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BEE HONEY QUALITY ACCORDING TO HONEY BEE COLONY PERFORMANCE

Elbassiouny, A.M.[1]; M.A. Abdul Rahman [2] ; M.I. Abdel-Megeed[1] and M.M. Salama [3]

1- Plant Protec., Dept. Fac. of Agric., Ain Shams Univ., Shoubra EL-Kheima, Cairo, Egypt.

2- Pediatric Dept., Fac. of Medicine, Ain Shams Univ., EL-Abbasia, Cairo, Egypt

3- Scientific Missions Sector, Ministry of Higher Education, Cairo,Egypt.

ABSTRACT

Three types of bee honey were performed: 1st floral honey (bees rehoused on empty combs); the 2nd non floral honey (bees rehoused on empty combs and fed on sugar syrup 50% only) and the 3rd common honey (the colonies were left undisturbed as its same status and fed on sugar syrup 50% in dearth periods). Fifteen free flying honey bee colonies relatively similar strength headed with open mated local Carnica queens, *Apis mellifera carnica*, were divided into three groups (five colonies each). During the season of 2006, the colonies were prepared at the apiary of the Faculty of Agriculture, Ain Shams University, Cairo, Egypt then transferred to its direction (1st & 3rd groups to clover field at El Mehala, Gharbia Governorate and the 2nd group to screen green house at the Faculty of Agriculture, Ain Shams University).

The data showed that the extracted floral (monofloral) honey recorded an average of 1.130 ± 0.630 kg / colony and the colonies were decreased by 12% in strength (number of combs covered with adult bees) and 21.3% for the number of brood cells. The extracted non-floral honey averaged 2.466 ± 0.586 kg / colony and the reduction of colony strength and the brood cells reached to 32 % and 53.1%, respectively. The common (heterofloral) honey recorded high rates reached to 5.266 ± 0.919 kg / colony, moreover the colony strength and the number of brood cells also increased by about 36% and 52.2%, respectively.

The Physicochemical properties of floral (monofloral), non-floral and common (heterofloral) honey showed that the specific gravity recorded 1.412, 1.424 and 1.417 respectively. The viscosity was 36.4, 69.0 and 48.1 poise, respectively. The electrical conductivity recorded 2.6, 0.6 and 1.9 ($\times 10^{-4}$) S/cm, respectively. The moisture percentage recorded 18.5, 17.0 and 18.0 %, respectively. The PH values were 3.6, 3.2 and 4.1, respectively. The free acidity of tested honey types being 20.4, 18.2 and 32.2 milliequ / kg, respectively. The values of Lacton recorded 7.2, 1.2 and 5.6 milliequ / kg, respectively. The values for reducing sugars recorded 74, 61 and 69%, respectively, whereas in case of non-reducing sugar it was 3.3, 19.2 and 9.5%, respectively.

Keywords: honey bee - *Apis mellifera* – honey – physicochemical

INTRODUCTION

Bee honey considered one of the most important component in honey bee colony products, it is a sweet, aromatic and viscous liquid product prepared by bees from nectar of flowers. The bees collect the nectar, modified and stored it in combs for their food.

The honey gain depends upon the colony status such as, race of bees(Guzman-Novoa & Uribe-Rubio 2004 and Rinderer *et al* 2004), genetic aspects (Zarin *et al* 2003), queen quality (Gilley *et al* 2003), brood rearing

activity (Shoreit *et al* 2002), type of combs (Seeley 2002), foraging behaviour (Wenning 2002) and effect of feeding(Mladenovic *et al* 2002; and Keller *et al* 2005). The surrounding environment either weather (Mattila *et al* 2001) or nectar production (Nyeki *et al* 2002) also play an important role for honey production.

The characters of bee honey, as well as its medicinal properties were important for consumers (Dustmann 1993). The physical properties of honey is an important technical parameters during honey processing, where the honey flow during extraction and filtration were attributed to the viscosity (Campos and Modesta 2000) and the specific gravity (Crane 1980 and Gidamis *et al* 2004). The chemical composition of honey was an indicator for its quality. The chemical analysis of honey is complex and the contents of individual constituents vary considerably (Crane 1980). The main portion of the soluble solid in honey was sugar, where reducing sugar (mono-saccharides) represent the major portion and the non reducing sugar (di- & tri- saccharides) represent the minor portion of it. Moreover, the microscopic pollen analyses were identified the botanical origin of the honey (Behm *et al* 1996).

