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QUALITY OF SOME SUGAR BEET VARIETIES UNDER DIFFERENT ENVIRONMENTAL CONDITIONS

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ABSTRACT

Six field experiments were carried out in 2015 -16 and 2016 -17 seasons. A randomize complete block design with three replications was used at three locations :1. Giza Experiment Station (latitude 30.01 0 N and longitude 31.21 0 E); 2. Tamiya District, Fayoum Governorate (latitude 29.30 0 N and longitude 30.84 0 E) and 3. Ismailia Governorate (latitude 30.36 0 N and longitude 32.16 0 E)]. The performance of six sugar beet varieties (cvs.); Samba, Pleno, Gloria, Poly belga, Oscar poly and Gazella was studied to estimate sugar yield and its contributing traits as well juice quality traits under the three environmental conditions. The obtained results showed that growing seasons had a significant effect on impurities (K, Na and α-amino N), some technological characteristics (purity, extractable sugar, sucrose and sugar lost to molasses percentages) as well sugar yields/fed. The effect of varieties and locations factors significantly affected sugar percentage, extractable and sugar yield. The obtained results indicated that sowing Samba variety in the three locations had the highest sugar extraction and sugar percentages as well as sugar yield/fed. In general, results revealed that Samba variety followed by Gazella is favorable for the regions of Giza, Fayoum and Ismailia Governorates.

Key words: Sugar beet, locations, varieties, juice quality, seasons, sugar extraction.

INTRODUCTION

Sugar beet (*Beta vulgaris* L.) is an important sugar crop supplying approximately 35% of the world's sugar, and it is widely cultivated in arid and semi-arid regions (**Wu *et al.,* 2013**). The production of sugar beet in the world during 2014 was about 266.8 million tons with area of 4.47 million ha with an average root yield of 59.6 ton/ha **(FAO STAT, 2016).** European Union, USA and Russia are the three largest sugar beet producers in the world. In Egypt the production of sugar beet in 2016 was about 13,323,369 tons with area 254,991 ha with an average root yield of 52.3 ton/ha. Sugar beet produced 1.255 million tons of sugar represented about 50% from the local production **(FAO STAT, 2016) and Okasha and Mubarak (2018).**

Seed quality of Sugar beet varieties is considered the corner stone in sugar production. The required conditions of thermo-photo periods for sugar beet vernalization are not available, so productions of seeds are not appropriate in Egypt. Sugar companies import seeds from European countries annually. These imported varieties are subjected to the experimental evaluation across a wide range of locations and years in Egypt by Sugar Crops Research Institute to test their productivity and quality characteristics, and then select the appropriate ones under the different conditions **(Bader, 2017).**

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The evaluation and screening of beet varieties pass by three stages of experimentation, namely primary, main and final experiments to select the superior ones characterized with high yield and quality traits, along with the resistance to any epidemic pests and diseases. Thereafter, varieties prove superiority is registered after some specific procedures **(Abd El-Razek, 2012).**

The expansion in sugar beet area became one of the possible strategies for Egypt to satisfy the sugar need, which increases by more than 70,000 tons annually; in a time Egypt suffers from a negative gap reached about 800,000 tons of sugar. It is well known that different locations have variable soil types and meteorological factors, in respect to maximum and minimum temperatures, wind speed, relative humidity and solar radiation **(LMC, 2017)**. This shows the importance of genotype x environment interaction through the evaluation program of imported genotypes in Egypt. This study was carried out to throw some light around the interaction between the tested genotypes and the prevailing conditions in three locations, *i.e.* Giza, Fayoum and Ismailia Governorates to select the best one(s) for each location in sugar beet quality.

MATERIALS AND METHODS

Six field experiments were carried out in 2015/2016 and 2016/2017 seasons at three locations [1. Giza Experiment Station (latitude of 30.01^0N and longitude of 31.21^0 E); [2. Tamiya District, in Fayoum Governorate (latitude of 29.30^0N and longitude of 30.34^0E)] and [3. Ismailia Governorate (latitude of 30.36^0N and longitude of 32.16^0E)] to study the performance of six sugar beet varieties namely Samba, Pleno, Gloria, Polybelga, Oscar poly and Gazella for sugar and root yields and its contributing traits as well juice quality traits under the three environmental conditions.

A randomize complete block design with three replications was used at the three locations. Plot area was 21 m^2 (1/200 fed) consisted of 6- ridges, 7-m in length, 50-cm in width with 20-cm spacing between hills.

A chemical and physical analyses of the experimental soil for each location was done according to **Piper (2011)** as shown in Table 2. Monthly data of temperature and relative humidity of locations are presented in Table 3. A list of varieties and their country origin is presented in Table 1. Sowing was done on the first week of September at the three locations, in the two seasons, while harvesting took place 210 days after sowing.

During seed bed preparation, 15 kg P_2O_5/fed., was added in the form of super phosphate (15.5% P_2O_5). Moreover, 90 kg N/fed., was added in the form of urea (46.5% N) in two equal doses (after thinning, which was done at 4- leaves stage to one plant per hill) and four weeks later. Moreover, 24 kg K_2O per fed was applied with the 1^{st} nitrogen dose in the form of potassium sulfate (48% K_2O). Other agronomic practices were carried out as recommended in sugar beet fields.

The following characters were studied:

Juice Quality

At harvest, sample of thirty roots was taken at random from each plot and sent to Sugar factories to determine the following parameters:

Impurities characteristics

1. Potassium and sodium percentages were determined in the digested solution using "Flamephotometer" according to the method described by **Brown and Lilliand (1964)** and **Sirsat *et al.* (2017)**.
2. Alpha amino nitrogen percentage was determined using "Hydrogenation" method described by **Carruthers *et al.* (1962) and Mousa *et al.* (2015**).

