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EVALUATION OF TOPS, PULP AND MOLASSES OF SUGAR BEET *(Beta vulgaris)* AS ANIMAL FEEDS IN EGYPT.

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ABSTRACT

This study was carried out to estimation of tops and roots yields and tops yield / roots yield ratio of some sugar beet varieties in different types of soils(clay and sandy) and chemical evaluation for some minerals, oxalate and amino acids contents of sugar beet by-products (sugar beet tops, dried sugar beet pulp and sugar beet molasses). Also the effect of drying method in chemical composition, fiber fraction, oxalate (total and soluble) contents and their loss in fresh sugar beet tops (FSBT) varieties was studied.

Nine sugar beet varieties were used in this experiment namely Teri, Ras poly, Athos poly, Sultan, Pleno, Gloria, Kawemira, Top, and Dema poly, and planted on three different followed dates of sowing (15 th August, 15 th September and 15 th October) in different types of soils (clay and sandy).

The results indicated that overall mean of SBR and SBT yields as ton/fed., kg/plant and root/tops (R/T) ratio, were 23.66 and 13.82 ton/fed.; 0.49 and 0.85 kg/plant and 1.7, respectively. As affected by soil type, yield of SBR and SBT was higher in clay than in sandy soil in term of ton/fed and kg/plant. The differences in content of DM, OM, CF, EE, NFE, ash, ADL, hemicellulose and gross energy among different SBT varieties were not significant, ranging between 11.86-13.17%; 77.80-81.34%; 13.57-14.36%; 0.93-1.21%; 46.22-51.13%; 18.74-22.20%; 1.77-2.23%; 9.80-13.99% and 15.04- 15.55%, respectively.while, CP, ADF and cellulose content showed significantly ($P<0.05$) differences between tested varieties.

Ras poly variety showed significantly ($P<0.05$) the highest P content and the lowest Mg content. Glorius variety showed significantly ($P<0.05$) the lowest contents of Na and Fe. Sultan variety had significantly ($P<0.05$) the lowest Ca and Mn contents. Pleno showed significantly the lowest P and K contents and the the highest Zn content.

DSBP and molasses had lower contents of total and soluble oxalate and lower Na, K, Fe, Cu, Zn contents than that in FSBT. While, Fe content was the highest only in molasses, being 2083 mg/kg.

Total content of essential amino acids in DSBP and molasses was lower than that in SBT, being the lowest in molasses (9.17 mg/100 g).

Chemical analysis of SBT as affected by drying was significantly ($P<0.05$) different only for OM, CP, ash, ADF, ADL, total oxalate, soluble oxalate, and gross energy.The higher loss by both drying methods of SBT was found in soluble oxalate, followed by ash and CP and the lowest for NFE. This loss was almost higher significantly in SDSBT than in HDSBT.

Keywords: Sugar beet varieties, sugar beet tops yield sugar beet pulp, molasses, chemical evaluation, minerals, oxalate, amino acids, and drying methods.

INTRODUCTION

Sugar beet (*Beta vulgaris*) has been introduced in Egypt on commercial scale in year 1981/1982 (El-Bilassi, 1987). In Egypt, the area cultivated with sugar beet (SB) increased annually (from 16943 feddan in 1981/1982 season to 227857 feddans in 2008/2009 season produced about 4087459 of tonns sugar beet roots and 2387485 tonns of sugar beet tops (SBT) as agricultural by-product) and there were seven factories (El-Daqahlia, two factories; El-Delta. two factories; Abokorcas; El-Fayoom and El-Noparia) produce large quantities of by-products of sugar beet industry (about 265684 tonns of sugar beet pulp (SBP) and 245247 tonns of sugar beet molasses (SBM) as a by-products of SB manufacture), which can be used for ruminant feeding in different forms. Also, El-Nile, El-Nouran and Alexandria companies are prepared now to receive large quantities of SB and the expansion in planting the crop in Egypt which may increase SB by-products. In addition, there are some factories (Ismeilia, Assuit, and Gharbia) under study and establishing.

Sugar beet pulp is a good remainder because it is always available with suitable quantities in specified regions, which can be easily collected and transported to the end user Also, SBP contains suitable amount of digestible feeding materials and fiber content. Also, it is an excellent digestible energy source for ruminants because of type of carbohydrate associated with the cell wall fractions. The high pectin content of beet pulp provides a readily available source of energy for microbial protein activity in the rumen. So, SBP would appear to be an excellent feed ingredient for ruminant diets (Metwally and Stern, 1989). Finally, SBP is a palatable feedstuff for feeding animals.

Several authors reported that large quantities of SBT are produced as an agricultural by-product after harvesting the sugar beet crops. Thus, the availability of using SBT (dried or silage) for livestock as a replacement of traditional high quality roughages such as berseem hay (BH) (high price feeds) was investigated (Bendary *et al*., 1992a; Mohi El-Din, 1998 and Senara, 2006).

SBT have high perishable nature its ferment quickly causing flying breeding nuisance and always present potential air, plant disease and water pollution problems (Baker, 1995). Also, there are some problems in using fresh SBT because it is high in moisture, potassium and oxalic acid content which lead to diarrhoea and must be taken in consideration when used in animal feeding and ration formulation (Bendary *et al*., 1992a and Senara 2006).

The main objective of this study was to evaluate yield, chemical composition and some minerals, oxalate and amino acids contents of different varieties of fresh SBT, dried SBP and SB molasses.

MATERIALS AND METHODS

The present investigation was conducted by the Daqahlia Sugar Company, at Meet Tareef –Dekerns as clay soil and at Zian –Belkass as sandy soil at Daqahlia governorate in cooperation with Department of Animal

Production, Faculty of Agriculture, Mansoura University, and supporting of Academy of Scientific Research of Technology, Ministry of Agriculture, Egypt. The experimental work was conducted during the period from August, 2008 to June, 2009.

