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FACTOR AFFECTING BEE HONEY QUALITY ACCEPTANCE INCLUDING CONTENTS AND EXTRACTION METHOD

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ABSTRACT

The Egyptian Standard ES: 355-1 / 2005 indicates that the content of nectar honeys from reducing sugars should not be less than 60%, while the content of reducing sugars in honeydew honeys should not be less than 40%. While the sucrose content should not exceed 10% in the case of citrus honey, and not more than 5% for each of Egyptian clover honey, cotton, fennel honey, and multifloral honey. These standards were examined within 165 randomized bee honey samples at the end of nectar honey flow and after honey extracted. The honey authenticity characterization according to the plants sources (i.e. citrus, clover, cotton, fennel, multifloral and unknown) In addition to artificial honey. Characters considered were extract method (only honey combs versus all combs), acceptance, pollen contents and percent sugars (i.e. fructose, glucose, sucrose, maltose and reducing sugars). For citrus honey 37 ones were accepted and 6 were rejected. For clover ones 5 were accepted and 16 were rejected. For cotton ones 18 were accepted and 5 were rejected. For fennel ones 26 were accepted and 4 were rejected. For multifloral honeys 10 were accepted and 8 were rejected for unknown honeys and artificial honey (30) all were rejected. Overall acceptance was 96 versus 69 rejections. For single factor affected acceptance higher fructose, and glucose were positively highly significant, while higher maltose was negatively significant. Applying multiple regressions indicated that increase of sucrose percentage and extracting methods were the significant factors influenced honey acceptance with Egyptian standards. The honey market needs future studies to follow up the management of apiaries in honey production and to limit the methods of honey adulteration.

***Keywords*:** Honey, sugar composition pollen, extraction methods and standard specifications

INTRODUCTION

Honey production depends on many factors, including plant-related factors (from the time of cultivation, fertilization and irrigation .... all agricultural operations) and others related to weather factors (temperature, humidity, wind ... etc.), and the presence of natural enemies of honey bee insects (birds or insects. ... etc, eating bees), the state of honey bee colonies (which includes the density of the forage bees whose task will be to collect honey, the age of the queen, the health status of the bee colonies) Apiary management mainly affects the state of bee colonies before, during and after the season, and the beekeeper also plays a major role in the level of honey produced.

Through the current study it is clear that the most important determinants of non-conformity of some Egyptian honey to the Egyptian standard specifications are the sugar feeding during the nectar flow season and there is a positive relationship between the degree of honey conformity to the standard specification and pollen density

Humanity is currently turning to natural materials and products in hospitalization and raising the level of the immune system in the face of many diseases, especially the last Corona virus, Covid 19.

Bee Honey is among the most important products of honeybees, selling and consuming than other products, which may prompt some producers to try to increase production in order to profit at the expense of the consumer, which falls under fraud. All countries seek to tighten control over the producers and marketers of honey to reduce this, as there are many methods of fraud, which include direct methods for adulteration honey & indirect methods, such as:

1. Mixing of less marketed, lower flavored varieties with higher marketed types of higher flavor,
2. Adulteration using the sugar syrup solution.,
3. The use of invertase enzyme or some other material to reduce the level of sucrose and the production of converted sugars (fructose and glucose).

Many of current research methods to uncover previous fraud attempts, (which cost countries a lot of efforts and money) to control the exhibits inside the honey market (Almeida-Muradiana, *et al.* 2014; Belay, *et al.* 2014; Castro-Vázquez, *et al.* 2014; Guertler *et al.* 2014; Puusepp and Koff, 2014; Zábrodská,Z. and Vorlová, L. 2014; Silvano, *et al.* 2014; Cimpoiu, *et al.* 2013; Bertelli, *et al.* 2010;Acquarone, *et al.* 2007; Cordella, *et al.* 2005; Anklam, 1998).

The aim of this study was evaluate a series of Egyptian produced honey of different sources to find the most effected factors which fit them to Egyptian Standards.

MATERIALS AND METHODS

One hundred and sixty five randomize honey samples collected from most of Egyptian Governorates at the end of nectar flow, and extracted honey season. Follow this, identification plant source and authentication of honey as (citrus "*Citrus* sp", Egyptian clover" *Trifolium alexandrenum*", cotton" *Gossypium* sp.", fennel" *Foeniculum vulgare"*, multifloral, unknown and artificial honeys), carried out Louveaux *et al.* (1978); Sugar content (Chengzhu Ni *et al.,* 2016).

Our observation about honey extract methods that used by beekeepers were recorded, and Egyptian standard uses for standing on honey quality.

Statistical analysis: Obtained results were subjected to simple correlation, regression and multiple regression using Procs Corr and Reg in SAS (Anonymous 2003).

