**Physico- chemical Characteristics of Algerian Steppe Honey and their Antioxidant and Antibacterial Properties**

**Abstract**

Honey is a natural substance produced by bees, known for its unique flavor and numerous health benefits, including antimicrobial and antioxidants properties that can support overall wellness. Honey has been used for centuries in various cultures, not only as a sweetener but also as a remedy for ailments and a key ingredient in traditional medicine. The maine objective of this study was to assess the physicochemical properties as well as the antioxidant and antibacterial activities of honey from Algerian steppe. Physicochemical parameters, such as pH, moisture content, electrical conductivity (EC), total acidity, ree acidity, ash and HMF were measured. The antibacterial activity of honey samples against *Pseudomonas aeruginosa* ATCC 27853, *Escherichia coli* ATCC 25922, *Staphylococcus aureus* ATCC 33862 was evaluated by using the agar incorporation technique method to determine the minimum inhibitory concentration (MIC).The antioxidant effect was assessed by using the 2,2-diphenyl-1-picrylhydrazyl (DPPH) test and the ferric reducing antioxidant power (FRAP) assay. The obtaind results indicated that the physico-chemical analysis of honey samples confirmed good quality of honey according to the standards set by European Union Commission and Codex Alimentarius Commission. All samples had the ability to scavenge DPPHfree radical and showed reducing potential analyzed by FRAP methods, with the highest antioxidant capacity obtained in *Euphorbia cheiradenia* honey. The result of the antibacterial effect of this study revealed that our honey samples have showed an important antibacterial activity against all the bacterial tested strains, *Noaea mucronata* honey has the better antibacterial effect against *Escherichia coli* and *Staphylococcus aureus.* The results of this study revealed that Algerian honey possess natural bioavtive compounds with antibacterial and antioxidant properties which can be used as natural agents in new drugs for therapy of diseases caused by pathogenic bacteria and oxidative stress.

**Keywords:** Honey, Physicochemical parameters, Antioxidant effect, Antibacterial activity, Bioactive compound.

1. **INTRODUCTION**

Honey is a natural sweet substance produced by bees (*Apis mellifera*) from the nectar of flowers or tree exudates (Liu et al., 2013).Honey has been used for its substantial nutritional benefits and its positive impact on human health. The chemical structure of honey is notably intricate, primarily composed of sugars, specifically fructose and glucose, whith account for approximately 70–80%, along with water content ranging from 10–20%, and various additional constituents, including organic acids (such as gluconic and acetic acids), mineral salts (including potassium, calcium, sodium, and phosphorus), vitamins (notably ascorbic acid and niacin), proteins, enzymes (such as invertase, glucose oxidase, catalase, and phosphatases), volatile compounds, phenolic acids, and flavonoids (Gulzar & Vikas, 2015). These multitude of minor compouds can be added by bees or comes directly from nectar due to the ripening process (Pauliuc et al., 2020). Honey's physico-chemical characteristics and composition are dependent to the plant species that the honey bees visit, as well as by the processing, storage, location, and climate (Saxena et al., 2010). The primary factors that affect the quality of honey are its sensory, physicochemical, and microbiological properties. The European Community Guidelines provide clear specifications for the physicochemical quality of honey (Council Directive of the European Union, 2001). Moisture, electrical conductivity, ash, reducing and non-reducing sugars, free acidity, diastase activity, and the amount of hydroxymethylfurfural (HMF) are the primary characteristics of interest (Azonwade et al., 2018). Furthermore, honey's physicochemical characteristics are crucial for granulation, texture, flavor, storage, and nutritional and medicinal properties (Attri, 2011). Honey has been used in traditional medicine in many contries and is highly valued for its nutritional qualities and therapeutic properties (Estevinho et al., 2008). Numerous scientific studies have demonstrated a wide range of pharmacological effects of honey, especially its antiviral, antibacterial, and antioxidant properties (Shahzad & Cohrs, 2012), treatment of wounds (Molan, 1999), burns (Molan, 2001), skin ulcers (Lasey & Van Rij, 1997) and inflammations. The therapeutic property of honey is due to its chemical composition. In Algeria honey is widely consumed and used in traditional medicine but there is not enough information on the physicochemical and biological properties of Algerian honeys.

1. **MATERIAL AND METHODS** 
   1. **Honey Samples**

Two monofloral honey samples (*Euphorbia cheiradenia* and *Noaea mucronata*) were purchased from beekeepers in region of the steppe of Algeria during the flowering season of 2017 to 2018. Honey samples were kept away from sunlight at room temperature until the analysis.

