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Development of a New Model to Estimate the Technical Quality of Sugar Beet in the Semi – Arid Climate

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ABSTRACT: Determination of the amount of sugar in sugar beet is usually accomplished by polarimetric method in sugar industry. This method is not accurate due to impurities such as sodium, potassium and amino-nitrogen that are present and might cause some errors in the evaluation of the technical quality of sugar beet. In this research, 7309 samples of sugar beet from two semi- arid county, Isfahan and Chahar-Mahaal, were analyzed by Betalyzer for two consecutive years. Comparison between the experimental results and the estimated one based on the Reinefeld model showed that this model couldn't successfully estimate the amount of sugar loss in molasses for semi-arid areas. Therefore a new model based on the obtained results has been developed and was suggested for this type of climatic condition, especially for samples with 13.5-17.5% sugar content.

Keywords: *Reinefeld Model, Semi-Arid Area, Sugar Beet Impurities, Sugar Loss in Molasses, Technical Quality.*

Introduction

According to the last 5 years records, the average sugar beet production in Iran has not covered more than 80 % of the formal capacity of the factories. Decrease in sugar beet cultivation, low yield of cultivated farms are some of the reasons for this pattern. More over the lower quality of produced beet especially at semi - arid areas in the recent years would not allow the processors to extract sugar from beet efficiently therefore approximately 10 % of sugar might be lost in molasses (Anonymous, 2004).

During the last 10 years some researchers investigated the technological quality of sugar beet that was affected by sugar content and the amount of impurities such as potassium (k), sodium (Na), amino nitrogen and molasses (Rover, 1999). Climatic conditions and agronomic factors such as location, nutrition, pH of the soil, irrigation, pests and diseases, harvesting time, storage and also delivery technique of the crop might affect the quality of sugar beet (Huijbregts, 1996; Vandergeten, 1998). Studies in Italy showed that the quality of beet might be changed in different locations (Vallini, 1992). Rover (1999) reported that in the year that precipitation is low and the corps suffer drought stress, impurities are increased and the quality of beet is decreased. Gordo (1999) proved that beets that suffered drought stress in south part of Spain had lower response to N- fertilizers.

Investigations in Yugoslavia during 1981-1995, indicated that spring rainfall might affect the technological quality of sugar beet. Pacuta (2000) showed that the quality of beet might be changed by liquid application of N- fertilizer at moderate and warm climatic condition of Slovakia.

Methods, formula and relationships have been developed concerned with molasses

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sugar (ZM) content by many researchers as shown below and referred as Reinefeld formula;

ZM=0.343(K+ Na) +0.094(amino-N) - 0.031

Later corrections were made and the formula was represented as indicated below and called Braunschwik model (Burba, 2003).

ZM=0.12 (K+ Na) + 0.24 (amino-N) + 0.48

The presence of invert sugar (I) that might be an affecting factor was also investigated by some other investigators and showed that the extractable sugar content (ZB) might be calculated from the following equation (Draycott, 2006).

ZB=pol – [0.19(K+ Na) + 0.274 (amino-N)+1.145 I+0.576]

Where pol is the sucrose content.

Factors affecting the quality of sugar beet in semi- arid area of Isfahan has been determined in our recent study and the results showed that the quality of beet is more affected by sodium content than other impurities. The main object of this research is to develop a new formula to estimate the technical quality of sugar beet in this type of climatic condition.

Materials and Methods

Eight locations from semi - arid and six locations from temperate areas were selected that were near the three sugar factories. Beet samples from all of the mentioned locations were harvested daily for two years and transferred to the factories. Samples were frozen and analysed by Betalyser system in "Research and Laboratory Services Center" (Isfahan, Iran) to measure the sugar content, K, Na and amino-N (Kernchen, 1997). The amount of sugar loss in molasses was estimated according to the Reinefeld formula that was mentioned earlier and compared with the actual sugar loss in molasses on the basis of the published reports at the end of the exploitation time of the Isfahan and Mobareke factories.