Nine sugar beet varieties were used in this experiment namely, Teri; Ras poly, Athos poly, Sultan, and Pleno; Glorius, Kawemira, and Top; and Dema poly. These varieties were imported from Hungary, Sweden, Holland, Germany and France, respectively, by Ministry of Agriculture; and distributed for growing by farmers through the Daqahlia Sugar Company; and planted on three different followed dates of sowing (15 th August, 15 th September and 15 th October) in 2008/2009 season at Meet Tareef –Dekerns as clay soil and at Zian –Belkass as sandy soil at Daqahlia governorate.

Cultivation of sugar beet:

In both types of soils (clay and sandy), six plots were cultivated from each sugar beet variety; the plot size was 42 m ^{2} (6 x 7 m). Each plot included ten ridges, 60 cm apart and 7 m long to avoid the effect of lateral movement of irrigation water; the horizontal plots were isolated by levees 1.5 m wide.

The phosphorous fertilizer with mentioned rates were applied before sowing took place.; Seeds were sown in hills at rate of 2-3 seeds per hill, 14 cm a part(to receive 30000 plant/feddan). Then, all plots were irrigated immediately.

Thirty five days after sowing, thinning to one plant per hill was done. The nitrogen fertilizer with mentioned rates was applied in two and three equal splits in clay and sandy soil respectively. The first split was added just before the second irrigation after thinning, the second split was added before third irrigation. While the third split in sandy soil was added with the fourth irrigation. Other cultural practices were done as recommended.

Harvesting and yield estimation:

At maturity (195 days from sowing), the area of 10.5 m ^{2} from each devoted plots for yield determinations were harvested to estimate the following:

- Root or top weight per plant (root or top yield from plot/No. of plants).
- Root or top yield per plot (transformed to metric tons per feddan).
- Root/ tops ratio (root yield per plot/ tops yield from plot).

Drying of sugar beet varieties tops:

Drying of sugar beet varieties tops made by two different methods (sun and heat dried) to study the effect of drying method on nutrients and oxalate (total and soluble) contents and their loss in FSBT varieties.

For 24 hours. For sun dried sugar beet tops (SDSBT), samples of FSBT were spread on ground; the plant material was turned upside down every day at 10 a.m. after dew disappearance until being cured, the drying time was 7 days. However, for heat dried sugar beet tops (HDSBT), samples of FSBT were dried by curing in heat oven on 500^{o}C for 30 minutes.

Loss percentages as affected by different drying methods were calculated by the differences percentage in change of chemical composition, fiber fraction and oxalate (total and soluble) contents of SDSBT and HDSBT comparing to FSBT.

Chemical composition and fiber fraction:

Composite sample (18 kg) of different fresh sugar beet varieties tops (1 kg from each variety in both types of soils was taken and very good mixed); Samples were dried as follows: For fresh sugar beet tops (FSBT), samples were dried by heat oven on 105ºC.

Samples from FSBT, DSBP and sugar beet molasses were analyzed for proximate analysis according to the methods of the A.O.A.C. (2000); While Neutral detergent fiber (NDF), acid detergent fiber (ADF) and acid detergent lignin (ADL) were determined according to Goering and Van Soest (1970). Hemi cellulose was calculated as the difference between NDF and ADF, while cellulose was calculated as the difference between ADF and ADL.

Gross energy (GE) of tested ingredients was calculated according to MAFF (1975) using the following equations: GE Mj /kg DM = 0.0226 CP+ 0.0407 EE + 0.0192 CF + 0.0177 NFE.

Calcium, magnesium, sodium, potassium, copper, iron, manganese and zinc in prepared samples were carried out as reported by A.O.A.C. (1995) using atomic absorption spectrophotometer (Perken Elemmer Techtran Pty. Ltd, Melbourne, Australia). Phosphorus in feed was determined according to Fiske and Subbaraw (1925) by using Molybedenum blue color method.

Estimate of oxalate (total and soluble) contents of FSBT, DSBP and sugar beet molasses were determined according to A.O.A.C. (1995) and Moir,K.W.,(1953).

Amino acid analyzer (Model 121) was used for determination of amino acids in fresh SBT, SBP and sugar beet molasses as described by Moore *et al*. (1958).

Statistical analysis:

Statistical analysis for the obtained data was performed by Analysis of Variance using the method of least square analysis of Co-variance of SAS (1996) Duncan Multiple Range Test was used to test the differences among means (Duncan, 1955).

RESULTS AND DISCUSSION

Yield of fresh sugar beet roots (SBR) and tops (SBT):

Results in Table (1) show that overall mean of SBR and SBT yields as ton/fed., kg/plant and root/tops (R/T) ratio, were 13.82 and 23.66 ton/fed.; 0.49 and 0.85 kg/plant and 1.7, respectively. As affected by soil type, yield of SBR and SBT was higher in clay than in sandy soil in term of ton/fed and kg/plant. Increasing the yield of SBR and SBT as ton/fed in clay soil was about 46.4 and 22.11% as compared to the sandy soil. It is well known that the clay soil is high fertility due to high content of dry matter compared to the sandy soil. The corresponding increase as kg/plant was 28.4 and 27.3%, respectively (Table 1).

In addition, there was marked differences in SBR and SBT yield during different culture months, being the highest in October as compared to August and September, regardless plant density. This may be due to the growth condition of sugar beet crop in October such as weather factors and diseases are more suitable compared to these in August and first half of

September .These results indicated the highest SBR and SBT yield when sugar beet was cultured in clay soil in October month.

Table (1): yield of fresh sugar beet roots and tops and roots / tops (R/T)per feddan of some varieties of sugar beet in different soils and dates of sowing .

