This reagent contains 200 mg of CBB G_{250} dissolved in 100 ml of 95% ethanol and 200 ml of 85% phosphoric acid; the final 2-l volume was adjusted with water. CBB forms a blue complex with proteins. After 2 min of incubation, the absorbance was measured at 595 nm against a blank using a spectrophotometer (Beckman Du 640, USA). Bovine serum albumin was used for the calibration curve (10–100 lg/0.1 ml in 0.15 M sodium chloride). The protein content was calculated and expressed as mg/100 g of honey (21).

Results

All honey samples exhibited no antimicrobial activity against *Streptococcus* sp., *P. aeruginosa*, *E. coli* and *B. subtilis* at any concentration tested and did not produce inhibition zones. The lowest level at which the

Table 1. Antimicrobial activity of different amounts of honey samples with standard drugs (mm).

Sample	Cons.(ml)	*Streptococcus* sp.	*Pseudomonas aeruginosa*	*Escherichia coli*	*Salmonella typhimurium*	*Staphylococcus aureus*	*Bacillus subtilis*	*Enterobacter aerogenes*	*B. subtilis niger*	*Klebsiella pneumoniae*	*Saccharomyces cerevisiae*	*Candida glabrata*	*Proteus vulgaris*
H_1	10	-	-	-	-	-	-	-	-	-	-	-	-
	50	-	-	-	11.333 ± 0.577	11.000 ± 0.000	-	11.333 ± 0.577	11.666 ± 0.577	12.333 ± 0.577	12.333 ± 0.577	12.666 ± 1.154	12.000 ± 0.000
	100	-	-	-	15.333 ± 0.577	14.666 ± 0.577	-	15.666 ± 0.577	16.000 ± 0.000	16.333 ± 0.577	17.666 ± 0.577	18.000 ± 0.000	15.000 ± 0.000
H_2	10	-	-	-	-	-	-	-	-	-	-	-	-
	50	-	-	-	11.333 ± 0.577	11.666 ± 0.577	-	12.333 ± 0.577	12.000 ± 0.000	11.666 ± 0.577	13.000 ± 0.000	13.333 ± 0.577	11.666 ± 0.577
	100	-	-	-	14.333 ± 0.577	15.333 ± 1.155	-	16.333 ± 0.577	16.000 ± 0.000	15.666 ± 0.577	11.333 ± 1.155	18.000 ± 0.000	16.000 ± 0.000
H_3	10	-	-	-	-	-	-	-	-	-	-	-	-
	50	-	-	-	12.000 ± 0.000	11.333 ± 0.577	-	12.000 ± 0.000	12.666 ± 0.577	11.000 ± 0.000	11.000 ± 0.000	13.000 ± 0.000	12.333 ± 0.577
	100	-	-	-	15.000 ± 0.000	14.333 ± 0.577	-	15.666 ± 0.577	16.000 ± 0.000	15.000 ± 0.000	14.333 ± 0.577	15.666 ± 0.577	15.666 ± 0.577
H_4	10	-	-	-	-	-	-	-	-	-	-	-	-
	50	-	-	-	12.333 ± 0.577	12.333 ± 0.577	-	12.666 ± 0.577	12.333 ± 0.577	11.000 ± 0.000	13.333 ± 0.577	11.666 ± 0.577	12.666 ± 0.577
	100	-	-	-	15.333 ± 0.577	15.333 ± 0.577	-	16.000 ± 0.000	15.333 ± 0.577	14.000 ± 0.000	16.666 ± 0.577	15.333 ± 0.577	15.333 ± 1.154
H_5	10	-	-	-	-	-	-	-	-	-	-	-	-
	50	-	-	-	12.000 ± 0.000	12.000 ± 0.000	-	13.000 ± 0.000	12.333 ± 0.577	12.666 ± 0.577	13.333 ± 0.577	13.000 ± 0.000	12.333 ± 0.577
	100	-	-	-	15.333 ± 0.577	15.000 ± 0.000	-	16.333 ± 0.577	15.333 ± 0.577	17.000 ± 0.000	17.333 ± 0.577	16.000 ± 0.000	16.333 ± 1.154
Streptomycin	10	12.333 ± 0.577	11.333 ± 0.577	12.333 ± 0.577	12.000 ± 1.000	12.666 ± 1.154	13.333 ± 0.577	13.000 ± 0.000	12.333 ± 0.577	14.333 ± 0.577	11.000 ± 0.000	11.333 ± 0.577	11.000 ± 0.000
	50	17.333 ± 1.154	17.666 ± 0.577	18.666 ± 0.577	17.000 ± 0.000	17.333 ± 1.547	18.333 ± 0.577	17.333 ± 0.577	17.666 ± 0.577	20.333 ± 0.577	17.333 ± 0.577	18.333 ± 0.577	17.000 ± 0.000
	100	26.000 ± 0.000	24.666 ± 0.577	27.333 ± 0.577	27.333 ± 0.577	25.666 ± 0.577	28.000 ± 0.000	17.666 ± 0.577	26.666 ± 1.154	26.666 ± 1.154	27.666 ± 0.577	28.000 ± 0.000	17.333 ± 0.577