**2.2. Physico-Chemical Analyses**

The physico-chemical parameters of honey samples were determined according to the harmonized methods of the International Honey Commission (Bogdanov et al., 1997). A pH meter (HI 98127, Hanna instruments, Mauritius) was used to measure the pH of a 10% (w/v) solution of honey prepared in double distilled water. For the water content an Abbe refractometer was used, ash was determinated by incineration in a muffle furnace at 625 °C and for the electrical conductivity a Consort C951 conductivity meter was used. HMF was determined by the Winkler method, absorbance of the red colored reaction product was measured at 550 nm using a spectrophotometer UV visible type Schimadzu 1200. The free acidity is obtained by plotting the neutralization curve with a sodium hydroxide solution and determining the pH of the equivalence point (pHe). The lactonic acidity is obtained by adding an excess of sodium hydroxide to the honey solution and plotting the neutralization curve of the excess sodium hydroxide by a back titration with sulphuric acid.

**2.3. Evaluation of the Antibacterial Activity**

**2.3.1. Bacterial Strains and Inoculums Standardization**

*Pseudomonas aeruginosa* ATCC 27853, *Escherichia coli* ATCC 25922, *Staphylococcus aureus* ATCC 33862, were kindly provided by the university hospital Mustapha Pasha of Algiers (Algeria). Prior to the experiment the strains were maintained by subculture in the specific media; the inoculums suspensions were obtained by taking five colonies from 24-hour cultures. The colonies were suspended in 5 ml of sterile saline solution (0.9% NaCl) and shaken for 15 seconds. The density was adjusted to the turbidity of a 0.5 McFarland Standard (equivalent to 1x108 cfu/ml).

**2.3.2. Minimum Inhibitory Concentration Measurement (MIC)**

The Minimum Inhibitory Concentration (MIC) of honey samples was determined by using the incorporation method; concentrations of honeys between 5 % and 15% (vol/vol) were added into Mueller Hinton agar media to test their efficiency against bacteria. The final volume of honey and media in each plate (diameter of 60 mm) was 5mL. Then standard inoculums of 0.5 McFarland of each bacterial strain was inoculated and the plates were incubated at 37 °C for 24 h. The Minimum Inhibitory Concentration (MIC) was determined by finding the plates with the lowest concentration of honey on which the strain would not grow.

**2.4. Evaluation of The Antioxidant Activity of Honey**

**2.4.1. Total Phenolic Content (TPC)**

Total phenolic content (TPC) of honey samples was determined spectrophotometrically using the Folin-Ciocalteu reagent according to the method of Beretta et al, (2005). One gram of honey was treated with distilled water (10 mL), mixed and filtered using a qualitative filter No. 40 filter paper (Whatman, Cambridge, England). An aliquot of this solution (200 μL) was mixed with Folin-Ciocalteu reagent (500 μL, 10%) for 5 min and then 1500 μL of Na2CO3 solution (10%) was added. All samples were incubated at room temperature for 30 min in the dark and their absorbance was read at 765 nm. A standard curve of gallic acid was drawn with a concentration range of 3.125 x 10–3 to 5 x 10–2 mg/mL. The content of total phenolics was expressed as mg of gallic acid equivalents per 100g of sample (mg GAE/ 100g). All determinations were carried out in triplicates.

**2.4.2. Total Flavonoid Content (TFC)**

The flavonoid content was measured using a colorimetric method, based on the formation of a complex between the aluminum ion and the carbonyl and hydroxyl groups of flavonoids that produce a yellow color (Al Farsi, et al., 2018). One milliliter (1 mL) of honeys solutions (0.2 g/mL) were mixed with 1 mL of a 2% aluminum chloride solution. Following incubation for 30 min, the absorbance of the reaction mixture was measured at 430 nm against a distilled water blank. A standard curve of quercetin was drawn with a concentration range of 3.0 x 10–4 to 4.0 x 10–3 mg/mL, and the results were expressed as mg quercetin equivalents per 100g of honey (mg QE/100g). All determinations were carried out in triplicates.