Variety	Soil	Date of sowing	Density (plant/feddan)	Roots yield		Tops yield		R/ T ratio
				Ton	Kg/plant	Ton	Kg/plant	
Teri	Clay	15 th August	24508	21.416	0.87	12.98	0.53	1.65
Ras poly			24516	23.865	0.97	14.04	0.57	1.70
Athos poly			24513	23.516	0.96	13.91	0.57	1.69
Mean			**24512.3**	**22.93**	**0.93**	**13.64**	**0.56**	**1.68**
Glorius		15th September	28632	26.054	0.91	14.97	0.52	1.74
Sultan			28570	26.820	0.94	15.24	0.53	1.76
Pleno			28662	27.194	0.95	14.94	0.52	1.82
Mean			**28621.3**	**26.70**	**0.93**	**15.05**	**0.52**	**1.77**
Kawemira		15 th October	30141	29.961	0.99	16.74	0.55	1.79
Top			30201	30.070	0.99	16.89	0.56	1.78
Dema poly			30150	30.81	1.02	17.02	0.56	1.81
Mean			**30164**	**30.28**	**1.00**	**16.88**	**0.56**	**1.79**
Average of clay soil			27765.9	**27765.9**	**0.95**	**15.19**	**0.55**	**1.73**
Teri	Sandy	15 th August	24506	17.069	0.70	10.47	0.43	1.63
Ras poly			24499	17.121	0.70	11.26	0.46	1.52
Athos poly			24518	17.962	0.73	10.75	0.44	1.67
Mean			**24507.7**	**17.38**	**0.71**	**10.83**	**0.44**	**1.61**
Glorius		15th September	28660	20.617	0.72	12.65	0.44	1.63
Sultan			28590	21.082	0.74	12.33	0.43	1.71
Pleno			28611	21.051	0.73	12.46	0.43	1.69
Mean			**28620.3**	**20.92**	**0.73**	**12.48**	**0.43**	**1.68**
Kawemira		15 th October	30150	23.541	0.78	14.012	0.46	1.68
Top			30210	23.66	0.78	14.00	0.46	1.69
Dema poly			30163	24.05	0.80	14.06	0.47	1.71
Mean			**30174.3**	**23.75**	**0.79**	**14.024**	**0.46**	**1.69**
Average of sandy soil			**27767.4**	**20.68**	**0.74**	**12.44**	**0.44**	**1.66**
Overall mean			**27766.6**	**23.66**	**0.85**	**13.82**	**0.49**	**1.70**

In similarity with the present data, Zaki (1995) found that the fresh and dry yields (ton/fed.) of leaves and roots of sugar beet (variety Ras Poly) were higher in clay soil than in sandy soil, being 8.6 as fresh (1.337 DM) and 50.0 as fresh (7.8DM) in clay soil and 5.6 as fresh (0.894 DM) and 15.6 as fresh (2.708 DM) in sandy soil, respectively. It was found that yields of sugar beet roots and tops and R/T ratio were affected by planting method and sugar beet variety. In this respect, Khodeir (2002) found that sugar beet roots and tops yields and R/T ratio were 1.4 and 1.6 for mechanical and manual planting methods, respectively.

Also, El-Sheref (2007) found that the means of sugar beet roots and tops yield (Ton/feddan and kg/plant), of Belino variety treated with different sources and rates of nitrogen and boron fetilizers, were (32.47 and 0.93) and (18.43 and 0.52), respectively, in 2003/20004 season, while its were (30.85 and 0.89) and (17.52 and 0.50), respectively, in 2004/2005 season. Means of root/top ratio at harvest were 1.79 and 1.70 in 2003/2004 and 2004/2005 seasons, respectively.

Chemical analysis of SBT, dried sugar beet pulp (DSBP) and molasses:

Analysis of variance revealed significant ($P<0.05$) differences in contents of CP, NDF, ADF and cellulose between different SBT varieties (Table 2). Results show that variety of Ras poly variety had significantly ($P<0.05$) the highest contents of CP (18.06%) and hemicellulose (13.99%). While, Kawemira variety significantly ($P<0.05$) slowed the highest NDF (32.15%), ADF (19.08%) and cellulose (17.31%). On the other hand, Pleno variety showed significantly ($P<0.05$) the lowest CP content (15.09%) and NDF content (28.90%, Table 2). Several studies reported that CP content of FSBT or sugar beet leaves varying from 14.72 to 27.95% (Eweedah *et al*.,1999b and Shalaby, 1991) while cell wall constituents ranging between 29.94-47.17% for NDF, 15.81 to 16.79% for (ADF and 3.15 to 4.62% for ADL (Ali, 1996 and Zaki ,1995).

The differences in content of DM, OM, CF, EE, NFE, ash, ADL, hemicellulose and gross energy among different SBT varieties were not significant, ranging between 11.86-13.17%; 77.80-81.34%; 13.57-14.36%; 0.93-1.21%; 46.22-51.13%; 18.74-22.20%; 1.77-2.23%; 9.80-13.99% and 15.04- 15.55%, respectively (Table 2).

In contrast to the present results, several studies reported that DM content of FSBT or sugar beet leaves varying from 6.08 to 15.55% (Shalaby, 1991 and Zaki, 1995), Several studies reported that CP content of FSBT varying from 14.72 to 27.95% (Eweedah *et al*.,1999b and Shalaby, 1991); CF content from10.80 to14.88% (Salo and Sormumen, 1974 and Eweedah *et al*.,1999b); EE content from 2.55 to 5.50% (Vukic et al., 1983 and Shalaby, 1991); NFE from 32.25 to 53.30% (Shalaby, 1991 and Vukic *et al*.,1983) and ash from 14.53 to 26.44% (Vukic *et al*.,1983 and Ali, 1996).