RESULTS

Obtained mean value for different studied honeybee and their acceptance with Egyptian Honeybee Standards (EHS) (i.e.36.12, 31.76, 3.39 and 1.66% for fructose, glucose, sucrose and maltose respectively) are presented in Table (1).

Obtained honey samples were divided into seven types based on the types of pollen present in honey according to a plant source (Yan Song; 2012 and Louveaux *et al.,* 1978) to citrus, clover, cotton, and fennel, multifloral, unknown and artificial honeys.

Thirty seven citrus honey samples were accepted according to Egyptian Standard with means of 38.09, 33.39, 3.51 and 1.72% for fructose glucose, sucrose and maltose respectively. Another six samples were unaccepted slightly high mean percentage of sucrose which reached 10.18%, as a bad beekeeper management during flowering season (Farag, 2020; Abdulkhaliq and Swaileh, 2016).

Egyptian clover honey samples were twenty one. Six samples were accepted with means of 34.33% for fructose, 31.3% for glucose, 0.78% for sucrose and 1.5% for maltose. Sixteen honey samples were not accepted with mean sugar values of 37.08, 30.98, 8.42 and 2.51% for fructose, glucose, sucrose and maltose. This results disagree with Zaghloul, *et al.*(2016) whom stated that sugars with mean percentage should not exceed 32.39, 24.96 and 3.77% for fructose, glucose and sucrose, respectively.

Cotton honey recorded eight samples divided to two groups. The first group was in line with ESS (i.e.36.12, 31.76, 3.39 and 1.66%for fructose, glucose, sucrose and maltose respectively).Second group did not comply with the ESS (i.e. 31.17, 29.4, 7.72 and 2.73% for fructose, glucose, sucrose and maltose, respectively). Also fennel honey showed that near results as a mean read for first group 35.08, 31.7, 1.85 and 1.51%; and second group 34.73, 28.4, 8.55 and 2.49%for fructose, glucose, sucrose and maltose, respectively.

Table 1 : Obtained mean value for citrus, clover, cotton, fennel, multifloral and unknown; and its acceptance with Egyptian standard specifications

Honey type	Studied[1] cases	Extract[2] method	Acceptance[3]	Percent Sugars					Pollen[4] De.
				Fructose	Glucose	Sucrose	Maltose	Reducing	
Citrus	19	1	Yes	37.42	33.05	2.27	1.56	70.47	1.84
Citrus	18	2	Yes	38.76	33.72	4.74	1.87	72.48	2.65
Clover	3	1	Yes	33.4	31.3	0.93	1.49	64.7	1.67
Clover	2	2	Yes	35.25	31.3	0.63	1.53	66.55	4
Cotton	5	2	Yes	36.12	31.76	3.39	1.66	67.88	1.8
Fennel	13	1	Yes	32.5	32.13	2.26	1.63	64.63	1.62
Fennel	14	2	Yes	37.65	31.27	1.44	1.39	68.92	3.71
Multi	12	2	Yes	33.69	29.78	2.84	1.55	63.48	2.67
Unknown	7	1	Yes	34.47	37.28	1.09	0.99	71.75	1
Unknown	3	2	Yes	34.77	30.7	2.52	1.25	65.47	4
Citrus	4	1	No	32.15	30.65	10.19	1.41	62.8	1.75
Citrus	2	2	No	32.42	29.15	10.17	1.42	61.57	2.25
Clover	9	1	No	35.36	30.36	7.07	2.43	65.72	1.67
Clover	7	2	No	38.79	31.6	9.76	2.59	70.39	3.86
Cotton	3	1	No	31.17	29.4	7.72	2.73	60.57	1
Fennel	2	2	No	34.73	28.4	8.55	2.49	63.13	3.5
Multi	1	1	No	36.2	27.5	10.9	1.7	63.7	1
Multi	3	1	No	31.13	26.53	5.53	1.27	57.65	3.5
Unknown	4	1	No	31.81	30.56	6.04	1.81	62.37	1.25
Unknown	4	2	No	31.51	27.21	8.19	1.49	58.73	5
Artificial honey	24	1	No	24.04	23.29	20.87	3.57	47.33	1
Artificial honey	6	2	No	24.26	25.31	6.82	2.04	49.57	4

1. studied cases= number of sample of etch honey type;
2. extract method = 1:extract only honey combs, 2: extract all combs in the hive
3. Acceptance= accept with Egy. Standard; Yes: accept, No: not accept
4. Pollen density= measure as a range from 1(for low density) to 5 (for high density)

Sugar composition in multi-floral honeys (12 samples) results were 33.69 for fructose, 29.78 for glucose, 2.84 for sucrose and 1.55% for maltose in accepted samples. Unaccepted honeys which were four samples record 33.67, 27.95, 8.22 and 1.49% for fructose, glucose, sucrose and maltose, respectively. Eighteen unknown honey samples divided to ten accepted honey samples with a mean values 34.62 fructose, 33.99, glucose, 1.51**%**sucrose and 1.12% maltose and unaccepted with the mean value 31.0 fructose, 33.99 glucose, 1.51 sucrose and 1.12% maltose.