**2.4.3. Ferric Reducing Antioxidant Power (FRAP Assay)**

The ferric reducing power of honey samples was determined by the method of Yen & Duh (1993) with slight modifications. 2.5 ml of the honey samples solutions at various concentrations (16 mg/mL to 300 mg/mL) were mixed with 2.5 mL of potassium ferricyanide (1%) and phosphate buffer (2.5 mL, 0.2 M, pH 6.6). The mixtures were incubated for 20 min at 50 °C. After incubation, 2.5 mL of trichloroacetic acid (10%) was added to the mixtures, followed by centrifugation at 3000 rpm for 10 min. 1 mL of the upper layer was mixed with 1 mL of distilled water and 0.5 mL of ferric chloride (0.1%). Ascorbic acid and gallic acid were used as reference standards. The increase in absorbance provided an indication of higher reducing power of the samples being analyzed. The reducing potential of honey samples and standards (gallic acid and ascorbic acid) is expressed by the values of the effective concentrations 50% (EC50) that correspond to the concentration of sample needed to give an absorbance equal to 0.5 at 700 nm. The lowest EC50 corresponds to the most important activity.

**2.4.4. Free radical scavenging activity (DPPH test)**

The antioxidant scavenging activity was studied using 1,1-diphenyl- 2-picrylhydrazyl free radical (DPPH) as described by Blois (1958) with some modifications; 1.5 mL of various solution of the honey samples at various concentrations (16 mg/mL to 300 mg/mL) were mixed with 1.5 mL of a 0.2mM ethanolic DPPH solution. After an incubation period of 30 min at 25 °C, the absorbance at 517 nm, the wavelength of maximum absorbance of DPPH, were recorded as a (sample). A blank experiment was also carried out applying the same procedure to a solution without the test material and the absorbance was recorded as A (blank). The free radical-scavenging activity of each solution was then calculated as percent inhibition according to the following equation: % inhibition = 100 (A (blank) – A (sample) */*A (blank).The antioxidant activity of honey was expressed as IC50, defined as the concentration of the test material required to cause a 50% decrease in initial DPPH concentration. Ascorbic acid and Gallic acid were used as a standard. All measurements were performed in triplicate**.**

**3. RESULTS AND DISCUSSION**

**3.1. Physicochemical Analyses**

The results of physico-chemical analyses of our honey samples were indicated in the Table 1.

**Table 1. Physico-chemical characteristics of the studied honey samples**

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Parameter  Honey | pH | Water content  (%) | Electrical conductivity(mS/cm) | Ash  (%) | Free acidity  (meq/k) | Lactonic  Acidity  (meq/kg) | Total  Acidity (meq/kg) | HMF  (mg/k) |
| *Noeae mucronata*  Honey | 4.87 | 14.6 | 0.31 | 0.17 | 9 | 2 | 11 | 19.29 |
| *Euphorbia*  *Cheirdenia*  Honey | 4.35 | 14.4 | 0.63 | 0.21 | 14 | 36 | 50 | 8.77 |

**3.1.1. pH of honey samples**

The studied honey samples are acidic, *Euphorbia cheiradenia* honey is the most acid with a pH value of 4.35 compared to *Noaea mucronata* honey wich present a pH value of 4.87, so our results is consistent with international standards limit (pH 3.40–6.10) (Codex Alimentarius, 2001). Our finding is similar to those previously reported for other honey samples from Algeria (Ouchemoukh et al., 2007) Turkish (Kayacier & Karaman, 2008) and Morocco (Abselami et al., 2018). Numerous organic acids are the cause of honey's acidity. Gluconic acid is the primary acid; other acids include butyric, lactic, oxalic, citric, succinic, formic, tartaric, maleic, and other aromatic acids (Mbogning, 2005). This acidity helps preserve honey's flavor and prevent microbial deterioration.

**3.1.2. Water content**

The honey samples analyzed in this study have comparable water contents, with a values of 14.4% for *E.cheirdenia* honey and 14.6% for *N. mucronata* honey, this values are included in the water range limits (<20%) approved by the international regulations (Codex Alimentarius, 2001). Our moisture levels were similar to those of Algerian honeys (Ouchemoukh et al., 2007) and lower than those found in Moroccan honeys (Abselami et al., 2018) and Estonian honeys (Kirs et al., 2011). Many factors affect the water content of honey, including the degree of maturity reached in the hive, harvesting season, and climatic conditions (Finola et al., 2007).