On other hand, the proximate chemical analysis of DSBT ranged from 81.75 to 89.60, 75.86 to79.21, 12.43 to 13.47, 12.44 to 14.50, 1.71 to 2.91, 47.44 to 49.11 and 20.79 to 24.14 for DM, OM, CP, CF, EE, NFE and ash, respectively (Ali, 1996; Mahmoud *et al*., 2001; Eweedah *et al*., 2004 and Senara, 2006). Whereas, the cell wall constituents were 31.39, 18.88 and 2.49% for NDF, ADF and ADL, respectively (Ali, 1996).

Concerning the chemical analysis of DSBP, it had lower CP content (10.14%) and higher CF content (21.75%) and fiber fraction than that in fresh SBT (Table 6). In comparable with the present results of the proximate chemical analysis of DSBT, several reports show that DSBP (on DM basis) contained 86.30-93.06% DM; 92.31-96.40% OM 8.99- 13.30% CP; 18.05-27.16% CF; 0.42-1.16% EE; 53.76-66.86% NFE and 3.60-7.69% ash. However, cell wall constituents ranged between 48.00 and 64.20% NDF; 26.10 and 33.30% ADF; and 2.00 to3.51% ADL (Kelly, 1983; Maareck, 1997; NRC, 1989; Salem, 2000; Varhegyi *et al*., 2002; Abedo *et al.,* 2005; and Khalel *et al*., 2007).

It is of interest to note that gross energy content increased in molasses (16.23 MJ/Kg DM) as compared to fresh SBT(15.04 – 15.62 MJ/Kg DM) and dried SBP(17.90 MJ/Kg DM) (Table 2). Proximate chemical analysis of beet molasses of this study (Table 2) was nearly similar to those reported by many authors who indicated that DM content ranged from 65.0 to 79.0%, OM from 89.7 to 91.79%, CP from 3.30 to 6.6%, CF from 0 to 0.3%, EE from 0 to 0.2%, NFE from 86.4 to 87.31% and ash from 8.21 to 17.1% (El-Santiel *et al*., 1983; Abdel-Hamid ,1992 ; Afaf. M. Fayed *et al*., 2001 ; CLFF, 2001).

The gross energy of sugar beet by-products estimated by many authors, being 4.58 Mcal/kg in DSBP (Darwish *et al*., 1989), 535. 33 and 3442.65 cal/g in DSBP on fresh and DM basis (Zaki 1995) and 14.64 Mj/kg DM in DSBT (Mohammed 2002). In addition, Senara (2006) found that the gross energy of DSBP and DSBT (on DM basis) were 18.13 and 15.55 Mj/kg DM, respectively. While, Murray *et al*. (2008) reported that the gross energy contents of DSBP was 16.5 Mj/kg DM.

Oxalate and mineral contents in FSBT, DSBP and molasses:

Analysis of variance revealed signficant ($P<0.05$) differences among SBT varieties in contents of minerals (Ca, P, Na, K, Mg, Fe, Zn and Mn). However, oxalate content as total and soluble as well as content of Cu did not differ significantly among SBT varieties (Table 3).

Results show that Ras poly variety showed significantly ($P<0.05$) the highest P content and the lowest Mg content. Glorius variety showed significantly ($P<0.05$) the lowest contents of Na and Fe. Sultan variety had significantly ($P<0.05$) the lowest Ca and Mn contents. Pleno showed significantly the lowest P and K contents and the the highest Zn content.

On the other hand, Kawemira had significantly ($P<0.05$) the lowest Zn content. However the highest Na, Mg and Mn contents were significantly ($P<0.05$) observed in Top variety and the highest Ca and K contents were significantly ($P<0.05$) found in Dema poly variety (Table 3).

It is of intrest to note that DSBP and molasses had lower contents of total and soluble oxalate and lower Na, K, Fe, Cu, Zn contents than that in FSBT. While, Fe content was the highest only in molasses, being 208.3 mg/kg (Table 8).

It is worthy noting that the differences in different SBT variety in macro-and micro-element content may be related mainly to type of the soil and mineral contents in the soil, fertilization and partially related to variety of SBT.

Although beet pulp is well known for its phosphorus deficiency. it is significantly contained higher Ca, Mg, Mn and Fe contents than the other energy rich concentrates (Bhattcharya and Sleiman, 1971 and Shukle *et al*., 1981). The later authors found that the minerals content of DSBP (on DM basis) were: Ca 0.72, P 0.09, Mg 0.30 and Fe 0.03% versus Ca 0.80, P 0.19, Mg 0.65, Na 0.06 and K 0.74% in the molasses dried sugar beet pulp (Kelly 1983).

Under Egyptian conditions, the minerals contents in the FSBT of 11 varieties of Ca, P, Na, K, Fe, Zn and Mn ranged from 5.84 to 8.00, 1.14 to 2.50, 3.48 to 5.15, 32.4 to 42.0 (g/kg), 70 to 189, 28 to 117 and 18 to 56 (mg/kg), respectively (Bendary *et al*., 1992c).

T2-3

In fresh and dried SBT cultivated under the Egyptian condition, Eweedah *et al*. (1999b) found that the minerals contents (on DM basis) were: Fe (1150and 1675), Cu (15 and 22), Zn (38 and 25), and Mn (73 and 88), respectively. However, the corresponding contents (%) were 0.95-0.44; 1.51-0.67; 2.95-2.40 and 0.53-0.48 for Ca, Mg, K and P, respectively. Similar ranges were reported by Ghoneim (1964) and Salo and Sorumen (1974).

