# PHYSICO -CHEMICAL PROPERTIES AND COMPOSITION OF EGYPTIAN HONEY COLLECTED BY *APIS MELLIFERA LAMARCKII* L.

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***Abstract***

A total of 15 honey samples from different five sources and two origins were analyzed ,results are presented concluded ,specific gravity ,viscosity (Poise) ,colour, granulation, EC (%),TSS % ,moisture %, pH ,free acidity mg/kg, lacton mg/kg , total acidity mg/kg ,fructose %, glucose %, sucrose %, maltose %, HMF (mg/kg) and protein %.

The results of physical properties was specific gravity parallel ranged from 1.396 to 1.44 , viscosity ranged 19.63 to 87.83 (Poise), colour ranged 0.136 to 0.328 , granulation ranged 1.451 to 2.01, EC from 0.009 to 0.044 % and TSS ranged 80 to 83.17 % .

The results of chemical properties was parallel ,showed that, pH ranged from 3.66 to 4.77,free acidity 11.7 to 125.67 mq/kg , Lacton 10.5 to 34.3 mq/kg ,total acidity 26.2 to 140.67 mq/kg ,fructose 38.58 to 41.0 % , glucose 30.1 to 33.4 % , sucrose 0.9 to 3.97 % , maltose 4.03 to 9.9 % ,HMF 2.9 to 20.57 mg/kg and protein 0.43 to 0.96 %.

## INTRODUCTION

The composition of a particular honey sample greatly depends on the composition of nectar when it originates. A number of investigations have been related to physical properties and chemical composition of honey ( Arquilue, *et al.* , 1994).

Besides carbohydrates ( 1.3%sucrose , 38.2% fructose , and 31.3% glucose) , honey also has other components such as minerals salts , acids , amino acids and proteins ( Belitz & Grosch, 1988) .

Honey is produced by bees from nectar collected from flowers or other plants secretions. These are converted by bees into honey by the addition of enzymes produced by the bees and through evaporation of the water content. Water and sugar make up most of the content of honey (99%) . The remaining 1% comprises a number of compounds found in very small amounts , but important in giving a honey its personality ; these include enzymes , organic acids , minerals and amino acids, Laurino and.Gelli (2000)

This work was implemented in the Beekeeping Res. Plant Protec.Res. Intst. during the year 2003- 2005.

The aim of the work is study the chemical composition of honey produced by *Apis mellifera lamarckii L* in two region (Assiut and Siwa)

## MATERIALS AND METHODS

Sample of Egyptian honeys were collected from Egyptian honeybee colonies (*Apis mellifera lamarckii L)* from two regions (Assiut and Siwa) in Egypt. All the samples fresh were analyzed for the following properties:-

Physical properties; specific gravity, viscosity, colour, electrical conductivity (%), granulation (G/W) and total soluble solids (% ).

Chemical properties; moisture (%), pH, free acidity (mq/kg) , lactone (mq/kg), total acidity (mq/kg) , fructose (%), glucose (%), sucrose (%), maltose (%) , protein (%) and Hydroxymethylforfural (HMF) .

### The physical properties

The specific gravity was measured according to (Wedmore, 1955) , the viscosity was measured according to (Munro, 1943) , the color was measured according to (White , 1978) , the granulation was measured according to the electrical conductivity ( % ) was measured according to (AOAC,1990 and Vorwohl , 1964).

We used 10 gm of honey sample to determinate the specific gravity, colour and electrical conductivity .

### The chemical composition

The moisture (%) was measured according to (AOAC,1990), the total soluble solids (%) was measured according to (The AOAC, 1980). The quantitative of sugars by using High Performance Liquid Chromatography (HPLC) and measured the concentration of fructose, glucose , sucrose and maltose (%) according to (Bogdanov and Baumann, (1988), the total protein was measured according to (Loiseleur,1963), while the Hydroxymethylfofural (HMF) was measured according to( Lee, *et al.* , 1990). We used 1gm to determinate the moisture, the total soluble solids , fructose, glucose , sucrose and maltose and 0.2gm to determinate the protein.

## RESULTS

Data in Table (1) show the physico-chemical properties of honey produced in Assiut and Siwa by *Apis mellifera lamarckii* . Five types of honey were produced ( clover, citrus , cotton ,alfa alfa and eucalyptus honeys) through three years . The average of specific gravity of five honeys were ( citrus 1.396, clover 1.4 , cotton 1.41, alfa alfa 1.407 and eucalyptus 1.44 ) ,viscosity ( citrus 19.69, clover 69.33 , cotton 34.63 , alfa alfa 48.4 and eucalyptus 87.83 poise) , colour ( citrus 0.328, clover 0.256 and cotton 0.213 , alfa alfa 0.136 and eucalyptus 0.30 ) , granulation ( citrus 1.415, clover 1.716 ,cotton 1.546, alfa alfa 1.7 and eucalyptus 1.949 ) , EC.( citrus 0.016 , clover 0.009 , cotton 0.013, clover 0.018 and eucalyptus 0.044 %) and TSS. ( citrus 80.0 , clover 83.7 and cotton 80.17 , alfa alfa 81.0 and eucalyptus 83.17 % ) .

