Study of linear absorption-fluorescence spectroscopy of natural honey as an active medium.

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Abstract:

In the present work, a study of absorption-fluorescence characterization of natural honey was presented, an optical tests were employed such as, absorbance and fluorescence spectrophotometer. An important parameter The area under the curve were calculated using GEUP program with other function, the results show that the natural pure honey can be used as an active laser medium.

Key words: active medium, spectroscopy, natural honey

Introduction:

Honey is the most primitive nourishing and healing agent. It is a thick, syrupy, translucent. It has a characteristics odour and a sweet, faintly acidic taste. Honey has been used as a food and medicinal product since ancient times. The high sugar concentration, low pH and the presence of flavonoids, hydrogen peroxide, phenolics and terpenes make it a powerful antiseptic and antimicrobial agent. Honey is a mixture of sugars and other compounds. With respect to carbohydrates, honey is mainly fructose (about 38.5%) and glucose (about 31.0%) [1,2]

In spectroscopy, the fluorescence depends on the radiative transitions that are resulted by the transitions of the excited molecules from upper state to lower state, these transitions are, absorption, fluorescence and phosphorescence. The radiation life time (τ_{FM}) can be calculated using Bowen & Wokes relation as follow:[3]

$$\frac{1}{\tau_{FM}} = 2.88\text{X}10^{-9} n^2 (\nu'^2) \int \varepsilon(\nu') d\nu' \quad \ldots(1)$$

Where:
n: refractive index of a medium,
ύ: wave number at the maximum absorption,
$\int \varepsilon(ύ)\, dύ$: the area under the absorption spectrum curve as a function of the wave number ύ.

The radiation life time relates to the fluorescence lifetime (τ_F) as follow:[3]

$$\tau_F = \phi_F \tau_{FM} \quad \ldots (2)$$

Where:
Φ_F: the fluorescence quantum yield, which can be calculated by the ratio of fluorescence spectrum area to the area of absorption spectrum as follow:[3]

$$\phi_F = \frac{\int F(\nu') d'\nu}{\int \varepsilon(\nu') d'\nu} \quad \ldots (3)$$

It was observed that the fluorescence quantum yield (ΦF) for several compounds depends upon the excited wavelength and temperature, such that the ΦF increases as the nonradative transitions decrease with temperature.[3-6]

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The use of spectroscopic measurements may provide a convenient spectroscopic approach for monitoring spectra properties in honey. Therefore this paper examines the fluorescence-absorption spectroscopy for monitoring the spectra curvesto estimate the capability for using the honey as an active medium.
Different spectrophotometer tests were discussed and absorption elements techniques were employed to find quality of honey.

Materials and Methods:

Sample of a pure honey was prepared for measurements, figure (1), Since flavonoids are fluorescent and known to provide honey its characteristic color, use of fluorescence spectroscopy may provide another more convenient spectroscopic approach [7,8]. Visible and near-infrared (VIS-NIR) spectroscopy is a fast and non-destructive technique [9, 10].
The fluorescence-absorption tests were done using UV-visible spectrophotometer model (OPTIMA SP-300) and spectrofluorometer model (S1 174) for measuring the transmission and fluorescence respectively; also, the absorption probe test was employed to analyze the chemical functional groups of the sample besides the chemical elements.
Several parameters were calculated using equations (1) to (3), such as, the fluorescence life time τF, radiation life time τFM etc. the main item that is determined was the area under the fluorescence-absorption curve that is determined by GEUP program.
All the resulted data were plotted using Microsoft excel.