Mohiel-Din *et al*. (2000) found that the minerals composition of sugar beet tops hay was ash (24.10 g/kg), Ca (4.09 g/kg), P (2.96 g/kg), Na (3.02 g/kg), K: (32.54 g/kg) and Mg (3.09 g/kg). Mostafa (2004) found that the minerals contents of DSBP were 0.45, 0.09, and 0.24% for Ca, P and Mg respectively. Recently, Murray *et al*. (2008) reported that the minerals contents of DSBP were 1.2, 4.5, 16, 0.5 and 2.7 (g/kg) for, Na, K, Ca, P and Mg, respectively.

Concerning the comparison with present results of oxalate, Lennon and Tagle (1974) estimated the total oxalic contents in leaf, root, and pulp of sugar beet, being 4.9 g/100 g DM, 366.5 and 236.9 mg/100 g DM, respectively. Also, Bendary *et al*. (1992b) found that the total oxalic content of 11 varieties of FSBT ranged between 3.30 to 4.89% (on DM basis). Also, they determined the oxalic acid content in DSBT of these varieties, ranging from 4.75% in shade DSBT to 4.81% in sun DSBT) with the average 4.78%. Nearly similar results were obtained by Mohiel-Din *et al*. (2000), who found that oxalate content in DSBT was 4.73%. Recently, Senara (2006) found that the total and soluble oxalic acid contents were (5.94 and 0.89%) and (4.60 and 0.81%) in FSBT and DSBT, respectively.

Generally, the observed variations in mineral contents for different studies may be related to the different sugar beet varieties, agriculture system, soil, environmental condition, different method of analysis and drying methods.

Amino acid profile:

Data in Table (4) show that Pleno variety showed the highest contents of isoleucine, phenylalanine, aspartic acid, proline, ornithine and non-essential amino acid contents and the lowest contents of arginine, histidine, lysine and threonine as compared to other varieties. However, Sultan variety showed the highest contents of arginine, histidine, valline, alanine, serine and the lowest contents of methionine, aspartic acid and total non- essential amino acids.

It is of intrest to note that Dema poly variety showed the lowest contents of leucine, phenylalanine, valline, and total essential amino acids. However, Athos poly had the highest contents of essential amino acids, in particular therionine (Table 4).

The present results indicated that total content of essential amino acids in DSBP and molasses was lower than that in SBT, being the lowest in molasses (9.17 mg/100 g).

Boldizsar *et al*. (1975) mentioned that the essential and non-essential amino acid ratio in leaf protein concentrates (LPC) prepared from leafy sugar beet tops were satisfactory. Omole and Oke (1980) stated that the amino acid pattern of LPC of sugar beet tops was very similar to that of fish meal.

Shalby (1991) compared between sugar beet LPC when isolated from green sugar beet leaves and dried sugar beet leaves. The essential amino acid contents (g/16g N) were arginine 4.43-4.28, histidine 1.54-1.48, isoleucine 5.00-4.95, leucine 9.20-9.10, lysine 7.09-7.04, methionine 1.48-1.47, phenylalanine 4.19-4.17, threonine 3.56-3.54 and valline 4.33-4.32, while non essential amino acids were alanine 4.32-4.20, aspartic acid 6.74-6.75, cystine 1.23-1.20, glutamic acid 8.14-8.03, glycine 3.94-3.85, proline 3.39-2.92, serine 3.50-3.47, tyrosine 3.06-3.04 and tryptophan 1.18-1.18.

Table (4): Amino acids profile (mg/100 g DM) of sugar beet by-products (in different varieties of FSBT, DSBP and molasses).

Amino acids	Agricultural by-product (some varieties of SDSBT)										Manufactural by-products	
	Teri	Ras poly	Athos poly	Glorius	Sultan	Pleno	Kawemira	Top	Dema poly	Overall mean	DSBP	Molasses
Essential amino acids (EAA) : (mg/100 g)												
Arginine	4.51	4.68	4.71	4.38	5.01	4.32	4.66	4.57	4.29	4.57	2.95	0.88
Histidine	1.61	1.70	1.69	1.47	1.82	1.38	1.59	1.62	1.44	1.59	2.40	0.79
Isoleucine	4.98	4.82	4.96	4.77	5.01	5.04	4.68	4.91	4.99	4.91	3.64	1.01
Leucine	9.17	9.08	9.18	9.16	8.87	9.52	8.54	10.01	8.77	9.14	5.51	0.99
Lysine	7.11	7.15	7.02	7.14	7.05	6.93	6.98	7.51	7.14	7.14	6.77	1.91
Methionine	1.50	1.43	1.44	1.62	1.09	1.81	1.90	1.22	1.45	1.49	1.25	1.01
Phenylalanine	4.27	4.19	4.65	4.18	4.04	5.12	4.22	4.71	3.86	4.36	3.85	0.82
Threonine	3.55	3.91	3.92	3.61	3.71	3.55	3.91	3.81	3.91	3.76	3.58	1.20
Valline	4.37	4.46	4.08	4.70	5.02	3.99	4.38	5.01	3.96	4.44	5.31	0.57
Total EAA	41.07	41.42	41.65	41.03	41.62	41.66	40.86	43.37	39.81	41.40	35.26	9.17
Non essential amino acids (NEAA) : (mg/100 g)												
Alanine	4.32	4.19	4.33	4.18	4.55	4.49	4.27	4.21	4.11	4.29	3.88	0.91
Aspartic acid	6.74	6.58	6.75	6.60	6.21	6.91	6.81	6.71	6.70	6.67	11.33	2.45
Cystine	1.31	1.27	1.36	1.32	1.29	1.31	1.26	1.29	1.32	1.30	1.90	0.98
Glutamic acid	8.25	8.30	8.26	8.31	8.36	8.50	8.71	8.05	8.44	8.35	7.81	2.02
Glycine	4.02	3.99	4.11	4.26	4.01	3.97	3.88	4.51	4.03	4.09	3.60	0.96
Proline	3.37	3.41	3.44	3.05	3.38	3.71	3.29	3.38	3.32	3.37	1.21	0.78
Serine	3.49	3.50	3.55	3.46	3.28	3.66	3.33	3.90	3.04	3.47	3.72	1.13
Tyrosine	3.11	2.93	3.10	3.16	2.99	3.14	3.85	3.19	2.77	3.14	4.18	1.41
Ornithine	1.22	1.18	1.25	1.17	1.20	1.25	1.09	1.17	1.18	1.19	2.87	1.53
Total NEAA	35.83	35.35	36.15	35.51	35.27	36.94	35.49	36.41	34.91	35.87	40.50	12.17