honey samples displayed antimicrobial activity against *S. typhimurium*, *S. aureus*, *B. subtilis*, *E. aerogenes*, *B. subtilis niger*, *K. pneumonia*, *S. cerevisiae*, *C. glabrata* and *P. vulgaris* was 50 µl. The antimicrobial activities of H_1 and H_2 (17–18 mm) against *S. cerevisiae* and *C. glabrata* were greater than those of H_3, H_4 and H_5 (Table 1). All propolis samples exhibited antimicrobial activity against all microorganisms at all concentrations tested. The inhibition zones of propolis were similar to those of the antibiotic streptomycin at 100, 50 and 10 µl. The largest inhibition zone of a propolis sample at 10 µl was 13 mm, and the largest zones from all the samples were against *E. aerogenes*, *S. typhimurium*, *P. aeruginosa*, *Streptococcus sp*. and *S. cerevisiae* (Table 2).

H_2, H_3 and H_5 contained no fatty acids. H_1 contained linolenic (18:2), γ-linolenic (18:3 GLNA), ei-

Table 2. Antimicrobial activity of different amounts of propolis samples compared to a commercial antibiotic.

Sample	Cons.(ml)	*Streptococcus* sp.	*Pseudomonas aeruginosa*	*Escherichia coli*	*Salmonella typhimurium*	*Staphylococcus aureus*	*Bacillus subtilis*	*Enterobacter aerogenes*	*B. subtilis niger*	*Klebsiella pneumoniae*	*Saccharomyces cerevisiae*	*Candida glabrata*	*Proteus vulgaris*
Pr_1	10	11.000 ± 0.000	11.000 ± 0.000	11.666 ± 0.577	11,333 ± 0.577	11.666 ± 0.577	12.333 ± 0.577	13.000 ± 0.000	11.000 ± 0.000	11.000 ± 0.000	12.000 ± 0.000	11.666 ± 0.577	11.000 ± 0.000
	50	14.333 ± 0.577	14.000 ± 0.000	15.000 ± 0.000	15.000 ± 0.000	15.666 ± 0.577	15.000 ± 0.000	14.000 ± 0.000	15.000 ± 0.000	15.333 ± 0.577	14.000 ± 0.000	15.666 ± 0.577	14.000 ± 0.000
	100	22.000 ± 0.000	23.333 ± 0.577	24.333 ± 0.577	22.333 ± 0.577	21.000 ± 0.000	23.666 ± 1.154	21.000 ± 0.000	22.000 ± 0.000	24.333 ± 0.577	21.667 ± 0.577	23.000 ± 0.000	23.666 ± 0.577
Pr_2	10	11.333 ± 0.577	12.333 ± 0.577	11.666 ± 0.577	13.000 ± 0.000	11.666 ± 1.154	11.000 ± 0.000	12.000 ± 0.000	12.000 ± 0.000	12.000 ± 0.000	12.000 ± 0.000	11.000 ± 0.000	11.000 ± 0.000
	50	14.000 ± 0.000	15.000 ± 0.000	15.000 ± 0.000	16.000 ± 0.000	15.666 ± 0.577	15.000 ± 1.000	15.666 ± 0.577	15.000 ± 0.000	16.333 ± 0.577	16.333 ± 0.577	16.000 ± 0.000	15.000 ± 0.000
	100	21.666 ± 0.577	23.000 ± 0.000	22.000 ± 0.000	22.333 ± 1.154	21.000 ± 0.000	24.000 ± 0.000	21.000 ± 1.732	22.000 ± 0.000	24.333 ± 0.577	23.666 ± 0.577	23.000 ± 0.000	22.000 ± 0.000
Pr_3	10	13.000 ± 0.000	11.000 ± 0.000	11.333 ± 0.577	11.000 ± 0.000	12.333 ± 0.577	12.000 ± 0.000	11.000 ± 0.000	11.333 ± 0.577	11.666 ± 0.577	11.000 ± 0.000	11.000 ± 0.000	12.000 ± 0.000