Pure honey is a flower's nectar gathered by bees. Recently some beekeepers increased their honey production by illegal methods (fraud) by offering sugar syrup to their bees before and during the flowering season, so the sugar syrup was mixed with the nectar by bees. The extract honey looks like pure honey but with deficiencies of nutritive and curative values.

Therefore, the present study aimed to throw more light on the factors affecting quantity and quality of bee honey through production under different conditions

MATERIALS AND METHODS

The present work was conducted during blooming season of white clover (During the season of 2006). Fifteen free flying honey bee colonies relatively similar strength headed with open mated local Carniolan queens, *Apis mellifera carnica*, were divided into three groups; each one consisted of five colonies. The colony vigor (colony strength which expressed as the number of combs covered with adult bees and the number of brood cells) for all experimental colonies were measured at first, afterwards the colonies within each group were prepared at the apiary of the Faculty of Agriculture, Ain Shams University, Cairo, Egypt then transferred to different directions as follows:

1st group, floral (monofloral) honey: The bees were rehoused on empty combs, then after the colonies transferred to clover field at El Mehala, Gharbia Governorate until the end of blooming season. The surpluses of empty combs were added when the colony needed.

2nd group, non-floral honey: The bees were rehoused on empty combs plus feeders, then after the colonies transferred to screen green house (10x10x3 meters) at the Faculty of Agriculture, Ain Shams University). Therefore, the bees were free flying but confined and fed on sugar syrup (50%) only.

3rd group, common (heterofloral) honey: The colonies were left undisturbed as its same status from traditional beekeeping, then after the colonies transferred to clover field at El Mehala, Gharbia Governorate until the end of the blooming season. The surpluses of empty combs added when the colony was needed. The colony content of honey stored before the beginning the experiment were weight by weighting the hole honey comb/s then subtract the weight of the empty comb (achieved from similar comb).

In the end of the blooming season of clover, the colony vigor for all experimental colonies measured and then honey of the three groups harvested.

Honey characters

Samples of each type of bee honey were collected and sent to analyzed physicochemical properties in the Chemical Analysis Laboratory of Honey Bee Products, Beekeeping Research Center, Plant Protection Research Institute, Agriculture Research Center as follows:

1 - Physical properties

Which includes; specific gravity according to Crane 1980, viscosity according to Crane 1980, electrical conductivity according to Vorwohle 1964 and Fermentation. The analysis of pollen grain was done in the apiary at Fac. of Agric., Ain Shams Univers.

2 - Chemical analysis

Which includes; moisture percentage (measured using Abbe refractometer at 20 ^{o}C), total soluble solids according to AOAC 1990 (Association of Official Analytical Chemists), pH (pH meter Lutron206), free acidity, lacton, total acidity, concentration of reducing and non reducing sugar according to Bogdanov & Baumann 1988.

Statistical analysis

The statistical analysis for the present results were analyzed using SAS 2001

RESULTS AND DISCUSSION

Colony performance

Honey bee colonies were preparing to perform three types of honey; floral (monofloral), non floral and common (heterofloral). The colonies for each of honey type were investigated to record some of their activities before and after supplying with food.

1 – Floral (monofloral) honey

In the 1st group, the experimental colonies which supplying the floral (monofloral) honey had 5 combs / colony, but at the end of the experiment it had an average of 4.4 ±0.5 combs / colony. The same trend could be applied for the number of brood cells, where it recorded at beginning an average of 3857 ± 514 cells per colony. This record was decreased after performing this type of honey to reach 2977 ±570 cells per colony. Before starting the experiment; no honey combs were presented in the colony, but after the end of the experiment the extracted floral honey recorded an average of 1.130 ± 0.630 kg / colony. It was noticed that the colonies were decreased by 12%

(0- 20%) for the number of combs covered with adult bees and 21.3% (+5.3 : - 43.8%) for the number of brood cells, (Table 1). This mean that the colonies oriented their activities to collect food (nectar and pollen) from the neighbor field to start in building up themselves from the starting point (Wenning 2002) and the brood need much more food for development (Karacaoglu *et al* 2003), moreover the flowers are only food source for feeding.

