Available online at www.easletters.com

ISSN No: 2349-2864

Entomology and Applied Science Letters, 2016, 3, 6: 26-30

Liquid glucose from corn and wheat instead of white sugar in honey bee feeds

Nasrollah Vali[1]* and Seid Mazaherseidi[2]

[1]Department of Animal science, Agriculture faculty, Shahrekord University, Shahrekord, Iran
[2]Research Center site number (2) of Agriculture and Natural Resources in Isfahan Province, Isfahan, Iran
**Corresponding Author Email: nasrollahvali9@gmail.com*

Received on: 12/9/2016 *Accepted on: 17/12/2016*

ABSTRACT

Colonies are moved into many different locations for pollination, and some areas may not have sufficient forage. In this situation, bees depend on the beekeeper to provide them with food. In this study was to compare the liquid glucose from corn and wheat instead of white sugar in bee feeds on both the incubator and the desert, were studied. Glucose of wheat and corn each with three levels (0, 25, 50, and 75 percent) for each treatment. According to the results of the food intake of control treatments in the incubator Commercial bee were largest and most losses were related to liquid glucose over 75 percent of wheat and corn treatments. Results show that, was significant difference among treatments in terms of saved honey ($P<0.05$). It seems, liquid glucose at 50 percent can be used as part of the feeding bees sugar substitute.

Keywords: *Corn, Honey bee, Liquid glucose, Nutrition, Sugar, Wheat.*

INTRODUCTION

Honeybees are facing a myriad of challenges today from interacting stressors, including diseases, parasitic mites, and pesticides, as well as substandard diets, all of which affect their ability to stay healthy [1]. Besides these challenges, commercial bee operations (beekeepers who maintain over 1,000 beehives) encounter significant stress from a variety of management practices, including repeated long-distance trucking of colonies to pollinate crops, feeding bees inadequate or insufficient amounts of food, and the questionable ability of modern crop monocultures to provide adequate nutritional diversity for bees [2]. Carbohydrates also fuel cellular respiration and physical activities such as thermoregulation and locomotion (Chapman, 1982). Floral nectars are the major source of natural carbohydrates for bees, containing among other things, sugars, amino acids, vitamins, organic acids, metal ions, alkaloids, proteins, and oils [3-5]. Commercial bee colonies are moved into many different locations for pollination, and some areas may not have sufficient forage. In this situation, bees depend on the beekeeper to provide them with food. Because large numbers of colonies (sometimes over 20,000). Can be temporarily held in a single location, There is a growing eliance on mass-feeding bees carbohydrates and proteins. Though honey has long been considered to be the “ideal bee feed” [6], Researchers and beekeepers have recognized that sucrose may be a better sugar supplement [7]. In some situations, especially in noncommercial operations, providing additional frames of sealed honey to a carbohydrate deficient colony might be the least labor intensive method, but this practice can also increase the risk of spreading American foulbrood disease, a spore-forming bacterial disease commonly found in honey. By feeding sugar syrup, spreading this disease is avoided [8, 9]. However, in commercial operations, there are certain disadvantages to feeding large quantities of sucrose syrup (SS), such as making the syrup, which requires a significant labor input [8], and the tendency of sucrose to crystallize and ferment, making long-term storage difficult.

One of these types can be liquid glucose syrups, liquid glucose, transparent, colorless, without crystal with high viscosity a mixture of dextrose, maltose and polysaccharides such as glucose Syrup by other names, Syrup corn, sugar confectionery and etc. called and used as an ingredient in various food industry, liquid glucose to dark colors, yellow, light brown to black, and Syrup from corn starch, rice or potatoes is achieved [10]. The purpose of this test was alternative liquid glucose from corn and wheat instead of white sugar in the honey bee nutrition.

MATERIALS AND METHODS

The location of the project implementation was the number 2 research Center of Agriculture and Natural Resources in the Isfahan province of Iran. The area is located 1550 meters above sea level and it is hot and dry in the summer and cold in the winter. The project started from September 2011 to September 2014 and lasted for two years. Tests were done in two positions of incubator and Sahara with 42 colonies using the existing hybrid bees that were related to European Bee (Apismellifera L.). Treatments included glucose of the wheat and corn each with three levels (25, 50, and 75 percent) and 6 replicates for each treatment was considered and the treatments were set as follows:

First treatment, control group (sugar syrup)
Second treatment, Wheat glucose 25%
Third treatment, wheat glucose 50%
Fourth treatment, Glucose plants 75%.
Fifth treatment, glucose corn 25%
Sixth treatment, glucose corn 50%
Seventh treatment, Glucose corn 75%

How to prepare drinks was a mixture of sugar and liquid glucose, which then dissolve in cold boiled water and used in both the incubator and the desert. Dining syrup of each hive was just a plate that distributed half liter of syrup prepared at every turn.