Results and Discussion:

Absorption probe analyzes test

Figure (1) shows the functional group elements of the honey sample. These are different types of sugar in the sample which are under control of honey analysis. sugar, is a mixture of Fructose, Glucose, Maltose, also, honey includesa lot of natural parts like polls, enzymes and different sugars like maltose, turanose, glucose and fructose, partly also saccharose. All these elements have their specific spectrum. The syrup spectrum is influenced by the water signal. Subtraction of water is one possibility to get more information about the content of the syrup. Another possibility is to use pure sugar spectra for the subtraction activity. Figure(1) contains Dextrose, Glucose spectrum from powder. It seems comparing the pure spectrum withthe crystalline sugar they have more similarities. The most important element in the functional group is the dyes group like chlorophyll it is the cause of excited absorbance and so the fluorescence.
The typical honey analysis as follow [2]:

- Fructose: 38.2%
- Glucose: 31.3%
- Sucrose: 1.3%
- Maltose: 7.1%
- Water: 17.2%
- Dyes (chlorophyll)
- Higher sugars: 1.5%
- Ash: 0.2%
- Other/undetermined: 3.2%
- Honey has a density of about 1.36 kilograms per litre (36% denser than water).

The absorption-fluorescence tests:

Figures (2) and (3) show the absorption and fluorescence spectrum of a pure honey sample. Figure (4)

shows typical excited fluorescence-absorption spectra from pure honey samples. Both the spectra have been normalized with respect to peak fluorescence intensity that is characteristic the absorption peak of an active element of honey. All spectra from pure honey samples were characterized by two features, a peek around 675nm and 730 nm. In contrast, a single absorption band around 625nm to 710nm characterized the spectra from absorption spectra. The excitation spectra corresponding to 685nm to 775nm emission from pure honey. This suggests that these bands in the spectra of honey samples are due to the active element, which is dyes, inside the honey composition.

In Figure (2) the absorption spectra of a pure honey sample, two important peaks were appear at 320nm and 410nm, while the range of absorbance started from 280nm to 600nm and there is no limited absorption appear in the spectrum, therefore the excited wavelength for the fluorescence test was limited at 675nm, which in turn gives the emitted wavelength at 740nm, this is shown in Figure (3), the peak appears at 750nm, while the emission limited in the range of 710nm to 790nm. The area under the curve were calculated using GEUP (Geometrical Engineering Utility Program) program as shown in Figure (5) with other functions were also calculated and listed in Table (1)

Conclusions:

Fluorescence spectroscopic study of pure honey revealed significant spectral of honey. While the major contributor to the fluorescence is the active element, the most effected element in the functional group of the honey sample is dyes, (chlorophyll) it might be the cause of the activity of the honey sample.

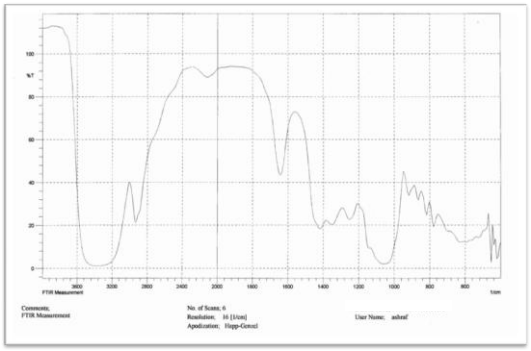

Fig. (1) The functional group diagram of the sample

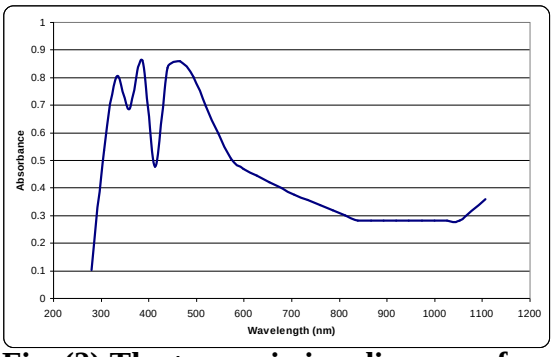

Fig. (2) The transmission diagram of the sample.