Table 1. Colonies status for performing floral (monofloral) honey

Rep.	Colony Strength						Honey Combs Before	Honey Extract (kg)
	C C A B*			No. of brood cells				
	Before	After	% (+ / -)	Before	After	% (+ / -)		
.1	5	4	-20	4413	3319	- 24.8	0	1.030
2	5	5	0	3524	3710	+ 5.3	0	0.460
3	5	5	0	3150	2965	- 5.9	0	0.740
4	5	4	-20	3993	2244	- 43.8	0	2.100
5	5	4	-20	4205	2647	- 37.1	0	1.320
mean	5	4.4	-12	3857	2977	- 21.3	0	1.130
± S.D		±0.5		±514	±570			±0.630

*** C C A B = Combs Covered with Adult Bees**

2 – Non floral honey

In the 2nd group (non floral honey), due to the presence of bees free flying but captured in screen green house, the rate of egg laying by the queen decrement as the time was progress, where the number of brood cells decreased from an average of 3905 ± 412 cells / colony before starting the feeding experiment to an average of 1840 ± 362 cells / colony after performing the non floral honey by reduction 53.1%(-44.8%: -62.4%). As the result of reduced brood cells, the colony strength was declined from 5 combs / colony to 3.4 ±0.5 combs covered with adult bees per colony by 32 % (-20%: -40%) reduction. On the other hand, and in spit of the colonies received the same arrangement (build up themselves from the starting point) as first group but the extracted non floral honey somewhat higher than the previous which averaged 2.466 ± 0.586 kg / colony, Table (2).

Table 2. Colonies status for performing non-floral honey

Rep.	Colony Strength						Honey Combs Before	Honey Extract (kg)
	C C A B*			No. of brood cells				
	Before	After	% (+ / -)	Before	After	% (+ / -)		
.1	5	4	- 20	4059	2240	- 44.8	0	1.740
2	5	4	- 20	4216	2090	- 50.6	0	2.430
3	5	3	- 40	4308	1910	- 55.7	0	2.950
4	5	3	- 40	3569	1340	- .62.4	0	3.140
5	5	3	- 40	3373	1620	- 51.9	0	2.070
mean	5	3.4	- 32	3905	1840	- 53.1	0	2.466
± S.D		±0.5		±412	±362			±0.586

*** C C A B = Combs Covered with Adult Bees**

This may be attributed to continuously offering sugar syrup only ad libitum as daily food and no effort was made to bring it from out side. The deterioration of the colonies strength related to keeping the bee colonies in enclosures of greenhouse. Caging honey bee affected both the bee behaviour and its activity mainly due to differential microenvironmental conditions (Vaishampayan and Sinha 2000), moreover suffering from protein nutritional deficiencies (Kalev *et al* 2002).

3 – Common (heterofloral) honey

The colonies in the 3rd group (common honey) were already build up (du to feeding sugar syrup in dearth period and has protein source as a pollen), so the colonies were strengthen during the blooming season. Consequently the number of combs covered with adult bees from both sides were increased from 5 combs / colony to an average of 6.8 ± 0.8 combs / colony with rate of increment averaged 36% ranging between 20% and 60%. The same rend could be applied for the number of sealed brood cells, where an average of 3723 ± 446 cells / colony increased to reach an average of 5668 ± 860 cells / colony by increasing about 52.2% (33.3% - 66.4%). The common honey gained recorded high rates, reached to 5.266 ± 0.919 kg / colony. It was noticeable that the quantity of honey in this group was not completely from flowers, but the colony starting the season with honey combs from previous feeding reach to 1.6 ± 0.4 combs / hive bearing about 1.067 ± 0.287 kg / colony. The amount of performed common honey include about 9.64% (15.1 – 22.9 %) from previous feeding, Table (3). This result coincides with Mladenovic *et al* 2002 and Keller *et al* 2005 for the influence of offering food on bee colony development.

Table 3. Colonies status for performing common (heterofloral) honey

Rep.	Colony Strength								Honey Extract		
	C C A B*			No. of brood cells			Honey Before				
	Before	After	%(+/-)	Before	After	%(+/-)	Combs	Weight (kg)	Total (kg)	% floral	% Ion floral
.1	5	8	+ 60	4110	6840	+ 66.4	1.0	0.740	4.030	81.6	18.4
2	5	6	+ 20	3228	4580	+ 41.9	1.5	1.220	6.020	79.7	20.3
3	5	7	+ 40	4192	5590	+ 33.3	2.0	1.445	6.310	77.1	22.9
4	5	7	+ 40	3785	6110	+ 61.4	1.5	0.735	4.850	84.9	15.1
5	5	6	+ 20	3300	5220	+ 58.2	2.0	1.100	5.120	78.5	21.5
mean	5	6.8	+ 36	3723	5668	+ 52.2	1.6	1.067	5.266	80.36	19.64
± S.D		±0.8		±446	±860		±0.4	±0.287	±0.919		