Results from adulterated or artificial samples, showed a nearby read for both fructose and glucose 24.15, 24.30; sucrose ranged from 6.82 to 20.87% and maltose recorded as a mean 2.81%.

Reduced sugars as the sum of individual sugars (fructose and glucose) ranges between 61.57 to 72.48% for citrus honey; 64.7 to 70.39% for clover honey; 60.57 to 67.88% for cotton honey; 63.13 to 68.92% for fennel honey; 57.65 to 63.48% for multifloral honey; 58.73 to 71.75% for unknown honey, and with a low percentage for reducing sugars that ranged between 49.57 to 47.33% in artificial honey samples (Boussiad *et al*., 2014; Eleazu *et al*., 2013; Aloisi, 2010; Ochemoukh *et al*., 2007 Atrouse *et al*., 2004; Kamal *et al*., 2002 and Yilmaz & Yavuz, 1999).

Table 2 : Simple correlation and regression values between honey contents and acceptance

Regression parameter	Fructose	Glucose	Sucrose	Maltose	Reducing sugar	Pollen De.	Extract method
Intercept	-0.57788	-0.91738	0.80279	0.78076	-1.03194	0.59381	0.11098
Slope	0.03506	0.04962	-0.04935	-0.10271	0.0255	-0.00461	0.42511
R	0.498	0.516	-0.528	-0.308	0.563	-0.023	0.111
P	<.0001	<.0001	<.0001	<.0001	<.0001	0.7695	0.1568

Table 3 : Partial regression values for the relation between honey contents and acceptance

Variable	Parameter Estimate	Error	t value	P
Intercept	-0.475	0.222	-2.14	0.034
Fructose	2.555	2.747	0.93	0.354
Glucose	2.562	2.747	0.93	0.352
Sucrose	-0.04	0.005	-7.37	<.0001
Maltose	-0.026	0.021	-1.23	0.221
Reducing sugar	-2.538	2.747	-0.92	0.357
Pollen De.	-0.004	0.014	-0.27	0.791
Extract method	-0.001	0.069	-0.01	0.991

The fraud may be an attempt to raise the amount of honey produced during the seasons of nectar flow of honey by continues feeding honey bee colonies during that period. The third adulteration methods as extraction honey combs which product of represents the feeding of honey bee colonies in other than the honey flow seasons with sugar syrup or inverted sugar, and the fourth method of adulteration is to express sugary products made faraway from honey bee colonies. From data that shown in Table (2&3) indicated that there were seventy five of samples that is subject to the second category of honey adulteration, while data informed that thirty samples falls under the fourth category of cheating, from the samples under study (Zábrodská and Vorlová, 2014; Guler *et al*., 2014; Bertelli *et a*l., 2010; Cordella *et al*., 2005).

The management of beekeepers within countries may differ based on the beekeepers culture or based on the density of pastures for bees and flowering areas; which form the method of beekeeping wooden or mud hives, consisting of one or two vertical units

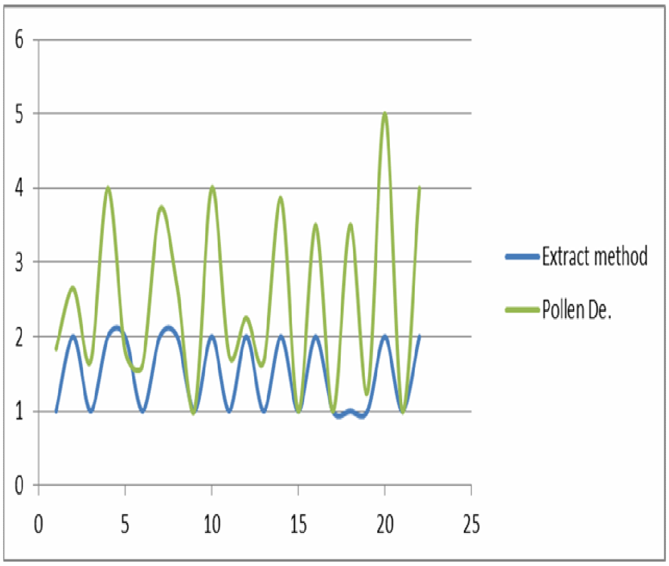

Fig. 1 : Relationship between the method of extraction honey method and pollen density

Most of the countries bordering the Mediterranean depend on beekeeping on single-unit wood cells, as in Greece, Romania, Italy, as well as Egypt.