In case of chemical composition , the average of moisture content of honey samples was ( citrus 20.0 , clover 17.5 , cotton 19.8, alfa alfa 19.0 and eucalyptus 17.13 %) , pH ( citrus 3.73 , clover 3.7 , cotton 3.66 , alfa alfa 4.77 and eucalyptus 4.23 ) , free acidity ( citrus 26.0 , clover 11.7 , cotton 43.3, alfa alfa 125.67 and eucalyptus 47.67 mq/kg) , lacton ( citrus 34.3 , clover 11.2 , cotton 19.0 , alfa alfa 15.67 and eucalyptus 10.5 mq/kg ) , total acidity ( citrus 60.0 , clover 26.2 , cotton 62.33 , alfa alfa 140.69 and eucalyptus 56.83 mq/kg ) . Fructose content was ( citrus 41.0 , clover 38.9 ,cotton 38.58, alfa alfa 39.77 and eucalyptus 40.37%) , glucose (citrus 30.4 , clover 30.1 , cotton 30.7 , alfa alfa 31.77 and eucalyptus 33.4 % ) , sucrose ( citrus 0.9 , clover 2.5 , cotton 2.9 , alfa alfa 2.07 and eucalyptus 3.97 % ) , maltose ( citrus 9.9, clover 6.6 , cotton 4.7, alfa alfa 4.03 and eucalyptus 4.97 % ) HMF ( citrus 14.5 , clover 6.4 ,cotton 2.9 , alfa alfa 20.57 and eucalyptus 3.98 mg/kg ) and protein ( citrus 0.43, clover 0.75 , cotton 0.96 , alfa alfa 0.76 and eucalyptus 0.61 % )

## DISCUSSION

The physical characteristics of honey of practical importance is density. Honey density, expressed as specific gravity (Sg) , it depends on the water content of the honey . The densities of tested honeys (Table 1) could be ranged 1.396 – 1.41 and 1.407 – 1.44 in Assiut (As) and Siwa (Sw) honey, respectively, these densities fall within the reported values by Tharwat & Nafea (2006) who reported that specific gravity (Sg) of Saudi Arabia honey ranged 1.42 – 1.43

Colour (as an optical density) varies with botanical origin , period and storage condition , but transparency or clarity depends on the amount of suspended particles

such as pollen. Data in Table (1) show that colour recorded 0.213 – 0.328 and 0.136 – 0.30 in (As) and (Sw) honey , respectively.

These results are in line with Thawley (1969) who explained that the dark color was partially attributed to condensation between amino acids and sugars in honey of the coloring materials are plans pigments .

Tharwat & Nafea (2006) concluded that the colour of Saudi Arabia honey samples ranged 0.25 – 0.94 .

Table 1 . Physico- chemical properties of different types of honey collected by Egyptian honeybee colonies . ( mean of three years )

| Parameters | Assiut | | | Siwa | |
|---|---|---|---|---|---|
| | Citrus | Clover | Cotton | Alfa alfa | Eucalyptus |
| Specific gravity | 1.396 | 1.40 | 1.41 | 1.407 | 1.44 |
| Viscosity(Poise) | 19.63 | 69.33 | 34.69 | 48.4 | 87.83 |
| Colour | 0.328 | 0.256 | 0.213 | 0.136 | 0.30 |
| Granulation | 1.451 | 1.716 | 1.546 | 1.7 | 2.01 |
| EC (%) | 0.016 | 0.009 | 0.013 | 0.018 | 0.044 |
| TSS % | 80.0 | 83.17 | 80.17 | 81.0 | 83.17 |
| Moisture % | 20.0 | 17.5 | 19.8 | 19.0 | 17.13 |
| pH | 3.73 | 3.7 | 3.66 | 4.77 | 4.23 |
| Free acidity mq/kg | 26.0 | 11.7 | 43.3 | 125.67 | 47.67 |
| Lacton mq/kg | 34.3 | 11.2 | 19.0 | 15.67 | 10.5 |
| Total acidity mq/kg | 60.0 | 26.2 | 62.33 | 140.67 | 56.83 |
| Fructose | 41.0 | 38.96 | 38.58 | 39.77 | 40.37 |
| Glucose % | 30.4 | 30.1 | 30.7 | 31.77 | 33.4 |
| Sucrose % | 0.9 | 2.5 | 2.9 | 2.07 | 3.97 |
| Maltose % | 9.9 | 6.6 | 4.7 | 4.03 | 4.97 |
| HMF mg/kg | 14.5 | 6.4 | 2.9 | 20.57 | 3.98 |
| Protein % | 0.43 | 0.75 | 0.96 | 0.76 | 0.61 |