Table (1): Origin of the examined sugar beet varieties

No.	Sugar beet variety	Type of Seeds	Origin	
			Company	Country
1	Samba	Multigerm	Vanderhave	Netherland
2	Pleno	Multigerm	Vanderhave	Netherland
3	Gloria	Multigerm	Strobe	Germany
4	Polybelga	Multigerm	Strobe	Germany
5	Oscar poly	Multigerm	Maribo	Denmark
6	Gazella	Multigerm	Maribo	Denmark

Table (2): Chemical and physical analyses of the experimental soil samples

Location	Giza		Fayoum		Ismailia	
Season	**2015/2016**	**2016/2017**	**2015/2016**	**2016/2017**	**2015/2016**	**2016/2017**
Mechanical analysis						
Sand %	23.41	25.32	21.90	26.10	35.36	40.53
Silt %	30.17	25.79	39.90	27.10	28.05	22.79
Clay %	46.42	48.51	38.20	46.80	36.59	36.68
Soil texture	Clay loam		Clay loam		Clay loam	
Chemical analysis						
pH	8.35	8.28	7.80	7.30	7.85	8.10
mohs/m	3.20	2.96	4.60	3.10	4.80	4.75
$CO3^{-}$%	3.10	3.30	2.60	2.18	2.76	2.45
Available N (ppm)	30.10	29.50	13.50	21.10	12.40	11.75

Table (3): Temperature and humidity distribution during 2015/2016-2016/2017 seasons

Month	Temperature °C						Relative humidity (%)		
	Maximum			Minimum					
	Giza	Fayoum	Ismailia	Giza	Fayoum	Ismailia	Giza	Fayoum	Ismailia
				2015-2016					
Sep.	28.6	32.2	29.3	22.8	18.5	22.7	62.4	63.0	73.0
Oct.	28.2	29.8	27.4	20.2	15.0	19.9	65.7	66.9	75.3
Nov.	23.7	25.2	22.5	16.3	11.7	15.3	62.3	61.0	69.0
Dec.	18.6	21.4	17.7	11.8	9.9	10.6	64.1	63.0	69.0
Jan.	16.5	18.0	15.3	8.8	8.7	9.3	63.4	65.0	72.0
Feb.	17.9	17.7	17.6	10.7	10.1	10.9	62.8	63.0	71.0
Mar.	20.7	25.7	19.8	12.1	11.5	11.0	61.5	59.0	69.0
Apr.	24.5	27.7	23.8	12.9	13.9	13.3	62.3	52.0	66.0
May.	28.1	29.8	27.9	14.6	15.3	14.5	59.4	53.0	64.0
				2016-2017					
Sep.	33.8	35.7	33.6	16.3	22.3	15.0	62.3	59.0	69.0
Oct.	29.4	30.0	28.9	12.6	18.4	11.1	61.4	59.0	67.1
Nov.	26.8	27.2	26.1	9.8	14.6	10.3	63.2	60.0	70.0
Dec.	22.7	23.0	22.4	9.6	11.5	8.1	60.3	62.0	73.0
Jan.	20.9	23.2	20.5	9.9	12.0	7.1	63.4	62.0	69.0
Feb.	21.8	22.9	21.4	8.9	9.8	8.2	62.8	58.0	68.0
Mar.	30.2	24.1	29.3	10.2	13.0	9.2	61.4	58.0	70.0
Apr.	27.8	29.3	27.1	10.3	15.2	11.0	58.7	53.0	65.0
May.	30.3	31.0	29.7	11.4	18.4	13.0	52.9	49.0	61.0

Source: Central laboratory for agricultural climate, Agric. Res. Center, Giza, Egypt

Quality traits

1. Sucrose percentage (Pol. %) was polarmetrically determined in a lead acetate extract of fresh minced root according to **AOAC (1995)** and **Aly and Khalil (2017)**.
2. Purity percentage, which was calculated according the following equation (**Devillers, 1988**; **Abashady *et al.*, 2011)**.

Purity (%) = 99.36 - 14.27 (Na + K+α-amino N)/ sucrose (%).

3. Sugar lost to molasses percentage (SM %) was determined using the following equation described by **Devillers (1988)** and **Abashady *et al.* (2011)**:

Sugar lost to molasses (SM %) = 0.14 (Na + K) + 0.25 (α-amino N) + 0.50

4. Extractable sugar percentage, which was calculated according the equation of **Dexter *et al.* (1967)** and **Abashady *et al.* (2011)** as follows:

Extractable sugar (%) =sucrose (%)-SM%-0.6

5. Extractability percentage was determined according to the equation shown by **Dexter *et al.* (1967)** and **Abashady *et al.* (2011):**

Extractability (%) =Sugar extraction/Sucrose (%)

Sugar Beet Yields

At harvest, all plants in each plot were uprooted, separated into roots and tops and weighed to estimate the following:

1. Root yield/fed (ton).
2. Sugar yield/fed (ton), which was calculated according to the following equation:

Sugar yield = root yield/fed (ton) x extractable sugar (%)

Statistical Analysis

Analysis of variance was computed for each experiment in each location. A combined analysis for the studied locations and seasons was done according to **Gomez and Gomez (1984)**. The treatment means were compared using LSD values at 5% level of significance.