*** C C A B = Combs Covered with Adult Bees**

The statistical analysis showed that there are significant differences among the three groups either for colony build up (represented by the number of combs covered with bees and the number of brood cells) or the quantity of produced honey, where the floral honey recorded the lowest amounts of honey which are not logic economically for commercial beekeeping, Table (4) and Fig. (1). The scantly amount of pure floral honey and may be related to rehoused the bees on empty combs and

consequently begin to rebuilding the colony, where the bees required more food (nectar and pollen) for brood production (Karacaoglu *et al* 2003) and encouraging early-age bees for foraging to collect more nectar and pollen (Wenning 2002).

Table 4. Colonies status for performing different types of bee honey

Honey Types	Colony Strength								Honey Extract (grm)
	C C A B			No. of brood cells			Honey Before		
	Before	After	% (+ / -)	Before	After	% (+ / -)	combs	Weight (grm)	
Floral	5	4.4±0.5[b]	-12	3857±514	**2977±570b**	-21.3	0	0	**1130±630c**
Non-Floral	5	3.4±0.5[c]	-32	3905±412	**1840±362c**	-53.1	0	0	**2466±586b**
Common	5	6.8±0.8[a]	+36	3723±446	**5668±860a**	+52.2	1.6±0.4	1.067±0.287	**5266±919a**
F values		35.2**		0.210	48.4**				42.2**
L. S.D		0.907			870.2				1001.7

C C A B = Combs Covered with Adult Bees ** = significant 1 %

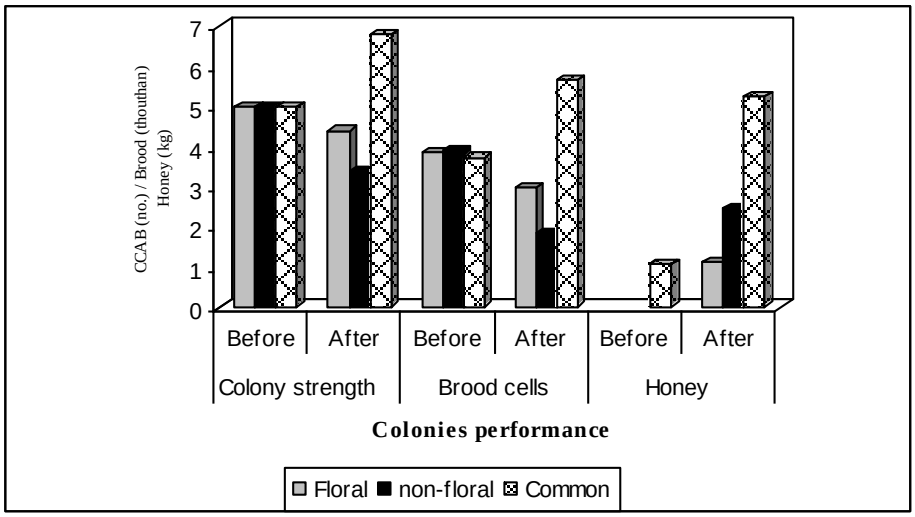

Fig. 1. Colonies status before and after performing different types of bee honey (C C A B = Combs Covered with Adult Bees)

Honey characteristics

1 - Physical properties

The important physical properties for honey marketing are summarized for the three tested bee honeys (floral, non floral and common) in Table (5). As shown in this table, the specific gravity that expressed the density of honey, it depends on water content of honey. The specific gravity for the three types of honey lies within the normal range (1.40 – 1.44) as recorded by Crane 1980. Its values are 1.412, 1.424 and 1.417 for floral, non floral and common honey, respectively. The higher rate in non floral honey than the others may be due to the less water content (high density).