The lower water content and the higher glucose content, the faster crystallization . Temperature is important , since above 25 and below 5 $^{0}$C virtually no crystallization occurs. Granulation of honeys tested were similar, it was ranged between 1.45 – 1.716 and 1.7 – 2.01 in (As) and (Sw) honey, respectively, Table (1).

Comparable results are reported by other authors such as Tharwat & Nafea (2006) who found that glucose / water 1.72 – 2.18 of Saudi Arabia honey .

Considerable differences in the electrical conductivity ( EC ) values of the tested honeys 0.009 – 0.016 % and 0.018 – 0.044 in (As) and (Sw) honey, respectively,(Table 1). These results were in agreement with Mishref *et al.*, (1999) who found that the EC of Egyptian honey was (0.45 , 0.72 , 0.87%) for clover, cotton and sunflower, respectively . Tharwat & Nafea (2006) found that the EC of Saudi Arabia honey samples ranged 0.01 – 0.09 % .

The Total soluble solids (TSS) values of honey samples were approximately the same in all honey samples (Table 1) , it ranged from 80.0 – 83.17 – 81.0 – 83.17 % in (As) and (Sw) honey, respectively Table (1). The dry matter, which should be 78 % or more , is responsible for protecting honey from fermentation . In this respect , Al-Arify (1998) found that the T.S.S of Saudi Arabia honey ranged 81.73-84.33 % . While Tharwat & Nafea (2006) concluded that the (TSS) content of Saudi Arabia honey ranged 83.0 – 84.5 % .

The chemical composition of the floral honeys including their contents of water, carbohydrate ,reducing sugars (glucose, fructose and maltose) and non reducing sugar ( sucrose) , protein and HMF.

The percentages of moisture in honeys tested were approximately 17.5 – 20.0 and 17.13 – 19.0 % in (As) and (Sw) honey, respectively, (Table, 1). These results are in agreement with the values obtained by other authors. Nafea *et al* ( 2004) found that the moisture of Egyptian honey ranged from 17.0- 19.5% .While Tharwat & Nafea (2006) concluded that the moisture content of Saudi Arabia ranged from 15.5-17.0 % . (Krell ,1996) found that the final water content depends not only on a number of environmental factors during production, such as weather and humidity inside the hive, but also on nectar conditions and treatment of honey during extraction and storage.

The active acidity of a material is expressed as pH . The lactone present in honey , contributes its acidity ( White and Doner , 1980 ) .The pH value of all tested honey types ranges from 3.66 – 3.73 and 4.23 – 4.77 in (As) and (Sw) honey, respectively Table (1) .These results are in line with those of Nafea *et al* (2004) who found that pH of different types of honey ranged from 3.8 – 4.1

The acidity and HMF (Table1) were used to determine the degree of deterioration of the honey .All honey types were found to be within acceptable limit of all samples . Owing to the presence of organic acids , in equilibrium with their corresponding lactones , or internal esters, and some inorganic ions such as phosphate and sulphate , the values for the free acidity ranged from 11.7 – 43.3 and

47.67 – 125.67 mg/kg in (As) and (Sw) honey, respectively ; the lactone acidity (considered as the acidity reserve when the honey become alkaline ) ranges from 11.2 – 34.3 and 10.5 – 15.67 mq/kg in (As) and (Sw) honey, respectively , while the total acidity ranges between 26.2 – 62.33 and 56.83 – 140.67 mq/kg in (As) and (Sw) honey, respectively Table(1) . Comparable results are reported by other authors, Terrab *et al*, (2002) reported that free acidity ranged from 10.3 – 102, lacton acidity ranges 0.01 and 21.4, while total acidity ranges between 12.6 – 115 mq/kg.