**3.1.3. Electrical conductivity**

In our investigation, the honey samples' electrical conductivity values were 0,31 mS/cm for *N.mucronata* honey and 0,63 mS/cm for *E.cheirdenia* honey. Our findings are consistent with those that have been previously reported by Saxena et al (2010) and Abselami et al (2018). Electrical conductivity is an essential physicochemical factor for confirming the authentication of unifloral honeys (Khalil et al., 2012). Electrical conductivity readings for floral honeys should be less than 0.8 mS/cm, whereas those for honeydew should be greater than 0.8 mS/cm (Downey et al., 2005). Our honey samples had Electrical conductivity measurements below 0.8 mS/cm which suggests that the studied honeys were of a floral origin. Electrical conductivity varies with the mineral content, the botanical origin and depends on organic acids, proteins and some complex sugars (Terrab et al., 2003).

**3.1.4. Ash content**

The percentage of ash in honey is a quality factor for its botanical and geographic origin. The result of our study inducated that *E.cheirdenia* honey showed a high ash content (0.21%) compared to *N.mucronata* honey (0.17%). Our honey samples' ash content fell within the permissible range (0.6–1.2%) as defined by the Codex range (Codex Alimentarius, 2001).

**3.1.5. Acidity**

Free, lactonic, and total acidity are the three ways that honey's acidity is measured. The total amount of free acids present in both ionized and unionized forms, measured in milliequivalents per kilogram of honey, is known as free acidity. Free acidity is attributed to the presence of organic acids, especially gluconic acids, which are in equilibrium with the corresponding lactones and some inorganic ions such as phosphate or sulfate. Free acidity is a crucial parameter particularly in the presence of hydrolysable ions. Lactonic acidity is the acidity reserve that occurs when honey turns alkaline. The sum of the free and lactonic acidities is the total acidity (Terrab et al., 2002). Our honey samples' free acidity values were 9 meq/kg for *N.mucronata* honey and 14 meq/kg for *E.cheirdenia* honey. Our findings were within the limit allowed by international rules, which stipulate that no more than 50 milliequiv acid/kg (Codex Alimentarius, 2001; European Commission, 2002) showing that there are no unwanted fermentations. The findings of our investigation showed that *E.cheidenia* honey has a much greater lactonic and total acidity than *N.mucronata* honey (Table 1). The acidity of honey contributes to its flavor, its stability against microbial spoilage and improves antioxidant acticity (Cavia et al., 2007). Harvest season and floral source have been identified as factors influencing variations in total acidity (Ojeda de Rodrıguez et al., 2004).

**3.1.6. HMF**

Hydroxymethylfurfural (HMF) is a quality parameter used to confirm the freshness of honey and its processing at high temperatures (Tosi et al., 2002). The HMF level in our honey samples is lower than the limit (40 mg/kg), recommended by the Codex Alimentarius (Codex Alimentarius, 2001). The low HMF contents found in the algerian studies honey attest to the high quality, raw, and unprocessed nature of these samples. Compared to *E.cheirdenia* honey (8.77 mg/kg), *N. mucronata* honey has a higher HMF level (19.29 mg/kg). The HMF contents of the studied honey samples were similar to the values reported by Mondragon-Cortez et al (2013) and Abselami et al (2018). The HMF content in honey can be affected by heat temperature and time, storage conditions, pH and floral source (Fallico et al., 2004).

**3.2. Antibacterial properties of honey samples**

Antibacterial activity of honey a significant benefit, as it has been shown to inhibit the growth of various bacteria and pathogens, making it a natural remedy for wounds and infections. The results of the antibacterial activity of our honey samples were showed in the Table 2. According to the findings of this investigation, our honey samples exhibited significant antibacterial activity against all the bacterial tested strains, they have a similar effect against *Pseudomonas aeruginosa* with a MIC value of 6%, while *N.mucronata* honey has the better antibacterial activity against *Escherichia coli* and *Staphylococcus aureus*, this is may be due to its high phenolic content (55.5± 2.07 mg GAE/100g) compared to *E.cheirdenia* honey. Compared to Gram-positive bacteria, Gram-negative bacteria are more resistant.This may be due to the nature of the Gram negative bacteria wall which is formed mainly of lipoprotein, lipopolysaccharide and lipid. These compounds play a barrier role and limit the penetration of antimicrobial agents through the bacterial wall unlike *S. aureus* which has a Gram-positive wall, free of these compounds (Larpent & Gourgaud, 1985). These results are similar to those obtained by Matzen et al., (2018) and Anand et al., (2019).