RESULTS AND DISCUSSION

Juice quality

Characteristics of impurities

It is well known from the industrial view that there is an inverse relationships between juice quality and the values of impurities in terms of percentages of potassium (K %), sodium (Na %) and α – Amino nitrogen. In the following we will study the values of impurities percentages to throw some light on juice quality.

Potassium percentage (K %) in roots

Results in Table 4 show the effect of the three location conditions (Giza, Fayoum and Ismailia) on root potassium percentage of six sugar beet varieties in 2015/2016 and 2016/2017 seasons. The results in Table 4 cleared that growing sugar beet at Giza location resulted in roots contained significantly higher potassium percentage compared to those grown at Fayoum and Ismailia. This result may be attributed to potassium percentage content of soil. Similar results were reviewed by **Al-Jbawi (2003)**, **Abd El-Razek *et al*. (2006), Aly (2006), Allam *et al*. (2007) and Aly and Khalil (2017).**

The maximum potassium (%) was recorded by Samba sugar beet variety under Giza location conditions, while the minimum potassium (%) was reported by Oscar poly sugar beet variety under Ismailia location conditions.

The results showed significant differences among the tested sugar beet varieties in potassium percentage in roots. Pleno variety recorded the highest value of this trait. On the other hand, Polybelga variety had the lowest potassium percentage in roots. The difference among varieties in this trait may be due to their gene make-up. These results are in line with those obtained by **Al-Jbawi (2003)**, **Abd El-Rahim *et al*. (2005), Abd El-Razek *et al*. (2006), Aly (2006)**, **Ismail *et al*. (2007), Hozayn *et al.* (2013) and Aly and Khalil (2017)**.

Concerning the interaction effect, potassium percentage in beet roots was significantly affected by the interaction between locations and varieties.

Sodium percentage (Na %) in roots

Results in Table 5 show the effect of the three locations (Giza, Fayoum and Ismailia) on sodium percentage in roots of six sugar beet varieties in 2015/2016 and 2016/2017 seasons. The results obtained pointed out that the values of sodium percentage significantly affected by different locations. These differences may be attributed to the soil properties. Results in Table 5 appeared a significant effect on sodium percentage due to the locations. It could be noted that values of sodium percentage in Ismailia location was higher than those of Giza and Fayoum locations. This effect may be mainly due to the differences in soil properties of the three locations. This result

Table (4): Potassium percentage (K %) of six sugar beet varieties as affected by location conditions in 2015/2016 and 2016/2017 seasons.

Season	2015/2016				2016/2017				
	Location								
Variety	Giza	Fayoum	Ismailia	Mean	Giza	Fayoum	Ismailia	Mean	Average
Samba	3.14	3.14	2.73	3.00	3.27	3.09	2.90	3.09	3.05
Pleno	3.25	3.16	2.82	3.08	3.33	3.04	2.76	3.04	3.06
Gloria	2.96	3.04	2.64	2.88	3.14	2.93	2.72	2.93	2.91
Polybelga	2.79	2.65	2.56	2.67	3.07	2.82	2.57	2.82	2.74
Oscar poly	3.31	2.95	2.24	2.83	3.43	2.90	2.35	2.89	2.86
Gazella	3.08	3.13	2.44	2.88	3.04	3.05	2.55	2.88	2.88
Mean	3.09	3.01	2.57		3.21	2.97	2.64		
L.S.D at 0.05%									
Locations (L)			0.130				0.080		
Varieties (V)			0.180				0.110		
L x V			0.310				0.190		

Table (5): Sodium percentage of six sugar beet varieties as affected by location conditions in 2015/2016 and 2016/2017 seasons.

Season	2015/2016				2016/2017				
	Location								
Variety	Giza	Fayoum	Ismailia	Mean	Giza	Fayoum	Ismailia	Mean	Average
Samba	1.76	2.38	2.52	2.22	1.84	2.22	2.38	2.15	2.19
Pleno	1.63	2.23	2.37	2.08	1.57	2.30	2.35	2.07	2.08
Gloria	1.56	2.22	2.25	2.01	1.55	2.02	2.25	1.94	1.98
Polybelga	1.74	2.37	2.54	2.22	1.73	2.28	2.44	2.15	2.19
Oscar poly	1.64	2.24	2.35	2.08	1.66	2.25	2.42	2.11	2.10
Gazella	1.53	2.16	2.35	2.01	1.53	2.05	2.22	1.93	1.98
Mean	1.64	2.27	2.40		1.65	2.19	2.34		
L.S.D at 0.05%									
Locations (L)			0.090				0.080		
Varieties (V)			0.010				0.110		
L x V			0.210				0.190		

is in agreement with **Al-Jbawi (2003), Allam *et al.* (2007) and Aly and Khalil (2017)**. The maximum sodium (%) was recorded by Samba sugar beet variety under Giza and Fayoum location conditions, while the minimum sodium (%) was reported by Oscar poly sugar beet variety under Fayoum and Ismailia location conditions. Results in Table 5 show significant differences among the tested sugar beet varieties in sodium percentage. Polybelga and Samba varieties recorded the highest value of this trait. On the other hand, Gazella variety had the lowest sodium percentage in roots. The difference among varieties in this trait may be due to their gene make-up. These results are in line with **Al- Jbawi, (2003), Abd El-Rahim *et al.* (2005)**, **Hoffmann *et al.* (2002)**, **Aly (2006), Ismail *et al.* (2007)**, **Hozayn *et al.* (2013) and Aly and Khalil (2017).**

The interaction between locations and varieties affected sodium percentage significantly. The highest value of this trait was recorded by sowing Polybelga variety at Ismailia location.