Another important character is viscosity. It was an important technical parameter during honey processing. The viscosity values of tested honey were varied according to the type of tested honey. The lowest value (36.4 poise) was recorded for floral honey, whereas the highest value (69.0 poise) was obtained for non floral honey. However, the viscosity of common honey (48.1 poise) was found to be inbetween. The variations in viscosity of honey are due to temperature and water content. Where, the less water the higher the density and the viscosity. Also, honey becomes very much less viscous as the temperature rises (White 1975 and Crane 1980). The present data for the floral honey differ with that cited by Mishref *et al* 1999 which stated that the viscosity of the clover honey was 55.56 poise.

The electrical conductivity (Ec) is diagnostic value indicating the source of the botanical origin of honey (Crane 1980), it was attributed to high minerals content (Nour 1988).The Ec for the floral, non floral and common honey recorded 2.6, 0.6 and 1.9($\times 10^{-4}$) S/cm, respectively. These results were relatively in agreement with Nour 1988 but not coincide with Mishref *et al* 1999 who stated that the Ec of clover honey was 0.45%.

The obtained data also show that, all fermentation values for all tested honey types were within the normal range which was safe.

Normally, pollen grains was absent in non floral honey because the colonies were captured in screen green house. The majority pollen grains found in floral honey was clover and tiny pits of pollen were from grasses which found within clover field. In common honey and in spite of the presence of clover pollen in reasonable amount, but there are other pollen from different sources such as corn, eucalyptus and other unknown, this due to the stored pollen in combs from the previous periods.

Table 5. Physical properties of different types of bee honey

Parameters	Type of honey			Normal Range
	Floral	Non floral	Common	
Specific gravity	1.412	1.424	1.417	1.39 – 1.44
Viscosity	36.4	69.0	48.1	13.6 – 420 Poise
electric conductivity (EC)	2.6	0.6	1.9	0.02 – 6 ($\times 10^{-4}$) S/cm
Fermentation	Safe	Safe	Safe	17–20% Safe / >20 % Danger
Pollen grain	found	Not found	found	

2 - Chemical analysis

Some chemical analysis of the three tested bee honeys; floral, non floral and common are summarized in Table (6).

Water considered one of the most important components of the bee honey; it depends on the weather conditions outside and inside the hive, moreover the conditions of extraction and storage**.** The moisture percentage in the present work varied according to the type of honey. Means of 18.5, 17.0 and 18.0 % were recorded for moisture in floral, non- floral and common honeys, respectively. All moisture values for the three types of honey were within the normal range, worth note that the moisture percentage for non-floral honey was lowest than the others may be due to the concentration of

the sugar syrup (50%) offered. The present results are in agreement with those of Sancho *et al* 1991 (12.4-20.3%).

The pH values also varied in different types of honey. The lowest (3.2) was recorded for non-floral honey, followed by floral honeys (3.6) and common honey (4.1). All values are found to be within the tabulated normal range (3.42 - 6.10).

Table 6. Chemical analysis of different types of bee honey

Parameters	Type of honey			Normal Range
	Floral	Non floral	Common	
Moisture	18.5	17	18	13.4 – 23.9 %
pH	3.6	3.2	4.1	3.42 – 6.1
Free acidity	20.4	18.2	32.2	6.75- 47.19 milliequ/ kg
Lacton	7.2	1.2	5.6	0.00- 18.67 milliequ/ kg
Total acidity	27.6	19.4	37.8	8.98- 59.49 milliequ/ kg
Total Soluble Solid (TSS)	81.5	83	82	77.0 – 86.5 %
Reducing sugar	74	61	69	65% - up
Non reducing sugar	3.3	19.2	9.5	Up to 10.0 %

The free acidity of tested honey types, being 20.4, 18.2 and 32.2 milliequ / kg for floral, non-floral and common honeys, respectively. The common honey is considered as high range. The values of Lacton, as being affected by the types of tested honey. In this case, the highest value (7.2 milliequ / kg) was recorded for floral honey followed by common honey (5.6 milliequ / kg) and the lowest was for non- floral honey (1.2 milliequ / kg). The calculation of total acidity in different honey types clear that the highest value (37.8 milliequ / kg) was recorded for common honey and lowest (19.4 milliequ / kg) was obtained for non-floral honey. Total acidity for floral honey gave an intermediate value (27.6 milliequ / kg) between both. However, all values are found to be with in tabulated normal range.