**Table 2. Antibacterial activityof the studied honey samples**

|  |  |  |  |
| --- | --- | --- | --- |
| Tested Strains  Honey samples | *Escherichia coli*  ATCC 25922 | *Staphylococcus aureus*  ATCC 33862 | *Pseudomonas aeruginosa*  ATCC 27853 |
| *Noea mucronata* Honey | 6% | 4 % | 6 % |
| *Euphorbia cheirdenia* Honey | 8 % | 5 % | 6 % |

Numerous research have shown that Algerian honey has antibacterial properties. According to a study done by Abdellah et al. (2012), three harmful bacteria namely *Staphylococcus aureus* OxaR ATCC 43300, *Escherichia coli* ATCC 25922 and *Pseudomonas aeruginosa* ATCC 27853 can be inhibited by Algerian wild carrot honey. Alzahrani et al. (2012) found that *Daucus carota* honey obtained from an Algerian beekeeper has a strong antimicrobial activity against *Staphylococcus aureus* 43300 (Oxa R), *Staphylococcus aureus* 25923 (Oxa S) and *Pseudomonas aeruginosa* ATCC 27853 and *Candida albicans.* Other *S*tudy done by Alzahrani et al. (2014) reported that Algerian *Daucus carota* honey possesses antifungal properties against *Aspergillus flavus* and *Aspergillus niger.* The findings of a study conducted by Nedji and Loucif (2014) demonstrated that Algerian honey inhibited the growth of the foodborne pathogens bacteria: *Bacillus cereus* (IPA), *Staphylococcus aureus* (ATCC 25923R), *Escherichia coli* (ATCC 25922), *Pseudomonas aeruginosa* (ATCC 27893R). Belaid et al. (2014) revealed in their study that honeys from northern Algeria had antibacterial effect and inhibited the growth of *Staphylococcus aureus, Bacillus subtilis, Streptococcus faecalis, Klebsiella pneumonia, Escherichia coli* and *Pseudomonas aeruginosa.* The results of a study done by Bouacha et al. (2018) revealed that six honey samples collected from various eastern Algerian locations shown strong antibacterial action against 11 multidrug-resistant bacterial strains, isolated from urinary tract infections of pregnant women. Honey's antibacterial properties are attributed to many factors suche as its acidic pH, osmotic effect of sugars, and production of H2O2 by peroxidase. Some non peroxidase substances also support antibacterial activity which include flavonoids, phenolic acids, and lysozyme (Bogdanov, 2011). Botanical origin plays an important role in influencing a honey´s antimicrobial activity (Taormina et al., 2001).

**3.3. Antioxidant Activity of Honey Samples**

**3.3.1. Total polyphenol content**

The total polyphenol content of the studied honey samples is shown in Figure 1.

**Figure 1. Polyphenol content of honey samples**

One of the most important bioactive compouds found in honey is polyphenol. The obtained result indicated that *N.mucronata* honey has the highest polyphenols content (55.5± 2.07 mg GAE/100g) compared to *E.cheirdenia* honey (54.82±1.83 mg GAE/100g). The total polyphenol content of the studied Algerian honeys is higher than those reported by Khalil et al. (2012), Juszczak et al. (2016) and Pauliuc et al. (2020). Our results are lower than those previously published for other honey samples from Oman (Al-Farsi et al., 2018) and Malysia (Chua et al., 2013). Season, environmental factors such soil type and climate, genetic factors,processing techniques, and the flower from which the nectar was extracted all affected the amount and of phenolic compounds in honey (Ruiz-Navajas et al., 2011).

**3.3.2. Flavonoid content**

Flavonoids are phenolic compouds with a low molecular weight that are essential to the aroma and also provide honey its antioxidant properties. The flavonoids found in honey might come from propolis, pollen, or nectar. The flavonoid contents of the the studied honey samples are represented in the following Figure :

**Figure 2. Flavonoid content of the honey samples**

The current study showed that the flavonoid content of *E.cherdenia* honey (9.37±3.66 mg QE/100g) was higher than that of *N. mucronata* honey (6.83±0.54 QE/100g). The tested honey's flavonoid content is higher than those reported by Khalil et al. (2012), Juszczak et al. (2016) and Pauliuc et al. (2020). Our flavonoid results are lower than those shown in other honey samples from Oman (Al-Farsi et al., 2018) and Malysia (Chua et al., 2013). Honey's flavonoid content varies according to its botanical and geographic origins as well as the time of year it is collected (Mouhoubi et al, 2016).