SDSBT:solar dried sugar beet tops

The recent results on amino acid profile (mg/100 g) of DSBP was reported by El-Badawi *et al*. (2007), being arginine 11.46, histidine 22.22, isoleucine 19.52, leucine 6.72, lysine 22.89, methionine 0.59, phenylalanine 9.05, threonine 14.68, valline 31.81, alanine 21.41, aspartic acid 37.46, cystine 0.43, glutamic acid 37.26, glycine 18.12, proline 7.78, serine 20.18, and tyrosine 5.98 mg/100 g DM. The corresponding values of Serena (2007) were 4.42, 3.54, 4.14, 6.27, 7.52, 1.83, 3.76, 4.71, 6.44, 4.78, 7.48, 1.36, 9.35, 4.39, 4.53, 5.23, and 4.06 (g/16g N). However, Khalel et al. (2007) concluded that DSBP contained 0.45, 10.69, 11.34, 11.95, 3.14, 3.12, and 5.32 mg/100 g substrate for methionine, lysine, histidine, alanine, leucine, tyrosine and arginine respectively.

Chemical analysis of dried SBT (DSBT):

The effects of drying method, solar (S) or heated (H) on chemical analysis of SBT as compared to fresh SBT are presented in Table (5). Analysis of variance (Table 5) shows that there were significant differences in contents of OM, CP, CF, EE, and ash; ADF and ADL; total and soluble oxalate and gross energy among SBT in fresh (FSBT), solar dried SBT (SDSBT) and heated dried SBT (HDSBT).

Results show that drying SBT by both methods significantly ($P<0.05$) decreased contents of OM, EE and increased ash content. While, contents of CF significantly ($P<0.05$) increased and NFE content did not differ significantly by drying (Table 5).

Interestingly to note that drying SBT by heat maintained CP content as in FSBT, being 16.69 and 16.74%, respectively. However, **Ali (1996)** observed that significantly ($P<0.01$) decrease in CP content in SBT hay making by sun drying and shad drying was 22.65 and 11.27%, respectively comparing with FSBT.

While, heating method affect on OM content, being significantly ($P<0.05$) higher in HDSBT than in SDSBT (79.09 vs. 76.64 %, Table 5). The present results were compared with those reported by Bendary *et al*. (1992a), who observed that the change of the proximate chemical analysis (%) was -7.82 and +0.51 for CP, -39.19 and -27.03 for CF, +10.43 and +4.53 for EE, -3.38 and -3.91 for NFE and +13.17 and +10.75 for ash when fresh sugar beet tops were dried by two methods (sun- dried and shade- dried), respectively, comparing with proximate chemical analysis of FSBT. Also, Bendary *et al*. (1992c) found that the losses (%) of DM and ash contents in shade dried SBT were 7.61 and 2.71, respectively, comparing with sun dried SBT.

Concerning the fiber fraction, only drying SBT by heat significantly ($P<0.05$) decreased ADF and ADL contents from 17.91 and 2.10 to 17.03 and 1.6 % in HDSBT and from 17.91 and 2.10 to 17.54 and 1.89 % in SDSBT. However, other fiber fractions did not differ significantly by drying SBT by heat or solar method (Table 5).

Regarding the oxalate content, total and soluble oxalate content significantly ($P<0.05$) decreased by both drying methods as compared to FSBT. Bendary *et al*. (1992c) found that the losses (%) of oxalate contents in shade dried sugar beet tops was 1.25% as compared with sun-dried SBT.

Also, gross energy content significantly ($P<0.05$) decreased by both drying methods, being significantly ($P<0.05$) higher in HDSBT than in SDSBT (Table 5).

Overall differences in chemical analysis of SBT as affected by drying was significantly ($P<0.05$) different only for OM, CP, ash, ADF, ADL, total oxalate, soluble oxalate, and gross energy (Table 5).

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Results in (Table 5) show that the higher loss by both drying methods of SBT was found in soluble and ADL followed by total oxalate, CP and gross energy and the lowest for OM and ADF. These differences as loss in OM, CP and gross energy contents were almost higher significantly in SDSBT than in HDSBT.

CONCLUSION

It could be concluded from the results of this study that the Chemical composition of sugar beet tops (fresh or dried), molasses and sugar beet pulp points to high potential nutritive values of rations contained such by-products. However, using it for feeding ruminants may offer a significant reduction in feed cost and decreased the requirements for expensive concentrate mixture, along with minimize the pollution caused by accumulation or burn of such agricultural by-products in the fields.

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تقييم عروش و لب ومولاس بنجر السكر كغذاء للحيوان فى مصر

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أجريت هذه الدراسة بهدف تقدير محصول العروش و محصول الجذور و نسبة محصول العروش: محصول الجذور للفدان لبعض أصناف بنجر السكر حيث استخدمت تسع اصناف هى تيرى , راس بولى , اثوس بولى, سلطان, بلينو , جلوريا, كواميرا, توب, وديما بولى في نوعين مختلفين من التربة(طينية ورملية) وا يضا تأثير طريقة التجفيف على التركيب الكيماوى والتغير فيه لعروش بنجر السكر.