Alfa amino-nitrogen root percentage

Results in Table 6 show the effect of the three locations (Giza, Fayoum and Ismailia) on Alfa amino-nitrogen percentage in roots of six sugar beet varieties in 2015/2016 and 2016/2017 seasons.

Results obtained cleared that there was a significant influence on the values of Alfa amino-nitrogen percentage due to the growing locations. This result may be indicating to the relative effect of soil properties of the various locations. The results revealed that roots of sugar beet grown at Giza contained higher Alfa amino-nitrogen percentage compared to those grown at Fayoum and Ismailia. This finding indicates to the differences between locations with respect to Alfa amino-nitrogen percentage mainly due to the differences in soil properties of the locations. These findings are in accordance with **Al-Jbawi (2003), Shalaby (2003), Allam *et al*. (2007) and Aly and Khalil (2017)**. The maximum Alfa amino-nitrogen (%) was recorded by Pleno sugar beet variety under Giza location conditions, while the minimum Alfa amino-nitrogen (%) was reported by Samba sugar beet variety under Ismailia location conditions.

Results in Table 6 appear significant differences in the values of Alfa amino-nitrogen percentage due to the tested six sugar beet varieties. Gazella variety recorded the highest value of this trait. On the other hand, Oscar poly had the lowest Alfa amino-nitrogen percentage. Difference among the varieties in this trait may be due their gene make-up. These findings are in harmony with those reported by **Aly (2000), Al- Jbawi (2003), Abd El-Rahim *et al*. (2005), Hoffmann *et al*. (2002), Ismail *et al.* (2007), Mohamed *et al*. (2012), Hozayn *et al.* (2013) and Aly and Khalil (2017).**

The maximum Alfa amino-nitrogen (%) was recorded by Pleno sugar beet variety under Giza location conditions, while the minimum Alfa amino-nitrogen (%) was reported by Samba sugar beet variety under Ismailia location conditions.

Concerning the interaction effect, the results in Table 6 show that Alfa amino-nitrogen percentage in sugar beet roots were significantly affected by the interaction between locations and varieties. The highest Alfa amino-nitrogen percentage in roots was given by grown Gazella variety at Giza location.

Quality Traits

Sucrose percentage

Results in Table 7 show the effect of the three locations (Giza, Fayoum and Ismailia) on sucrose percentage of six sugar beet varieties in 2015/2016 and 2016/2017 seasons.

The highest mean value of sucrose percentage was (20.28%) obtained from Ismailia location followed by (20.10%) obtained from Giza location in the first season (Table 7). These differences in sucrose percentage among the three locations may be due to the meteorological factors in these locations or the soil properties. The obtained result is in line with those obtained by **Al-Jbawi (2003), Abd El-Razek *et al*. (2006), Allam *et al*. (2007), El-Sheikh (2012) and Abd El-Razek and Ghonema (2016)**.

Differences among varieties in sucrose percentage were significant (Table 7). The variation in sucrose percentage of the studied varieties mainly may be due to variation in their genetic constituents and environmental conditions. Results illustrated in Table 7 show that the differences among the mean values of sucrose percentage of the six sugar beet varieties were significant. Samba variety recorded the highest sucrose (%) (21.34%) at Giza location; meanwhile Gazella variety recorded the highest value of sucrose percentage (21.92%) at Ismailia location in the 2nd season. Similar results

Table (6): Alfa amino-nitrogen percentage of six sugar beet varieties as affected by location conditions in 2015/2016 and 2016/2017 seasons.

Season	2015/2016				2016/2017				
Variety	Location								
	Giza	Fayoum	Ismailia	Mean	Giza	Fayoum	Ismailia	Mean	Average
Samba	2.21	1.87	1.79	1.96	2.25	2.05	1.85	2.05	2.00
Pleno	2.29	1.89	1.82	2.00	2.23	2.10	1.92	2.08	2.04
Gloria	2.06	2.04	1.85	1.98	2.16	2.00	1.87	2.01	2.00
Polybelga	2.26	2.17	2.00	2.14	2.23	2.10	1.95	2.09	2.12
Oscar poly	2.12	1.99	1.82	1.98	2.11	1.85	1.80	1.92	1.95
Gazella	2.30	2.08	1.92	2.10	2.17	1.99	1.88	2.01	2.06
Mean	2.21	2.01	1.87		2.19	2.02	1.88		
L.S.D at 0.05%									
Locations (L)		0.090					0.040		
Varieties (V)		0.130					0.050		
L x V		0.220					0.090		

Table (7): Sucrose (%) of six sugar beet varieties as affected by location conditions in 2015/2016 and 2016/2017 seasons.