	50	15.666 ± 0.577	15.000 ± 0.000	15.000 ± 0.000	15.333 ± 0.577	15.000 ± 0.000	16.000 ± 0.000	15.000 ± 0.000	15.000 ± 0.000	15.000 ± 0.000	15.000 ± 0.000	15.333 ± 0.577	16.000 ± 0.000
	100	24.000 ± 0.000	23.666 ± 0.577	22.000 ± 0.000	22.333 ± 1.577	24.000 ± 0.000	23.000 ± 0.000	23.666 ± 0.577	23.000 ± 0.000	24.000 ± 0.000	23.000 ± 0.000	24.333 ± 0.577	24.000 ± 0.000
Pr_4	10	11.333 ± 0.577	12.000 ± 0.000	12.333 ± 0.577	12.666 ± 0.577	12.000 ± 0.000	11.666 ± 1.154	13.000 ± 0.000	11.000 ± 0.000	11.666 ± 0.577	13.000 ± 0.000	11.000 ± 0.000	12.000 ± 0.000
	50	14.000 ± 0.000	16.000 ± 0.000	16.666 ± 0.577	17.000 ± 0.000	15.000 ± 0.000	15.666 ± 0.577	17.000 ± 0.000	15.000 ± 0.000	16.666 ± 0.577	16.666 ± 0.577	17.333 ± 0.577	15.000 ± 0.000
	100	22.000 ± 0.000	24.000 ± 0.000	24.333 ± 0.577	25.000 ± 0.000	23.000 ± 0.000	24.666 ± 0.577	23.333 ± 0.577	20.000 ± 0.000	24.666 ± 1.154	26.000 ± 0.000	26.333 ± 0.577	24.000 ± 0.000
Pr_5	10	12.333 ± 0.577	11.333 ± 0.577	12.333 ± 1.154	12.000 ± 1.000	12.666 ± 1.154	13.333 ± 0.577	13.000 ± 0.000	13.333 ± 0.577	14.333 ± 0.577	11.000 ± 0.000	11.333 ± 0.577	11.000 ± 0.000
	50	17.333 ± 0.577	17.666 ± 0.577	16.666 ± 0.577	17.000 ± 0.000	17.333 ±.1.154	18.333 ± 0.577	17.333 ± 0.577	17.666 ± 0.577	20.333 ± 0.577	17.333 ± 0.577	18.333 ± 0.577	17.000 ± 0.000
	100	26.000 ± 0.000	24.666 ± 0.577	27.333 ± 0.577	27.333 ± 0.577	25.666 ± 0.577	28.000 ± 0.000	27.666 ± 0.577	26.666 ± 1.154	26.666 ± 1.154	27.666 ± 0.577	28.000 ± 0.000	24.333 ± 0.577
Streptomycin	10	12.333 ± 0.577	11.333 ± 0.577	12.333 ± 0.577	12.000 ± 1.000	12.666 ± 1.154	13.333 ± 0.577	13.000 ± 0.000	12.333 ± 0.577	14.333 ± 0.577	11.000 ± 0.000	11.333 ± 0.577	11.000 ± 0.000
	50	17.333 ± 1.154	17.666 ± 0.577	18.666 ± 0.577	17.000 ± 0.000	17.333 ± 1.547	18.333 ± 0.577	17.333 ± 0.577	17.666 ± 0.577	20.333 ± 0.577	17.333 ± 0.577	18.333 ± 0.577	17.000 ± 0.000
	100	26.000 ± 0.000	24.666 ± 0.577	27.333 ± 0.577	27.333 ± 0.577	25.666 ± 0.577	28.000 ± 0.000	17.666 ± 0.577	26.666 ± 1.154	26.666 ± 1.154	27.666 ± 0.577	28.000 ± 0.000	17.333 ± 0.577

Table 3. Percentage fatty acid composition of honey.

Sample no	16:0	16:1	18:0	18:1	18:2	18:3 GLNA	18:3 ALNA	20:1	20:2	20:5	22:0	22:1	22:2	22.4	24:1
H_1	0.0	0.0	0.0	0.0	1.59	0.81	0.0	0,48	8,11	0.58	0.70	0.60	49.15	12.47	15.11
H_2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
H_3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
H_4	14.22	15.21	10.27	20.27	8.02	0.0	22.19	0.0	0.0	0.0	0.0	0.0	9.79	0.0	0.0
H_5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

Table 4. Percentage fatty acid composition of propolis.