The largest portion of the dry matter in honey consists of sugars. This attributes to the characteristic physical properties of honey : high viscosity, high density, and immunity from some types of spoilage. (White and Doner, 1980)

Results in Table (1) show that the concentration of fructose ranges 38.58 – 41.0 and 39.77 – 40.37 % in (As) and (Sw) honey, respectively . As for glucose content , it ranges from 30.1 – 30.7 and 31.77 – 33.4 % in (As) and (Sw) honey, respectively . On the other hand the reducing disccharide maltose a marked reduction was observed in concentration in the tested honey 4.7 – 9.9 and 4.03 – 4.97 % in (As) and (Sw) honey, respectively . On the contrary , a marked elevation in the sucrose content was recorded in the tested honeys 0.9 – 2.9 and 2.07 – 3.97 % in (As) and (Sw) honey, respectively . however, Nafea *et al* (2004) concluded that 36.9 – 41.0 % fructose , 28.3 – 34.2 % glucose, 1.1 – 4.17 % sucrose and 2.8 – 5.5 maltose in Saudi Arabia honey .

HMF, is a breakdown product of certain sugar solution particularly fructose, when stored at high temperature or for a long time or honey adulteration .In this study the values of HMF of Egyptian honey ranged between 2.9 – 14.5 and 3.98 – 20.57 mg/kg in (As) and (Sw) honey, respectively in table (1) . However, Tharwat & Nafea (2006) concluded that the HMF ranged from 0.48 – 21.12 mg/kg in honey of Saudi Arabia honey.

Results Table ( 1 ) show that the crude protein content ranges from 0.43 – 0.96 % and from 0.61 – 0.76 % , in (As) and (Sw) honey, respECtively . This indicates that the higher protein content was in Assiut honeys . Our results are slightly higher than those reported by Lee *et al.* (1990) , who rECorded a total protein content of 0.2 and 0.192 % , respectively. Nafea *et al* (2004) concluded that crude protein of different types of honey ranged as 0.31 – 0.44 % .

From obtained data it is clear that the biochemical variation can be useful for separating at least some different honey types within different types .In my opinion different factors affected the composition of different types of honeys resulted from different origin and different regions.

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# الصفات الطبيعية والكيميائية للعسل المصرى المجموع بواسطة النحل المصرى

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اجرى هذا البحث بهدف دراسة التركيب الكميائي للاعسال المنتجة بواسطة النحل المصرى فى كلا من اسيوط ومركز سيوة وتم اختيار ١٥ عينه عسل (٣ عينات لاعسال الموالح –البرسيم المصرى – القطن من محافظة اسيوط وعيناتين لعسل البرسيم الحجازى – الكافور من مركز سيوة) جمعت بواسطة سلالة النحل المصرى. وقد تم تقدير بعض الصفات الطبيعية والكيميائية لجميع العينات .الصفات الطبيعية وتشمل الكثافة النوعية ، اللزوجة، اللون ،التحبب ،درجة التوصيل الكهربى و المواد الصلبة الذائبة الكلية .الصفات الكيميائية وتشمل الرطوبة،رقم الحموضة ( pH) ،الحموضة الحرة ،اللاكتون ، الحموضة الكلية ، الجلوكوز، الفركتوز، السكروز، المالتوز، هيدروكسى ميثايل فورفورال والبروتين . وقد تم الحصول على النتائج التالية :-

الكثافة النوعية وكانت متشابه فى نوعى العسل تراوحت بين ١,٤٤الى ١,٣٩٦ ، اللزوجة من ١٩,٦٣ الى ٨٧,٨٣(poise) ،اللون من ٠,١٣٦ الى ٠,٣٢٨(O.D) ، التحبب من ١,٤٥١ الى ٢,٠١ ، درجة التوصيل الكهربى ٠,٠٠٩ الى٠,٠٤٤% ، المواد الصلبة الذائبة الكلية من ٨٠,٠ الى ٨٣,١٧ % . اما الصفات الكيمائية فتشمل الرطوبة من ١٧,١٣ الى ٢٠,٠، رقم الحموضة متشابه فى انواع العسل فى المنطقتين حيث تراوحت من ٣,٦٦ الى ٤,٧٧ ، الحموضة الحرة ١١,٧ الى ١٢٥,٧٦ ملى مكافئ / كجم، اللاكتون ١٠,٥ الى ٣٤,٣ ملى مكافئ / كجم، الحموضة الكليةمن ٢٦,٢ الى ١٤٠,٦٧ ملى مكافئ / كجم هيدروكسيى ميثيل فورفورال من ٢,٩ الى ٢٠,٥٧ ملىجرام /كيلو جرام . الفركتوز من ٣٨,٥٨ الى ٤١,٠% ، الجلوكوز من ٣٠,١ % الى ٣٣,٤% ، السكروز من ٠,٩ الى ٣,٩٧ % ، مالتوز من ٤,٠٣ الى ٩,٩ % ،والبروتين من ٠,٤٣ الى ٠,٩٦ % .