Accordingly, it may be difficult for some beekeepers to control eggs lying of queens during the honey flow seasons, which may depend on many methods such as partial, or total orphaning, seizing queens on a limited number of combs or placing horizontal barriers, which may not be effective often. Extraction all the combs for irregular storage of honey

Basically, from Fig. (1) display the existence of a direct relationship between the extracting honey method and the pollen density of the honey produced, as pollen densities increase in the case of over-extraction honey from all honeybee combs and decrease in the case of sorting the combs intended for honey by using the means of queen seizure during the honey season.

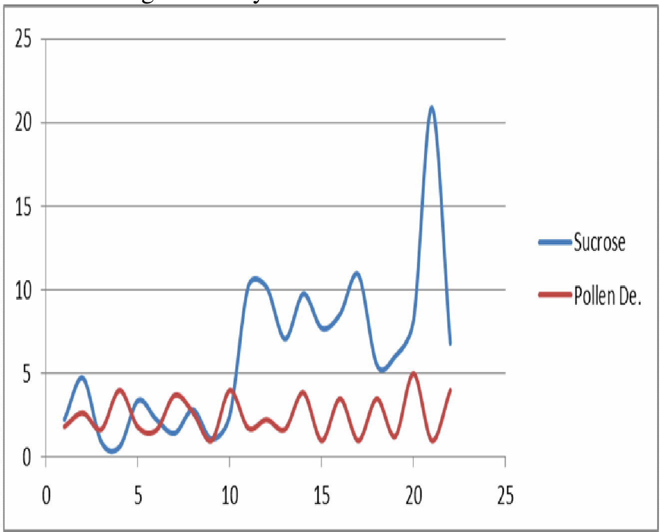

Fig. 2 : Relationship between sucrose percentage and pollen density

It seems that a negative relationship between pollen density in honey and the percentage of sucrose, with a non-significant means. (Fig. 2.). While most honey samples recorded a direct relationship between pollen density and the degree of acceptance of honey and their compliance with standard specifications with a clear significant differences (Table 4.).

Two exceptions given a Misleading results: manufactured honey or the product from feeding the beehives, to which pollen grains are added for the purpose of adulteration and selling it as a pure honey (Fig. 3), this is inconsistent with what Ayodele *et al*. (2006), who considered the presence of pollen as an indication of the originality of honey.

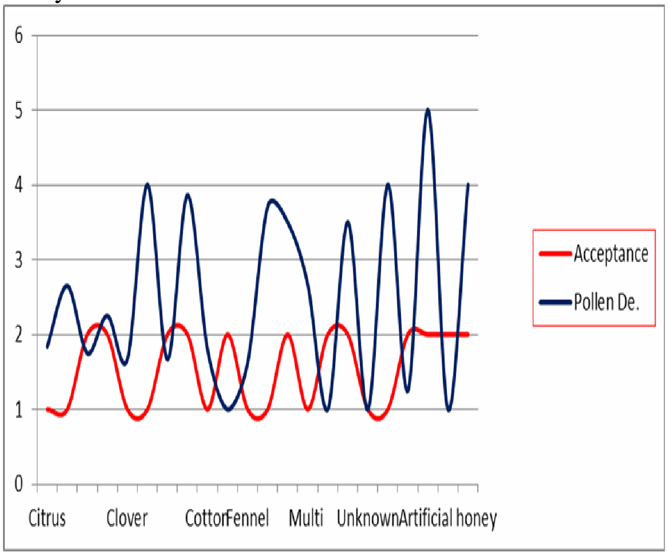

Fig. 3 : Relationship Acceptance of honey with Egyptian Standard and pollen density.

From Table (3) indicated that the significant determinant and important factor for the quality of honey produced under the Egyptian conditions during the study period was the proportion of sucrose.

That product from direct feeding with the use of sucrose during the honey overflow seasons (Farag, 2020; Ruiz-Matute *et al*. (2010).

Table 4 : Partial regression values for the relation between honey contents and extraction method

Variable	Parameter Estimate	Error	t value	P
Intercept	0.61709	0.25402	2.43	0.0163
Acceptance	-0.00098624	0.09180	-0.01	0.9914
Fructose	-0.22000	3.16845	-0.07	0.9447
Glucose	-0.24495	3.16844	-0.08	0.9385
Sucrose	-0.00045570	0.00719	-0.06	0.9496
Maltose	-0.00188	0.02402	-0.08	0.9376
Reducing s.	0.24037	3.16825	0.08	0.9396
Pollen	0.10207	0.01324	7.71	<.0001

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