Profile of incubation
Room size was 1.8 × 1.8 × 2.5 meters and was insulated with thick sheets of aluminum. The chamber was equipped with a thermostat through a ventilator with dimensions of 30 × 30 cm and by an apparatus with a speed of 2000 rpm and an electric element with power of 800 watt that leaded to the constant incubation temperature of 34 ° C in the room. Room humidity was provided about 60 percent relative humidity. The faucet was installed in room for water bee drinking. This room had an open window for air exchanging. In addition, there was a 40-watt red lamp in the lobby that lighted up in times of counting bees and working with them.

Bees in nucleus hive (small hive) in the incubator
The nucleus hive (small hive) includes wooden shelves with dimensions of 15 × 11 × 15 cm (source) that was enclosed on both sides by micro metal lace. On the roof of each cage, a circular-shaped hole (diameter 2.8 cm) was placed for drinking water of bees. Also in each cage a comb bees were put for resting of bees and also frame syrup, was installed for nutrition bees. The bees were caged in groups of hundreds and the cages were designed with micro metal lace to bring out the dead bees.

Field experiment
Prior to implementation in the field and to equate the 42 colonies in terms of population, newborn and storing honey, homogenization took place. Finally, colonies randomly selected and were divided in seven treatments (treatments listed). Spring-fed were considered skip a day in 500 cc per colony. Then laying, the population, the collected pollen and honey production of each hive for each treatment in eight times were measured and recorded.

The experimental model
The obtained data was analyzed by SAS [11] software Ver. 9.1 with general linear method procedures, and multiple range Ducan[12] test was applied for detection of possible significant differences among means ($P<0.05$).

RESULTS AND DISCUSSION

The results obtained from the effects of the consumption of wheat and corn glucose on syrup consumption (g) and mortality rate (%) of caged bees in the incubation stage is shown in the table 1. The data show that the use of syrup in the control treatment with is the highest with 3.41 average that showed no significant difference (p > 0.5) with the fourth treatment (wheat glucose at 75 percent) , whereas the difference was significant with other treatments (P <0.5).

The fifth treatment (corn glucose 25%) with an average of 2.73 gr showed the lowest amount of syrup and the difference was not significant with second, third, sixth and seventh treatments (p >0.5). The result regarding the maximum consumption of syrup for the control treatment or sugar (sucrose) is matched with reports of other researchers [7, 13, 14], which stated that sucrose is the best carbohydrate for honey bee according to acceptance and consumption. In order to process and store the carbohydrates (as honey), the honey bees first break down the disaccharides into monosaccharides, because only monosaccharides can pass through the midgut wall into the bee's hemolymph for later use by cells [15]. Therefore, all the complex sugars that bees ingest must be enzymatically transformed in order to become bioavailable to them [16].

The mortality rate in the incubator stage, the fourth treatment (wheat glucose 75 percent) with 3.59 percent was the highest mortality rate that it was not significantly different with the seventh treatment (corn glucose 75%) (P>0.05), but it was significantly different with other treatments (05/0 P <). The third treatment (wheat glucose 50 percent) indicated the minimal mortality, that was not significantly different with the first, second and fifth treatment (P>0.05).

Table 1: Least-squares means of different levels of consumption of wheat and corn glucose on syrup consumption (g) and mortality rate (%) of caged bees nucleus hive (small hive) in the incubator stage

Number	Treatments	Consumption of syrup(gr)*	Mortality rate (%)
1	Control group	3.41 ± 1.23^{a}	1.65 ± 2.24^{bc}
2	wheat Glucose 25%	2.98 ± 1.07^{bc}	1.69 ± 2.08^{bc}
3	wheat Glucose 50%	2.79 ± 1.21^{c}	1.15 ± 1.71^{c}
4	wheat Glucose 75%	3.20 ± 1.02^{ab}	3.59 ± 2.42^{a}
5	Corn glucose 25%	2.73 ± 1.07^{c}	1.46 ± 1.53^{bc}
6	Corn glucose 50%	2.85 ± 0.91^{bc}	1.95 ± 1.96^{b}
7	Corn glucose 75%	2.78 ± 0.85^{c}	2.90 ± 2.35^{a}
EMS**		1.12	4.23
Pr>F		0.0060	0.0001