أشارت النتائج الى أن المتوسط العام من محصول جذور بنجر السكر ومحصول عروش بنجرالسكر(طن/فدان و كجم/نبات) ونسبه الجذور الى العروش كانت٢٣,٦٦-١٣,٨٢طن/فدان ٠,٤٩-

٠,٨٥كجم/نبات- ١,٧ على التوالى وكانت التربه الطينيه أعلى من الرملية فى محصول الجذوروم‍حصول العروش.

كانت الفروق فى المحتوىمن الماده الجافه والماده العضويه والالياف الخام والمستخلص الاثيرى والمستخلص الخالى من الازوت والرماد واللجنين الهيموسليليوزوالطاقة الكلية بين الاصناف المختلفة من بنجر السكر غير معنوى يتراوح بين ١١,٨٦-١٣,١٧% و٧٧,٨٠ -٨١,٣٤% و ١٣,٥٧ -١٤,٣٦% و ٠,٩٣-١,٢١% و٤٦,٣٩-٥١,١٣% و١٨,٧٤-٢٢,٢٠% ١,٧٧- ٢,٢٣% و٩,٨-١٣,٩٩% ١٥,٠٤-١٥,٦٢ % على التوالى بينما كانت الفروق معنوية بين الاصناف بالنسبة لمحتواها من البروتين و والالياف المتعادلة والسليلوز .

كان صنف راس بولى الأعلى فى المحتوى من الفسفور والأقل فى المستوى من الماغنسيوم معنوياوصنف الجلوريا الأقل معنوياً فى المحتوى من الصوديوم والحديد كما أعطى صنف سلطان أقل قيمة معنوية للمحتوى من الكالسيوم والمنجنيز. أما صنف بلينو فأعطى أقل محتوى من الفسفور والبوتاسيوم وأعلى محتوى من الزنك.

كان لب بنجر السكر المجفف ومولاس بنجرالسكر أقل محتوى من الأوكسالات الكلية و الذائبة ومن الصوديوم والبوتاسيوم والحديد والنحاس والزنك عن عروش بنجر السكر الخضراء بينما كان مولاس بنجرالسكر أعلى المخلفات فى المحتوى من ا لحديد (٢٠٨,٣ملجم/كجم).

محتوى لب بنجر السكر المجفف ومولاس بنجر السكر من الأحماض الأمينية الضرورية أقل من عروش بنجر السكر والذى كان اقل فى المولاس(٩,١٧ مليجرام/١٠٠جرام).

أثرت طريقة تجفيف عروش بنجر السكر على التركيب الكيماوى معنويا فقط على محتواها من المادة العضوية والبروتين الخام والرماد والالياف المتعادلة واللجنين و الأوكسالات الكلية والذائبة والطاقه الكلية.

كان أعلى فرق عن طريق كل من طريقتى التجفيف لعروش بنجر السكر فى الأوكسالات الذائبة يليها الرماد والبروتين الخام وكان أقل فرق فى المستخلص الخالى من الازوت وغالبا كان هذا الفرق أعلى معنويا فى طريقة التجفيف الشمسى عنه فى طريقة التجفيف الحرارى٠

نستخلص من نتائج هذه الدراسة أن التركيب الكيماوى لعروش بنجر السكر (خضراء او جافة)و ومولاس بنجر السكر و لب بنجرالسكر المجفف يشير الى محتوى عالى من القيمة الغذائية للعلائق التى تحتويها ومع ذلك فان استخدامها فى تغذية المجترات يخفض معنويا تكلفة الغذاء و يقلل الاحتياجات من مخلوط المركزات غالى الثمن كما يخفض الى الحد الادنى التلوث الناتج عن تراكم المخلفات الزراعية فى الحقول.

Table (2): Chemical analysis and fiber fraction (on DM basis) of sugar beet by-products (some varieties of fresh sugar beet tops (FSBT), Dried sugar beet pulp (DSBP) and molasses.

Variety	DM	Chemical analysis (%)						Fiber fraction (%)					GE MJ/Kg DM
		OM	CP	CF	EE	NFE	Ash	NDF	ADF	ADL	Hemi cellulose	Cellulose	
Agricultural by-product(some varieties of FSBT)													
Teri	12.55	77.80	15.84^{CD}	14.36	1.21	46.39	22.20	30.91	18.06^{AB}	2.20	12.85	15.86^{BC}	15.04
Ras poly	11.86	80.31	18.06^{A}	13.90	1.04	47.31	19.69	31.51^{AB}	17.52^{B}	1.94	13.99	15.58^{BC}	15.55
Athos poly	12.33	79.57	16.17^{BC}	14.24	0.97	48.19	20.43	30.66^{ABC}	18.11^{AB}	2.04	12.55	16.07^{ABC}	15.31
Glorius	12.09	79.82	16.38^{BC}	14.08	0.95	48.41	20.18	30.31^{ABC}	17.61^{B}	2.15	12.70	15.46^{C}	15.36
Sultan	12.50	80.11	14.71^{D}	13.57	1.06	50.77	19.89	29.87^{BC}	18.06^{AB}	1.90	11.81	16.16^{ABC}	15.35
Pleno	11.99	81.26	15.09^{CD}	13.91	1.13	51.13	18.74	28.90^{C}	19.10^{A}	2.23	9.80	16.87^{AB}	15.59
Kawemira	12.27	79.01	17.38^{AB}	14.22	1.19	46.22	20.99	32.15^{A}	19.08^{A}	1.77	13.07	17.31^{A}	15.32
Top	11.95	81.34	16.40^{BC}	13.78	0.93	50.23	18.66	31.22^{AB}	17.51^{B}	2.03	13.71	15.48^{C}	15.62
Dema poly	13.17	80.15	16.40^{BC}	14.00	1.05	48.70	19.85	31.70^{AB}	18.15^{AB}	1.97	13.55	16.18^{ABC}	15.44
Overall mean	12.30	79.93	16.27	14.01	1.06	48.59	20.07	30.80	18.13	2.02	12.67	16.11	15.40
Manufactural by-products													
DSBP	90.94	95.32	10.14	21.75	0.88	62.55	4.68	45.38	24.16	1.47	21.22	22.69	17.90
Molasses	77.74	88.69	4.69	0.1	1.13	81.77	11.31	-	-	-	-	-	16.23

A, B,….D Means denoted within the same column with different superscripts are significantly different at $P<0.05$.