Season	2015/2016				2016/2017				
Variety	Location								
	Giza	Fayoum	Ismailia	Mean	Giza	Fayoum	Ismailia	Mean	Average
Samba	21.34	20.78	21.67	21.26	21.33	20.43	20.99	20.92	21.09
Pleno	19.29	19.45	19.64	19.46	19.22	18.43	19.77	19.14	19.30
Gloria	19	18.15	18.54	18.56	19.19	18.22	18.83	18.75	18.66
Polybelga	20.88	19.35	20.77	20.33	20.51	19.52	20.75	20.26	20.30
Oscar poly	19.78	18.17	19.47	19.14	19.8	18.25	19.23	19.09	19.12
Gazella	20.32	19.68	21.6	20.53	20.8	19.5	21.92	20.74	20.64
Mean	20.10	19.26	20.28		20.14	19.06	20.25		
L.S.D at 0.05%									
Locations (L)		0.371					0.256		
Varieties (V)		0.525					0.363		
L x V		0.200					0.219		

were reviewed by **Abd El-Razek *et al.* (2006), Aly (2006)**, **Ismail *et al.* (2006), Nasser (2006), Azzazy *et al.* (2007), Ismail *et al.* (2007), Shalaby *et al.* (2008), El-Sheikh *et al.* (2009), Refay (2010), Enan *et al.* (2011), El-Sheikh (2012), Mohamed *et al.* (2012) and Osman *et al.* (2014)**. Who reported that there were significant differences between varieties in sucrose percentage. Results pointed to a significant effect on sucrose percentage due to the interaction between locations and varieties. The highest sucrose percentage was recorded by growing Gazella variety at Ismailia location.

Purity percentage

Results in Table 8 show the effect of the three locations (Giza, Fayoum and Ismailia) on juice purity percentage of six sugar beet varieties in 2015/2016 and 2016/2017 seasons. The results pointed to a significant difference in purity percentage at the three locations. This result may be due to higher sucrose percentage (Table 7) and lower α-Amino N and potassium in root. This result is in agreement was those reported by **Al-Jbawi (2003), El-Hinnawy *et al.* (2003), Aly (2006), Abd El-Razek and Ghonema (2016)**.

Table (8): Purity (%) of six sugar beet varieties as affected by location conditions in 2015/2016 and 2016/2017 seasons.

Season	2015/2016				2016/2017				
Variety	Location								
	Giza	Fayoum	Ismailia	Mean	Giza	Fayoum	Ismailia	Mean	Average
Samba	94.6	94.28	94.72	94.53	94.44	94.22	94.52	94.39	94.46
Pleno	94.05	94.02	94.27	94.11	94.06	93.6	94.28	93.98	94.05
Gloria	94.42	93.62	94.17	94.07	94.26	93.92	94.17	94.12	94.09
Polybelga	94.73	94.06	94.48	94.42	94.47	94.1	94.58	94.38	94.40
Oscar poly	94.26	93.72	94.66	94.21	94.17	93.88	94.49	94.18	94.20
Gazella	94.51	94.02	94.92	94.48	94.73	94.17	95.04	94.65	94.57
Mean	94.43	93.95	94.54		94.36	93.98	94.51		
L.S.D at 0.05%									
Locations (L)		0.150					0.104		
Varieties (V)		0.212					0.147		
L x V		0.370					0.256		

The results in Table 8 reveal that the studied sugar beet varieties were differing significantly in juice purity in the three locations. Difference among varieties in juice purity percentage as well as sucrose percentage is due to the weather conditions **(Ulrich, 1954 and Forkes, 1972)**, whereas there is a positive correlation between juice purity and sucrose content. These findings are in accordance with **Al-Jbawi (2003), El-Hinnawy *et al.* (2003)**, **Osman *et al.* (2003), Azzazy (2004)**, **Ramadan and Nassar (2004), Abd El-Aal and Mohamed (2005), Aly (2006), Nasser (2006), Azzazy *et al.* (2007), Ismail *et al.* (2007)**, **Shalaby *et al.* (2008), El-Sheikh *et al.* (2009) and Aly and Khalil (2017)**. The results in Table 8 show that purity percentage of root was significantly affected by the interaction between locations and varieties. These results could be indicating to the relative importance of the act between the prevailing condition in terms of weather and soil in their influence on juice quality.

Sugar loss to molasses percentage

Results in Table 9 show the effect of the three locations (Giza, Fayoum and Ismailia) on percentage of sugar loss to molasses of six sugar beet varieties in 2015/2016 and 2016/2017 seasons.

The results pointed out that growing location had a significant effect on percentage of sugar lost to molasses. Sowing sugar beet at Ismailia resulted in less sugar loss to molasses percentage, compared to that sown at Giza and Fayoum locations. This result could be attributed to higher sucrose percentage (Table 7), lower α-Amino N in roots (Table 6), higher purity percentage (Table 8) at Ismailia compared to those recorded at Giza and Fayoum. The same result with obtained by **Al-Jbawi (2003) and Aly (2006)**.

The results showed significant differences among the tested sugar beet varieties in sugar loss to molasses percentage. Samba and Pleno varieties recorded the highest value of this trait. On the other hand, Gloria and Oscar poly had the lowest sugar loss to molasses percentage. The difference among varieties in this character may be due to their gene make-up. These results are in agreement with those given by **Abd El-Rahim *et al.* (2005), Abd El-Razek *et al.* (2006), Aly (2006) and Ismail *et al.* (2007)**.

The interaction between locations and sugar beet varieties affected sugar loss to molasses percentage significantly.

Table (9): Sugar loss to molasses (%) of six sugar beet varieties as affected by location conditions in 2015/2016 and 2016/2017 seasons.

Season	2015/2016				2016/2017				
	Location								
Variety	Giza	Fayoum	Ismailia	Mean	Giza	Fayoum	Ismailia	Mean	Average
Samba	1.74	1.74	1.68	1.72	1.78	1.76	1.7	1.75	1.73
Pleno	1.75	1.73	1.68	1.72	1.75	1.77	1.7	1.74	1.73
Gloria	1.65	1.74	1.65	1.68	1.7	1.69	1.66	1.68	1.68
Polybelga	1.7	1.74	1.71	1.72	1.73	1.74	1.69	1.72	1.72
Oscar poly	1.72	1.72	1.6	1.68	1.74	1.68	1.62	1.68	1.68
Gazella	1.72	1.76	1.65	1.71	1.68	1.71	1.64	1.68	1.69
Mean	1.71	1.74	1.66		1.73	1.73	1.67		
L.S.D at 0.05%									
Locations (L)		0.032					0.018		
Varieties (V)		0.045					0.025		
L x V		0.070					0.435		

Extractable sugar percentage

Results in Table 10 show the effect of the three locations (Giza, Fayoum and Ismailia) on extractable sugar percentage of six sugar beet varieties in 2015/2016 and 2016/2017 seasons.