The total soluble solid (TSS) was also determined in the three types of bee honey. Means of 81.5, 83.0 and 82.0 % were recorded for TSS in floral, non- floral and common honeys, respectively, these values are found to be within the normal range (77-86.5%). The dry matter, which should be 78% or more, is responsible for protecting honey from fermentation. In this respect, Tosi *et al* 2003 reported 79 – 80 % in honey from Argentin and Schroeder *et al* 2005 reported 78.5% and 86.0% for blossom honey while honeydew honey varied between 81.6 % and 87.4%. Sugars, reducing or non- reducing are quantitatively representing the most prevalence component in the soluble solid. The values for reducing sugars in the three types of honey were recorded highest value (74%) in floral honey, followed by common honey (69%) and non- floral honey (61%). In case of non-reducing sugar, the lowest value (3.3%) was found in floral honey followed by the common honey (9.5%) which was found to be closed to the maximum normal rang .In case of non-floral honey the super level reached 19.2%; which was highest than the maximum level of normal range. Therefore, it is advisable to take the non-reducing sugar value into consideration for evaluation of different types of honeys. Such value must be located in between the normal range (up to

10.0%) to ensure the good quality of bee honey to ensure its floral source and to be safe for consumption.

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جودة عسل النحل طبقا لانجاز طائفة نحل العسل

عادل محمد البسيونى[1]، ممدوح عبد المقصود عبد الرحمن[2]، محمد ابراهيم عبد المجيد[1] و مجدى محمد سلامة[3]

1 – قسم وقاية النبات – كلية الزراعة – جامعة عين شمس , شبرا الخيمة – القاهرة – مصر

2 - قسم الأطفال– كلية الطب – جامعة عين شمس ,العباسية – القاهرة – مصر

3 - قطاع البعثات العلمية – وزارة التعليم العالى – القاهرة – مصر

تم انتاج ثلاثة انواع من عسل النحل, الاول عسل نحل زهرى والثانى عسل نحل لازهرى والثالث عسل نحل تجارى. قسمت خمسة عشر طائفة نحل متساوية القوة تقريبا وتحتوى ملكة كرنيولى حديثة ملقحة طبيعيا الى ثلاث مجموعات. جهزت طوائف النحل للدراسة فى منحل كلية الزراعة – جامعة عين شمس وذلك باعادة تسكين المجموعتين الاولى (العسل الزهرى "وحيد الزهرة") على اقراص فارغة و الثانية (العسل اللازهرى) على اقراص فارغةايضا مع وتغذيتها بمحلول سكرى 50% فقط. اما المجموعة الثالثة (العسل التجارى "عديد الازهار") فتم الابقاء على حالتها وتغذيتها بالمحلول السكرى. تم نقل طوائف النحل للمجموعتين الاولى والثالثة الى أحد حقول البرسيم اثناء فترة التزهير فى مركز المحلة الكبرى – محافظة الغربية.اما المجموعة الثانية تم نقلها الى صوبة سلكية كبيرة محكمة فى كلية الزراعة – جامعة عين شمس وذلك خلال موسم 2006.

أظهرت نتائج الدراسة ان متوسط انتاج الطائفة من العسل الزهرى النقى 1.130 ± 0.63 كيلو جرام / للطائفة وصاحبها نقص فى قوة الطائفة (عدد الاقراص المغطاة بالنحل البالغ) وكمية الحضنة وصل الى 12% و 21.3% على التوالى. كان متوسط انتاج الطائفة من العسل اللازهرى 2.466 ± 0.586 كيلو جرام / للطائفة مع نقص فى قوة الطائفة وكمية الحضنة وصل الى 32% , 53.1% على التوالى. اما فى حالة العسل التجارى كان متوسط انتاج الطائفة من العسل 266.5 ± 0.919 كيلو جرام / للطائفة مع زيادة فى قوة الطائفة وكمية الحضنة وصل الى 36% , 52.2% على التوالى.

أظهرت دراسة الخصائص الطبيعية والكيمائية للثلاث انواع من العسل (الزهرى"وحيد الزهرة" واللازهرى والتجارى"عديد الازهار") على التوالى ان الكثافة النوعية سجلت 1.412,1.414 , 1.417. اللزوجة 36.4 ,69.0 , 48.1 poise . درجة التوصيل الكهربائى 2.6 , 0.6 , 1.9 S/cm (×10^{-4}) . الرطوبة 18.5 , 17 , 18 % .الاحماض الحرة 20.4 , 18.2 , 32.2 kg / milliequ .السكر المحول 74 , 61, 69 % والسكر الغير محول 3.3 , 19.2 , 9.5 %.