Sample no	13:0	15:0	15:1	16:0	16:1	17:0	18:0	18:1	18:2	18:3 GLNA	18:3 ALNA	20:0	20:3	20:5	22:0	22:1	22:2	22.6	24:0
Pr_1	0.0	0.0	3.16	15.22	0.0	1.79	1.28	16.26	2.05	8.01	0.96	0.0	22.91	0.0	2.70	2.10	8.66	0.0	13.52
Pr_2	0.0	0.0	2.92	13.56	0.0	2.19	1.35	24.43	2.67	7.50	1.40	0.0	21.44	0.0	1.11	1.33	8.24	11.80	0.0
Pr_3	0.0	0.0	2.61	16.39	0.0	2.47	0.0	21.31	2.21	7.95	0,81	0.0	22.20	0.0	0.0	2,33	5,68	15.99	0.0
Pr_4	0.40	0.43	2.27	11.78	0.28	2.40	1.19	16.96	1.91	8.00	1.05	0.97	22.21	0,53	2,49	1.55	0.0	0.0	0.0
Pr_5	0.0	0.0	4.54	23.63	0.0	0.0	0.0	24.40	2.59	7.93	0.0	0.0	23.56	0.0	0.0	0.0	0.0	13.32	0.0

cosanoic (20:1), eicosadienoic (20:2), eicosapentaenoic (20:5), behenic (22:0), erucic (22:1), docosadienoic (22:2), adrenic (22:4) and nervonic (24:1) acids. H_4 contained palmitic (16:0), palmitoleic (16:1), stearic (18:0), oleic (18:1), linoleic (18:2), γ-linolenic (18:3 GLNA), γ-linoleic (18:3 ALNA) and docosadienoic (22:2) acids. H_1 and H_4 contained linoleic (18:2), γ-linoleic (18:3 ALNA) and docosadienoic acids. Docosadienoic acid was the most (49.15%) and eicosapentaenoic acid was the least (0.58%) abundant in H_1, whereas γ-linoleic acid was the most (22.19%) and linoleic acid was the least (8.02%) abundant in H_4 (Table 3).

In propolis samples, the highest level of fatty acid (oleic acid; 24.43%) was found in Pr_2 while the lowest was found in Pr_4 (tridecanoic acid; 0.4%). No tridecanoic (13:0), pentadecanoic (15:0), palmitoleic (16:1), arachidic (20:0) and eicosapentaenoic (20: 5) acids were found in Pr_1, Pr_2, Pr_3 and Pr_5, while no lignoceric acid (24:0) was found in Pr_2, Pr_3, Pr_4 and Pr_5. Furthermore, Pr_4 and Pr_5 contained the largest and smallest numbers of different types of fatty acids, respectively (Table 4).

The highest protein content in the honey samples was found in H_5, whereas the lowest was found in H_1 (Table 5). In propolis, the highest protein content was in Pr_1 and the lowest was in Pr_2 (Table 6). Propolis samples contained more protein content than that in honey samples.

Table 5. Protein content (mg/g) of honey samples from Turkish markets.

Sample no	Protein content (mg)
H_1	2.77
H_2	3.38
H_3	3.32
H_4	2.95
H_5	3.66

Table 6. Protein content (mg/g) of propolis samples from Turkish markets.

Sample no	Protein content (mg)
Pr_1	149
Pr_2	136
Pr_3	148
Pr_4	141
Pr_5	146

Discussion

The results of this study showed that honey samples at 50 µl were effective against all yeasts. Gür et al. (2001) reported that honey samples have antifungal effects on *S. cerevisiae* UAG 102 and *C. albicans* FMC 17 (22).

Temiz *et al.* (2011) found that propolis exhibited antimicrobial activity against gram positive and negative bacteria (23). The authors also noted that the

antimicrobial effects of propolis samples from different regions were similar. In this study, we also found that propolis exhibited antimicrobial activity against gram positive and negative bacteria and that the antimicrobial effects were similar in samples from different sources. This suggested that active antimicrobial substances in propolis may be similar. Metzner *et al.* (1979) reported that flavonoid, pinocembrin, galangin and caffeic acid in propolis extract exhibited antimicrobial activity against *B. subtilis*, *S. aureus* and *C. glabrata* (24).

Boulanouar (2017) investigated the amount of protein in two different honey samples and propolis and found that the highest and lowest amounts of protein in honey were 1.33 and 0.85 mg/g, respectively, whereas the lowest amount of protein in propolis was 11.77 mg/g (25). In our study, the highest protein content found in honey was 3.66 mg/g in the H_5 sample, while the highest amount of protein in propolis was 149 mg/g in Pr_1.

In conclusion, propolis exhibits strong antibacterial activity against microorganisms as none of the organisms tested could grow in its presence. This effect is also important when compared with standard antibiotics. Therefore, propolis holds promise for use in antimicrobial treatment. Honey samples were not as effective as propolis .

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