Extractable sugar was significantly affected by studied locations conditions. Sowing sugar beet at Ismailia location resulted in higher mean value extractable sugar percentage than that gained by sowing it at Giza and Fayoum locations. This result could be attributed to higher sucrose percentage (Table 7), lower α-Amino N in roots (Table 6) and higher purity percentage (Table 8) at Ismailia location. These results are in line with those reported by **Al- Jbawi (2003), Allam *et al.* (2007) and Aly and Khalil (2017)**.

The results showed significant differences among the tested sugar beet varieties in extractable sugar percentage. Samba variety recorded the highest value of this trait. On the other hand, Gloria variety had the lowest extractable sugar percentage. The difference among varieties in this trait may be due to their gene make-up. These results are in agreement with. **Al-Jbawi (2003), Ramadan and Nassar (2004)**, **Hoffmann *et al.* (2002), Aly (2006)**, **Nasser, (2006)**, **Ismail *et al.* (2007), Refay (2010) and Aly and Khalil (2017)**.

The interaction between locations and tested varieties affected extracted sugar percentage significantly. The highest value of this trait was recorded by sowing Samba variety at Ismailia.

Extractability percentage

Results presented in Table 11 show the influence of three location conditions (Giza, Fayoum and Ismailia) on extractability percentage of six sugar beet varieties. The results revealed that extractability percentage significantly affected by growing locations. Concerning locations differences with respect to extractability percentage, the results revealed that the studied locations differed significantly in the values of extractability percentage of sugar beet roots. Ismailia location surpassed Giza and Fayoum locations in this respect. This result could be attributed to higher sucrose percentage (Table 7), lower α-Amino N in roots (Table 6) and higher purity percentage (Table 4) at Ismailia location. These results are in line with those obtained by **Allam *et al.* (2007) and Aly and Khalil (2017)**.

The results showed significant differences among the tested sugar beet varieties in extractability percentage. Samba variety recorded the highest value of this trait. On the other hand, Gloria had the lowest extractability percentage. The difference among varieties in this trait may be due to

Table (10): Extraction sugar (%) of six sugar beet varieties as affected by location conditions in 2015/2016 and 2016/2017 seasons.

Season	2015/2016				2016/2017				
Variety	Location								
	Giza	Fayoum	Ismailia	Mean	Giza	Fayoum	Ismailia	Mean	Average
Samba	19.00	18.44	19.38	18.94	18.96	18.08	18.69	18.58	18.76
Pleno	16.93	17.13	17.36	17.14	16.87	16.06	17.47	16.80	16.97
Gloria	16.76	15.81	16.29	16.29	16.89	15.92	16.56	16.46	16.37
Polybelga	18.59	17.01	18.45	18.02	18.18	17.18	18.46	17.94	17.98
Oscar poly	17.46	15.85	17.28	16.86	17.46	15.97	17.02	16.82	16.84
Gazella	18.00	17.32	19.35	18.22	18.52	17.19	19.68	18.46	18.34
Mean	17.79	16.93	18.02		17.81	16.73	17.98		
L.S.D at 0.05%									
Locations (L)			0.369				0.257		
Varieties (V)			0.521				0.363		
L x V			0.91 0				0.630		

Table (11): Extractability (%) of six sugar beet varieties as affected by locations conditions in 2015/2016 and 2016/2017 seasons.

Season	2015/2016				2016/2017				
Variety	Location								
	Giza	Fayoum	Ismailia	Mean	Giza	Fayoum	Ismailia	Mean	Average
Samba	89.04	88.73	89.46	89.08	88.85	88.47	89.03	88.78	88.93
Pleno	87.77	88.03	88.38	88.06	87.79	87.13	88.38	87.77	87.91
Gloria	88.17	87.07	87.87	87.70	88.02	87.41	87.97	87.80	87.75
Polybelga	88.99	87.88	88.85	88.57	88.64	88.02	88.97	88.54	88.56
Oscar poly	88.25	87.21	88.71	88.06	88.18	87.05	88.47	87.90	87.98
Gazella	88.58	88.00	89.57	88.72	89.03	88.15	89.79	88.99	88.85
Mean	88.47	87.82	88.81		88.42	87.71	88.77		
L.S.D at 0.05%									
Locations (L)			0.003				0.002		
Varieties (V)			0.004				0.003		
L x V			0.204				0.443		

their gene make-up. These results are in agreement with that given by **Aly (2006), Ismail *et al.* (2007) and Shalaby *et al.* (2008)**.

Yield

Root Yield (ton/fed.)

Results in Table 12 present the effect of locations conditions (Giza, Fayoum and Ismailia), sugar beet varieties and their interaction on root yield per feddan in 2015/2016 and 2016/2017 seasons.