Table (3): Some mineral and oxalate contents of sugar beet by-products (some varieties of FSBT, DSBP and molasses).

Variety	Composition of DM										
	Oxalate%		Macro- elements (g/kg)					Micro-elements(mg/kg)			
	Total	Soluble	Ca	P	Na	K	Mg	Fe	Cu	Zn	Mn
Agricultural by-product(some varieties of FSBT)											
Teri	4.81	1.03	7.82^{BC}	3.01^{A}	4.68^{AB}	33.59^{BC}	3.87^{ABC}	122.6^{AB}	22.61	79.31^{A}	28.61^{DEF}
Ras poly	4.73	0.98	7.21^{C}	3.05^{A}	3.91^{C}	32.51^{BC}	3.50^{C}	117.3^{BC}	23.51	68.21^{D}	29.55^{CDEF}
Athos poly	5.06	0.91	8.40^{B}	2.97^{A}	3.84^{C}	33.09^{BC}	3.92^{AB}	132.4^{A}	24.61	75.24^{AB}	30.14^{BCDE}
Glorius	4.86	0.89	6.99^{C}	2.84^{A}	3.15^{D}	34.18^{BC}	3.88^{ABC}	109.5^{C}	27.00	70.15^{CD}	33.20^{AB}
Sultan	5.32	0.92	6.82^{C}	2.61^{AB}	4.37^{BC}	35.67^{B}	3.54^{BC}	118.7^{BC}	21.93	75.90^{AB}	26.43^{F}
Pleno	4.54	0.89	6.95^{C}	1.99^{C}	4.09^{C}	30.96^{C}	3.91^{AB}	121.3^{B}	23.58	80.11^{A}	27.52^{EF}
Kawemira	4.75	0.85	6.88^{C}	3.08^{A}	4.11^{C}	33.61^{BC}	3.61^{ABC}	126.1^{AB}	25.09	67.43^{D}	31.54^{BCD}
Top	4.66	0.91	7.51^{C}	2.23^{BC}	4.96^{A}	35.27^{B}	3.96^{A}	120.3^{B}	26.70	69.59^{CD}	35.02^{A}
Dema poly	4.51	0.90	9.60^{A}	2.15^{BC}	4.90^{A}	39.15^{A}	3.87^{ABC}	119.8^{BC}	26.95	74.01^{BC}	32.71^{ABC}
Overall mean	4.80	0.92	7.57	2.66	4.22	14.22	3.78	120.9	24.66	73.33	30.52
Manufactural by-products											
DSBP	0.31	0.1	6.15	1.30	2.06	4.84	2.98	39.2	10.23	25.21	10.42
Molasses	0.12	0.05	5.97	1.03	3.11	3.08	2.76	208.3	11.65	47.28	25.31

A, B,….D Means denoted within the same column with different superscripts are significantly different at $P<0.05$.

Table (5): Effect of drying method on chemical analysis (%), fiber fraction (%) and oxalate contents of SBT (on DM basis).

Items	Chemical analysis (%)							Fiber fraction (%)					Oxalate%		GE MJ/Kg DM
	DM	OM	CP	CF	EE	NFE	Ash	NDF	ADF	ADL	Hemi cellulose	Cellulose	Total	Soluble	
FSBT	12.41	79.95^{A}	16.74^{A}	13.60^{B}	4.31^{A}	45.35	20.05^{C}	31.35	17.91^{A}	2.10^{A}	13.50	15.81	5.41^{A}	0.99^{A}	16.18^{A}
SDSBT	83.31	76.64^{C}	14.71^{B}	14.21^{A}	2.05^{B}	45.81	23.36^{A}	30.32	17.54^{A}	1.89^{A}	12.74	15.46	4.88^{B}	0.85^{B}	15.00^{C}
HDSBT	88.37	79.09^{B}	16.68^{A}	14.43^{A}	1.89^{B}	46.09	20.91^{B}	29.86	17.03^{B}	1.60^{B}	12.73	15.24	4.56^{B}	0.78^{B}	15.52^{B}
Difference (%):															
SDSBT/ FSBT		-4.13^{A}	-12.13^{A}	4.49	-52.44	1.01	16.51^{A}	-3.29	-2.06^{B}	-10.00^{B}	-5.63	-2.21	-9.80^{B}	-14.14^{-B}	-7.29^{A}
HDSBT/FSBT		-1.06^{B}	-0.30^{B}	6.10	-56.15	1.63	4.24^{B}	-4.75	-4.91^{A}	-23.81^{A}	-5.70	-3.61	-15.71^{A}	$-21..21^{A}$	-4.08^{B}
Overall mean:		-2.61	-6.22	5.30	-54.30	1.32	10.38	-4.02	-3.49	-16.90	-5.67	-2.91	-12.75	-17.68	-5.68

A, B,….D Means denoted within the same column with different superscripts are significantly different at P<0.05.
FSBT:Fresh sugar beet tops, SDSBT:Solar dried sugar beet tops, HDSBT:Heated dried sugar beet tops.

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