**Values with in column with no common superscript differ significantly (p<0.5).*
*** Error Mean Square*

Rate of mortality of bees

In this study, it was shown that the amount of liquid glucose from corn and wheat in the fourth and seventh treatment (75%) indicated its adverse effects on the incensement of the mortality of bees in cages. That the use of inverted sugar acid as a substitute for honey bees sometimes associated with risk of death of bee. The results of this study were similar with LeBlanc et al. [17] and Zirbes et al. [18] that reported, In addition to toxic sugars, another toxic substance that can be found in syrups that are fed for colony nutrition and survival is 5-hydroxymethyl-2-furaldehyde or, as it is more commonly referred to as, 5-hydroxymethylfurfural (HMF). Hydroxymethylfurfural is a chemical compound that is formed from carbohydrates, especially fructose, under thermal and/or acid-catalyzed degradation conditions. HMF is widely recognized as a marker of quality deterioration, resulting from excessive heating or inappropriate storage conditions in a wide range of foods including juices, jams, syrups and honey. Sucrose, or starch, hydrolysed with mineral or organic acids is toxic for honeybees, whereas sucrose hydrolysed with invertase is not. The best-known products of the action of acids on hexoses, 5-hydroxymethylfuraldehyde (HMF), laevulinic acid and formic acid were similarly toxic to bees when fed to them, but only if more concentrated than in acid-hydrolysed sucrose [6].

The annual honey hives production in the desert

The comparison of least squares means levels of wheat and corn glucose on the honey production (kg) of one-year period experimental treatments is showed in Table 2. Control group was the highest regarding honey production, which was not significantly different from other treatments (p>0.5).

Table 2: Least-squares means± standard deviation levels of wheat and corn glucose on the one year period honey production (kg) in colonies in the desert stage

Characteristic	Number	Annual Honey production (Kg)
Treatments	1	10.78±3.25
	2	10.08±2.75
	3	9.92±1.93
	4	9.33±1.81
	5	9.75±2.14
	6	9.92±1.46
	7	9.38±1.73
EMS*		4.87
Pr>F		0.9353
Replication	1	10.50±2.36
	2	10.53±2.62
	3	10.71±2.25
	4	9.75±1.65
	5	9.39±2.01
	6	8.38±1.25
EMS*		4.87
Pr>F		0.3573

**Error mean square*

The results of this study were similar with, Severson and Ericson (1984) that Mentioned, "There were no significant differences among treatments in early season weight gains, season honey production, or sealed brood measurements. There were no significant differences among treatments in winter consumption. During 1983, there were no significant differences among treatments in cluster size or newly emerged worker whole-body dry weights in the spring or head and thorax dry weights."

The different levels of wheat and corn glucose on the laying rate of the queen, the colony population, store pollen and honey the comb in each colony per each spring for the field are shown in Table 3. As can be seen, in the laying and the population were no significant difference among treatments. But, there was significant difference among treatments for honey reserve, however there were no significant difference among control group with the fourth, sixth and seventh treatments for honey reserve. Also, there was no significant difference among treatments for stored pollen. produced honey results were similar to the results of Sammataro and Weiss [19] that reported Comparison of productivity of colonies of honey bees, Apismellifera, supplemented with sucrose or high fructose corn syrup, they reported more stored honey in the colonies that used sucrose syrup than the colonies were fed with high fructose syrup.

Table 3: Least-squares means ± standard deviation of different levels of glucose, wheat and corn on laying rate of the queen, the colony population, store pollen and honey the comb in each colony per each spring the desert stage

Treatments	Rate of Laying (comb)	Population* (comb)	Honey reserve (comb)	Pollen reserve (comb)
1	3.92±0.84	$5.62±1.15^{a}$	$4.39±1.48^{a}$	0.23±0.14
2	4.14±0.94	$5.05±1.19^{bc}$	$3.69±1.19^{bc}$	0.16±0.14
3	4.09±0.79	$4.90±0.89^{bc}$	$3.31±1.05^{c}$	0.16±0.13
4	3.96±0.94	$5.31±1.00^{ab}$	$4.14±1.42^{ab}$	0.22±0.13
5	4.17±1.09	$5.92±1.05^{bc}$	$3.69±1.35^{bc}$	0.21±0.36
6	4.06±0.82	$4.68±0.88^{c}$	$3.91±1.19^{ab}$	0.20±0.13
7	4.31±0.87	$5.17±1.17^{b}$	$3.90±1.38^{ab}$	0.16±0.13
EMS**	0.81	1.10	1.69	0.03
Pr>F	0.4238	0.0014	0.0019	0.1432