Average root yield ton/fed was maximized when growing sugar beet under Giza conditions compared with that sown at Fayoum and Ismailia conditions, the highest mean value of root yield (31.53 and 30.72 ton/fed) in first and second seasons, respectively, was obtained from Giza location, while the lowest mean values of root yield (26.56 and 26.87 ton/fed.) in first and second seasons, respectively, were resulted from Fayoum location. It surpassed that sown at Fayoum and Ismailia by 4.97 and 4.61 tons/fed, in the 1st season, correspond to 3.85 and 2.38 tons/fed, in the 2nd one, respectively. These differences in root yield among the tree locations may be due to their soil properties or meteorological factors in these locations (Tables 2 and 3). Similar results are obtained by **Al-Jbawi (2000)**, **Mahmoud *et al.* (2002), El-Hinnawy *et al.* (2003), Abd El-Aal and Mohamed**

Table (12): Root yield (ton/fed) of six sugar beet varieties as affected by location conditions in 2015/2016 and 2016/2017 seasons.

Season	2015/2016				2016/2017				
	Location								
Variety	Giza	Fayoum	Ismailia	Mean	Giza	Fayoum	Ismailia	Mean	Average
Samba	32.67	27.34	29.77	29.93	31.72	28.30	28.33	29.45	29.69
Pleno	30.25	26.44	27.40	28.03	29.54	25.53	26.84	27.30	27.67
Gloria	34.27	26.40	31.20	30.62	33.27	27.40	30.25	30.31	30.47
Polybelga	31.73	27.30	20.17	26.40	30.15	27.80	28.44	28.80	27.60
Oscar poly	29.73	25.19	27.15	27.36	29.50	25.90	27.27	27.56	27.46
Gazella	30.50	26.70	25.82	27.67	30.15	26.27	28.89	28.44	28.06
Mean	31.53	26.56	26.92		30.72	26.87	28.34		
L.S.D at 0.05%									
Locations (L)		0.262					0.320		
Varieties (V)		0.369					0.460		
L x V		0.643					0.790		

(2005), Abd El-Razek, *et al*. (2006), Aly (2006), Allam *et al*. (2007), Abd El-Razek (2012), El-Sheikh (2012), Abd El-Razek and Ghonema (2016).

Results in Table 12 show that sugar beet varieties were differed significantly in root yield/fed, in both seasons. Gloria variety surpassed the other tested varieties recording 30.62 and 30.31 ton/fed., in first and second seasons, respectively. On the other hand, Oscar poly variety recorded the lowest root yield. 27.36 and 27.55 ton/fed., in first and second seasons, respectively. The differences among the tested sugar beet varieties in root yield could be due to their root characters. This attributed to their genetic structure. These results are in line with those obtained by **Abd El-Aal and Mohamed (2005), Osman (2005), Aly (2006), Ismail *et al.* (2006), Nasser (2006), Abd El-Aal *et al.* (2007), Allam *et al*. (2007), Azzazy *et al* (2007), Ismail *et al.* (2007), Shalaby *et al.* (2008), Enan *et al.* (2011), Abd El-Razek (2012), El-Sheikh (2012), Mohamed *et al.* (2012), Hozayn *et al.* (2013), Osman *et al.* (2014) and Okasha and Mubarak (2018).** They found significant differences among the varieties in root yield ton/fed.

The results in Table 12 show that the interaction between locations and sugar beet verities significantly affected root yield/fed, in both seasons. In the 1st season, Gloria surpassed Polybelga significantly in root yield/fed, under conditions of Ismailia. However, the variance between the two varieties failed to reach the level of significance when they were grown in Fayoum and Giza. In the 2nd season, there was insignificant variance in root yield/fed between Gloria and Polybelga varieties sown in Fayoum. Meanwhile, the difference between the two varieties was significant under conditions of Giza and Ismailia due to the superiority of Gloria over Polybelga in this trait.

Sugar yield (ton/fed.)

Results in Table 13 show sugar yield/fed of six sugar beet varieties as affect by the three locations (Giza, Fayoum and Ismailia) in 2015/2016 and 2016/2017 seasons.

The results showed significant differences between the three locations in their effect on sugar yield/fed. Growing sugar beet under Ismailia location conditions attained (5.61) and (5.10) ton/fed., in both seasons, respectively, compared with that sown at Giza (4.83) and (5.10) ton/fed in both seasons, respectively and Fayoum (4.17) and (4.50) ton/fed in both seasons, respectively. It was found that sugar beet grown under conditions

Table (13): Sugar yield (ton/fed.) of six sugar beet varieties as affected by location conditions in 2015/2016 and 2016/2017 seasons.

Season	2015/2016				2016/2017				
Variety	Location								
	Giza	Fayoum	Ismailia	Mean	Giza	Fayoum	Ismailia	Mean	Average
Samba	6.21	5.05	5.77	5.68	6.02	5.12	5.30	5.48	5.58
Pleno	5.12	3.52	4.76	4.14	4.98	4.10	4.69	4.59	4.36
Gloria	5.75	4.18	5.08	4.99	5.62	4.37	5.01	4.99	4.99
Polybelga	5.89	4.65	3.67	4.74	5.48	4.78	5.25	5.17	4.96
Oscar poly	5.19	3.99	4.69	4.63	5.15	4.14	4.64	4.64	4.64
Gazella	5.49	4.62	5.01	5.04	5.59	4.52	5.69	5.26	5.15
Mean	4.83	4.17	5.61		5.10	4.50	5.10		
L.S.D at 0.05%									
Locations (L)		1.09					1.13		
Varieties (V)		1.53					1.60		
L x V		2.50					2.79		

of Ismailia attained the highest mean value of sugar yield/fed. It surpassed that sown at Giza and Fayoum by 0.78 and 1.44 tons/ fed., in the 1st season, correspond that sown at Fayoum to 0.60 tons/fed., in the 2nd one, respectively. These results are in line with **Abd El-Razek *et al*. (2006)**, **Aly (2006), Allam *et al*. (2007)**, **Abd El-Razek (2012)**, **El-Sheikh (2012) and Abd El-Razek and Ghonema (2016).**