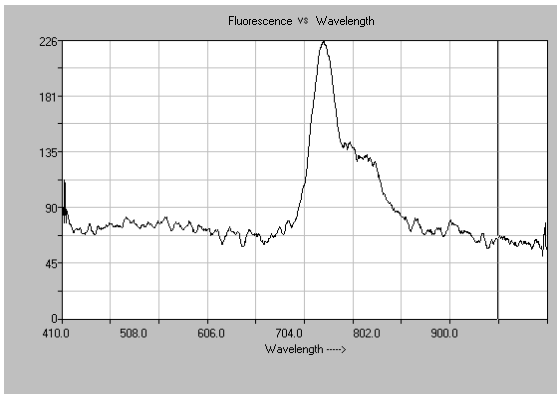

Fig. (3) The fluorescence spectrum diagram of the sample

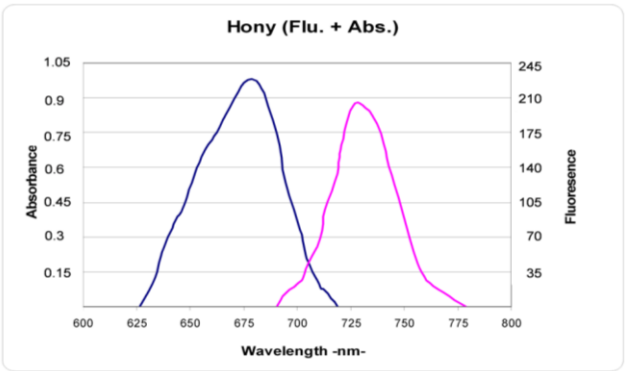

Fig. (4) The fluorescence-absorption spectrum of the sample

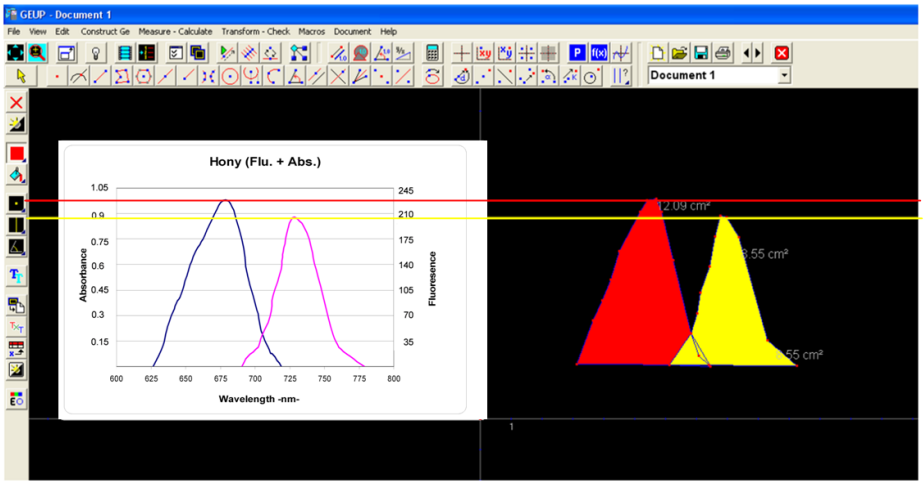

Fig. (5) The image process for measuring area by GEUP program

Table (1) the calculated parameters of the sample

n	area ov.	area Abso Cm2	area Fluo. Cm2	wavelength - nm-	v cm-1	KFM sec-1	ΦF	ζFM	ζF	qFM
1.7	3300	40840.5	18931	484	20661.1570 2	145108	0.41637698	6.89143	$2.87x10^{-6}$	0.4164

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دراسة اطياف الامتصاص و الفلورة الخطية للعسل الطبيعي كوسط فعال

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الخلاصة:
تضمن البحث دراسة الخواص الطيفية لنموذج من العسل الطبيعي, كما أجريت بعض الفحوصات البصرية مثل فحص الأمتصاصية والفلورة. تم كذلك حساب المساحة تحت المنحني باستخدام برنامج ال GEUP بالاضافة الى بقية الحسابات والمتمثلة بزمن عمر الفلورة وحسابات المساحة تحت المنحني, إضافة إلى حساب النتاج الكمي للفلورة. أظهرت النتائج أمكانية أستخدام العسل الطبيعي النقي كوسط فعال لانتاج الليزر.