**3.3.3. Ferric reducing antioxidant power (FRAP)**

The antioxidant capacity of honey is an important biological property because there is a strong need for effective natural antioxidants as alternatives to synthetic food additives in order to prevent deterioration of foods drugs and cosmetics. The result of the antioxidant activity of our honey samples evaluated by the FRAP assay is showed in Figure 3.

**Figure3. Ferric reducing antioxidant power of honey samples**

The examined honeys' antioxidant activity, determined by the reducing potential test, showed that *E.cheirdenia* honey and *N.mucronata* honey have an important antioxidant capacity with EC50 values in the ordre of 159.37±3.91mg/ml and176.93±4.65 mg/ml respectivly. The studied honey samples have a significantly lower reducing power than gallic acid (EC50 = 0.021±0.00236 mg/mL) and of ascorbic acid (EC50= 0.068± 0.00436 mg/mL). *E.cheirdenia* honey has the best reducing power this is may attributed to its high flavonoids content (9.37±3.66mg EQ/100g) compared to *N.muconata* honey (6.83±0.54 mg EQ/100g). Our findings are less than those previously documented for other honey samples from Palestine (Imtara et al., 2018) and Morocco (El-Haskoury et al., 2018).

**3.3.4. Free radical scavenging activity (DPPH test)**

Free radical scavenging capacity of honey is an important aspect of its health benefits, as it helps neutralize harmful free radicals in the body, potentially reducing oxidative stress and lowering the risk of chronic diseases***.*** The result of this study's DPPH test was showed in the Figure 4.

**Figure 4. Free radical-scavenging capacity** **of honey samples**

According to the findings of this study's DPPH test, the honeys under investigation exhibit significant antioxidant activity with IC50 values of 60.67±1.81 mg/mL for *E. cheirdenia* honey and 91.08±0.84 mg/ ml for *N.mucronata* honey. This result is lower than that of the standards antioxidant gallic acid and ascorbic acid, which have IC50s of the order of 0.00426±0.185 mg/mL and 0.00854± 0.75 mg/mL respectively. Our result reported that *E.cheirdenia* honey has the best scavenging activity this is probably attributed to its high flavonoids content (9.37±3.66mg EQ/100g) compared to *N. mucronata* honey (6.83±0.54 mg EQ/100g). The results of free radical-scavenging activity of our honey samples are lower than that reported by Alzahrani et al. (2012b), Kishore et al. (2011) and Almeida et al. (2016). The antioxidant effect of Algerian honey was demonstrated in many scientific researchs. According to Khalil et al. (2012), Algerian honey has a high antioxidant potential, as determined by the FRAP and DPPH tests. This study showed that Algerian honey is a rich source of natural antioxidants. The result of a study done Mouhoubi et al. (2016) showed that Algerian honey samples exhibited a high antioxidant activity. In their study, Rebiai et al. (2017) demonstrated that the phenolic extracts of Algerian honey from *Zygophyllum album* floral sources had antioxydant activity evaluated by 1,1-diphenyl-2-picrylhydrazyl (DPPH) radical scavenging activity and ferric reducing antioxidant power (FRAP) assay. Honey's antioxidant properties are attributed to a variety of substances, such as carodtenois, ascorbic acid, tocopherols, phenolic acides and flavoids, sugars, proteins, amino acids, carotenes, organic acids, Maillard reaction products, and other minor components (Ahmed et al., 2018). The enzymes glucose oxidase and catalase contribute also to the antioxidant activity through their ability to eliminate oxygen from the medium (Ruiz-Navajas et al., 2011). Numerous factors influence honey's antioxidant activity, including geographical origin, environmental factors (temperature, humidity and soil composition) as well as post-harvest condition (Yanishlieva-Maslarova, 2001).

**4. CONCLUSION**

According to the standards set by European Union Commission and Codex Alimentarius Commission, the results of the physico-chemical analysis of the examined honeys found in this study confirmed good quality of Algerian honey.The Evaluation of the biological activities of the tested honey samples demonstrated that Algerian honeys have antibacterial activity against all bacterial tested strains, *Noaea mucronata* honey has the better effect against *S.aureus* and *E.coli.* While *Euphorbia cheiradenia* honey has the better antioxidant effect. Our study's findings may indicate that Algerian honey contains natural bioacive compounds with antioxidant and antibacterial qualities that could be used as natural ingredients in novel medications to treat disorders caused by oxidative stress and pathogenic bacteria.

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