These results pointed to a significant variance among the tested sugar beet varieties in sugar yield ton/fed. Samba variety recorded the highest sugar yield per feddan producing (5.68) and (5.48) ton/fed in first and second seasons, respectively. The superiority of Samba variety in sugar yield is results of producing highest root yield/fed and recording the greatest value of sucrose percentage and purity percentage in juice. On the other hand, the results showed that Pleno variety produced the lowest sugar yield in compare with other tested varieties. On the other hand, Pleno variety produced the lowest sugar yield per feddan. The differences among the tested sugar beet varieties in sugar yield could be due to their root yield amount which attributed to their quality structure *i.e.* (Na, K and Alfa amino-nitrogen percentage) and environmental conditions as a suitable to all of varieties. Similar results were obtained by **Aly (2006), Ismail *et al.* (2006), Nasser, (2006 b)**, **Abd El-Aal *et al*., (2007), Allam *et al* (2007), Azzazy *et al*. (2007), Ismail *et al*. (2007), Shalaby *et al*. (2008), Enan *et al*. (2011), Abd El-Razek (2012), El-Sheikh (2012), Mohamed *et al*. (2012) and Okasha and Mubarak (2018).** They found that the influence of environmental was very high as shown by statistically significant differences in root yield and sugar content and technological sugar yield.

The interaction between locations and sugar beet varieties exhibited significant effects on sugar yield per feddan. Samba variety gave the highest mean value of sugar yield (6.61 and 6.02 ton/fed.) in both seasons, respectively, under Giza location, while Pleno variety gave the lowest mean value of sugar yield (3.52 and 4.10 ton/fed.) in both seasons, respectively, from Fayoum location.

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جودة بعض أصناف بنجر السكر تحت ظروف بيئية مختلفة

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أجريت ستة تجارب حقلية في الموسمين ٢٠١٥/٢٠١٦ و ٢٠١٦/٢٠١٧ في ثلاث مناطق (محطة بحوث الجيزة، محطة بحوث طامية بالفيوم، الإسماعيلية) لدراسة زراعة ستة أصناف من بنجر السكر (سامبا، بلينو؛ جلوريا، بولى بيلجيا واوسكار بولى وجازليا) تحت ظروف بيئية مختلفة، تم استخدام تصميم القطاعات كاملة العشوائية فى ثلاث مكررات فى ثلاث مناطق وكانت النتائج المشاهدة لكلا من انتاج السكر وجودة العصير ونسبة الشوائب (بوتاسيوم، صوديوم، الفامينو نيتروجين) وكذلك الصفات التكنولوجيا (النقاوة، الاستخلاص، الفاقد من السكروز والسكر فى المولاس كنسبة مئوية) بالنسبة للمحصول السكر للفدان وكان لعامل المنطقة تأثير معنوى على الصفات السابقة وكذلك تأثير الاصناف كان معنوى بالنسبة لكل الصفات وكان تاثير كلا من العاملين (المناطق والأصناف) معنوى على صفات محتوى السكر ونسبة الاستخلاص ومحصول السكر والنتائج الاساسية وقد كان أعلى معدل لنسبة البوتاسيوم ٣,٠٩% و٣,٢١% فى الموسم الأول والثانى على التوالى تحت ظروف منطقة الجيزة ولقد كان اعلى معدل انسبة البوتاسيوم ٣,٣١% للصنف "أوسكار بولى "بمنطقة الجيزة وأقل معدل كان ٢,٢٤% للصنف "أوسكار بولى" بمنطقة الإسماعيلية ولقد أوضحت النتائج أن أعلى معدل للنسبة المئوية للسكروز كانت ٢١,٦٧% للصنف "سامبا" بمنطقة الإسماعيلية وأقل نسبة ١٨,١٥% كانت للصنف "جلوريا" بمنطقة الفيوم فى الموسم الأول، بينما أعلى معدل للنسبة المئوية للسكروز بلغت ٢١,٩٢% للصنف "جازيلا" بمنطقة الإسماعيلية، لقد أوضحت النتائج أن أعلى معدل لقدرة الآستخلاص كان ٨٨,٨١% و٨٨,٧٧% فى الموسم الأول واثانى على التوالى تحت ظروف منطقة الإسماعيلية ولقد كان أعلى معدل لقدرة الآستخلاص ٨٩,٠٤% للصنف "سامبا" بمنطقة الجيزة ولقد أوضحت النتائج أن أعلى متوسط لمحصول الجذور كان ٣٤,٢٧، ٣٣,٢٧ طن/الفدان للصنف "جلوريا" بمنطقة الجيزة فى الموسم الأول والثانى على الترتيب وكان أعلى متوسط لمحصول السكر ٥,٦١ طن/فدان و٥,١٠ طن/فدان في الموسم الأول والثانى على التوالى تحت ظروف منطقة الإسماعيلية وتوصي الدراسة أن زراعة الصنف سامبا يليه الجازليا كان الافضل فى محافظات (الجيزة، الفيوم، الاسماعيلية)

الكلمات الاسترشادية: بنجر السكر، جودة العصير، مناطق، الأصناف، مواسم، استخلاص السكر.