**Values with in column with no common superscript differ significantly (p<0.5).*

***EMS: Error mean square.*

REFERENCES

[1]Alaux, C., Ducloz, F., Crause,r D., & Le Conte, Y. Diet effects on honeybee Immunocompetence. *Biology Letters*,**2010. 6:** p.562- 565.
[2] Winston, M. L. *The Biology of the Honey Bee. Harvard University Press*, **1987.**
[3] Bogdanov, S., Ruoff, K., &PersanoOddo, L. Physico-chemical methods for the characterization of unifloral honeys: a review. *Apidologie*, **2004.35:** p.S4–S17.
[4] Carter, C., & Thornburg, R.W. Is the nectar redox cycle a floral defense against microbial attack? *Trends plant science*, **2004.9:** p.320-324.
[5] Park, S. & Thornburg, R.W. Biochemistry of Nectar Proteins. *Journal Plant Biology*, **2009.52:** p. 27–34.
[6] Bailey, L. The effect of acid-hydrolyzed sucrose on honeybees. *Journal of Apicultural Research*, **1966. 5:** p.127-136.
[7] Herbert, E.W. Honey bee nutrition. In: Graham, J.M., Editor. *The hive and the honey bee*. **1992.** p. 197-233. Dadant and Sons.
[8] Goodwin, R.M. Feeding sugar syrup to honey bee colonies to improve pollination: a *Review.* **1997.78**: p. 56-62.
[9] Sammataro, D., Avitabile, A. The Beekeeper's Handbook, fourth edition. *Cornell University Press*, **2011.**
[10] Hull, P. Glucose Syrups: Technology and Applications. *John Wiley & Sons*, Inc.**2010.**
[11] SAS, Statistical Analysis Systems SAS Inst. *Inc., Cary,Nc*, USA 265P. **2002.**
[12] Duncan, D.B. Multiple range and multiple F tests. *Biometrics*, **1955. 11:** p. 1-42.
[13] Barker, R.J., &Lehner, Y. Laboratory comparison of high fructose corn syrup, Grape syrop, Honey, and sucrose syrup as maintenance food for caged honey bees. *Apidologic*, **1978.**9(2): p. 111-116.
[14] Ruiz-Matute, A.I., Weiss, M., Sammataro, D., Finely, J. &Sanz, M.L. Carbohydrate Composition of High-Fructose Corn Syrups (HFCS) Used for Bee Feeding: Effect on Honey Composition. *Journal Agriculture Food Chemistry*, **2010.**58(12): p. 7317–7322.
[15] Crailsheim, K. Intestinal transport of sugars in the honeybee (Apismellifera L.). *Journal of Insect Physiology*, **1988.**34: p. 839-845.
[16] Hausmann, C., Wackers, F.L., & Dorn, S. Sugar convertibility in the parasitoid Cotesiaglomerata (Hymenoptera:Braconidae). *Archives of Insect Biochemistry and Physiology*, **2005.**60: p.223-229.
[17] LeBlanc, B.W., G. Eggleston, D. Sammataro, C. Cornett, R. Dufault, T. Deeby& E. St. Cyr Formation of hydroxymethylfurfural in domestic high-fructose corn syrup and its toxicity to the honey bee (Apismellifera). *Journal Agriculture Food Chemistry*, **2009.**57: p**.** 7369-7376.
[18] Zirbes, L., Nguyen, B.K., Degraaf, D.C., Meulenaer, B.D., Reybroeck, Haubruge, W., E., &Saegerman C. Hydroxymethylfurfural: a possible emergent cause of honey bee mortality? *Journal Agricalture Food Chemistry*, **2013.** 61:p.11865-11870.
[19] Sammataro, D. & Weiss, M. Comparison of productivity of colonies of honey bees, Apismellifera, supplemented with sucrose or high fructose corn syrup. **Journal of Insect Science: 2013. 13** p.9.
[20] Severson, D.W. & Ericson, E.H.Jr. Honey bee coloney performance inrelation to supplemental carbohydrates. *J.Ecom-Ento*.**1984.** 77(6):p. 1473-1478.