All of the statistical analysis and modeling procedure for developing a new formula have been carried out by SAS software (Honarvar, 2000).

Results and Discussion

Gross correlation coefficients between sugar content of beet samples and each of the parameters including potassium (K), sodium (Na) and amino –N in semi – arid and temperate regions, for two consecutive years are shown in Table1. According to these results, the effect of potassium and sodium on sugar quantity was positive and negative, respectively, although the coefficient factors were very low for all of the studied cases. In table 2, the amount of sugar loss in molasses in the actual (reported by two of the known Iranian sugar industries) and estimated forms (based on the Reinefeld Model) are compared. The results showed that in both factories the estimated quantity was always greater than the real figure. Regarding the Mobareke factory, although the real quantity has been increased from the first to the second year but the estimated quantity decreased. As it might have been observed there are significant differences between the estimated and the actual amounts of sugar loss in molasses, therefore parameters (table 3) based on all the obtained data from the investigations during the two consecutive years resulted in a new model as shown in following formula:

ZB = 22.85 - 0.65 (k) – 0.98 (Na) – 0.04 (Amino- N)

where ZB is the extractable sugar.

(All variable was significant al 1 % level and r = 0.9379)

Sodium with the highest negative coefficient (-0.98) has the greatest effect on the amount of sugar loss in molasses and consequently output of the factory, followed by potassium (-0.65) and amino- N (- 0.04) that affected the sugar loss and factory output.

Conclusion

It has been previously proved that sugar beet in semi-arid areas suffer drought stresses (Vallini, 1992; Noe, 1996; Huijbregts, 1996; Vandergeten, 1998, Rover, 1999; Pacuta, 2000; Honarvar, 2000). Data obtained in this research showed that sodium is the main impurity in the soil and might be considered as one of the main reasons for low yield in semi-arid areas. Low precipitation, lack of water results in limited photosynthesis in sugar beet. Therefore by supplying enough water equal to evapo-transpiration, the negative effect might be relatively reduced. It was confirmed that Reinefeld formula might not be suitable for the semi-arid areas, that is the typical climatic condition in Iran. The new developed/simulated model is more applicable especially for the samples with sugar contents of 13.5% to 17.5%. In fact more experimental research is required to confirm the accuracy of the models.

Table 1. Correlation coefficients of sugar content (s.c.) concerned with the amount of potassium (K), sodium (Na) and amino-N in selected locations for two consecutive years

Year	Location and Condition	K	Na	Amino-N
First	Lenjan, semi-arid, low s. c.	0.514	-0.846	0.208
	Rouidasht, semi-arid, high s.c.	0.306	-0.708	0.125
	Khanmirza, temperate, low s. c.	0.375	-0.402	-0.299
	Semirom, temperate, high s. c.	0.148	-0.148	-0.322
Second	Mahyar, semi-arid, low s. c.	0.00	-0.670	0.223
	Rouidasht, semi-arid, high s. c.	0.201	0.615	0.123
	Khanmirza, temperate, low s. c.	0.149	-0.447	-0.212
	Semirom , temperate , high s. c.	0.127	-0.285	-0.218

Table 2. Actual and estimated* sugar loss in molasses (%) in Isfahan and Mobareke sugar factories for two consecutive years

Factory	Year			
	First		Second	
	Actual	Estimated	Actual	Estimated
Isfahan	2.10	3.86	2.08	3.63
Mobareke	1.56	3.88	1.95	3.66

* According to Reinefeld model

Table 3. Parameters estimates simulated model (based on data for 7309 samples)

Variable	Parameter estimate	Standard error	Prob>T
Intercept	22.845	0.105	0.0001
Potassium	-0.653	0.017	0.0001
Sodium	-0.981	0.003	0.0001
Nitrogen	-0.043	-0.012	0.0001

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